PROPAGATION STUDY:

USE OF SHRUBS

FOR

OIL SANDS MINE RECLAMATION

Completed on behalf of the Reclamation Research Technical Advisory Committee and the Oil Sands Environmental Study Group

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TABLE OF CONTENTS

Page

LIST OF TABLES

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1. INTRODUCTION

1.1 Purpose of Study

Techman Engineering Ltd. was jointly commissioned by the Reclamation Research Technical Advisory Committee and the Oil Sands Environmental Study Group to obtain state-of-the-art information on the propagation of selected woody plants. The purpose was:

a) to obtain information on the propagation of certain native and exotic woody plants selected by the client;

b) to present this information in form which both provides a summary of each reference reviewed and synthesizes the information at the species level by method of propagation; and

c) to make recommendations for further studies on selected species.

1.2 Scope of Study

Seed and vegetative propagation methods for selected species were reviewed as follows:

Caragana arborescens Lam.	- seed propagation
Prunus pensylvanica L.f.	- seed propagation
Amelanchier alnifolia Nutt.	- vegetative propagation
Elaeagnus commutata Bernh.	- vegetative propagation
Prunus pensylvanica L.f.	- vegetative propagation
Rosa acicularis/R. woodsii Lindl.	- vegetative propagation
Salix bebbiana Sarg.	- vegetative propagation
Shepherdia canadensis (L.) Nutt.	- vegetative propagation

The propagation characteristics examined included:

a) For seed propagation:

i) identification of type(s) of seed dormancy;

ii) germination pretreatments required to break dormancy;

iii) expected germination success under various pretreatments;

iv) location where seed was collected;

v) germination test conditions; and

vi) other relevant information on seed storage, collection, and handling.

b) For vegetative propagation:

i) type of cutting;

ii) age of cutting;

iii) location of cutting collection;

iv) time of cutting collection;

v) cutting treatments used;

vi) cutting propagation system used;

vii) effective time until rooting; and

viii) expected success for each method.

The sources of information used included, but were not confined to:

i) North American plant literature;

ii) government reports and files;

iii) industrial reports and files;

iv) existing trials and experiments;

v) personal contact with people involved in plant propagation; and

vi) information from a propagation questionnaire.

The species and propagation methodologies selected for review were those for which the existing reviewed information was limited. Reviews exist on the seed propagation of most of the species for which vegetative propagation was investigated (Babb 1959, King 1980, Schopmeyer 1974, Vories 1981).

1.3 Methodology

The review was based on information available from libraries, government reports and files, industry reports and files, existing trials and experiments, computer data bases and published and unpublished scientific reports.

The information from questionnaires sent to plant propagators in 1981 by the Reclamation Research Technical Advisory Committee and the Oil Sands Environmental Study Group were included in the review. Further information was obtained from questionnaire respondents in subsequent contacts. Other researchers studying the candidate species were also approached for information.

The definition of terms used in this report such as those referring to type of cutting, methods of propagation and treatments used are those of the authors and questionnaire respondents. An attempt has been made to standardize the terms using the definitions provided by Hartmann and Kester (1975). However, since the authors' definition of terms are often not available or may be imprecisely defined when they are, the authors' terminology for the most part has been left as reported. Some of the terms used in this report are defined in the Glossary.

In some instances the hormonal treatments reported are commercial preparations given by the trade name of the substance. Table 1 lists the active ingredients and their concentrations for the hormonal treatments mentioned.

TABLE 1

COMMERCIAL HORMONE PREPARATIONS REPORTED

Trade Name		Active Ingredient(s)	Concentration
Hormex	8	IBA	0.8%
	30	IBA	3.0%
Hormodin	#1	IBA	0.1%
	#2	IBA	0.3%
	#3	IBA	0.8%
Rootone	F	Naphthalene acetamide 2-Methyl-1-Naphthalene acetic acid 2-Methyl-1-Naphthalene acetamide Indole-3-butyric acid thiram fungicide	0.067% 0.033% 0.013% 0.057%
	10	As above except hormones (first four items) at double concentration	
Seradix	#1	IBA	0.1%
	#2	IBA	0.3%
	#3	IBA	0.8%
Stim Root	#1	IBA	0.1%
	#2	IBA	0.4%
	#3	IBA	0.8%
Synergol	25%	IBA NAA	1250 ppm 1250 ppm
	50%	IBA NAA	2500 ppm 2500 ppm
Jiffy-Grow		IBA and NAA in alcohol	(no longer available)

IBA Indolebutyric acid
NAA Napthylacetic acid
Thiram tetra methylthiuram disulfide (fungicide)

2. SEED PROPAGATION

2.1 *Caragana arborescens* Lam. - Common Caragana

2.1.1 General Biology

Caragana arborescens, a native of Siberia and Manchuria, is a small deciduous tree with spiny stems. Introduced to the United States in 1752, it now has widespread use throughout Canada's northern plains in windbreaks, shelter belts and garden hedges. Caragana readily adapts to sandy alkaline soil and open unshaded sites. It has had limited use in reclamation for erosion control. It has a moderate growth rate reaching a mature height of three to six metres with a life span of approximately 80 years. Caragana belongs to the legume family and may fix free nitrogen.

Yellow, bisexual flowers appear in May and June. The fruit is reddish-brown at maturity and contains about six oblong to spherical seeds. Fruit ripening occurs in late August and is followed by rapid seed dispersal, which restricts the seed collection period to about two weeks.

2.1.2 Summary of Results

Table 2 summarizes seed propagation methods reviewed.

The seeds were collected when the pod ripened to amber or brown (Dietz and Slabaugh 1974). The pods were dried until they open (Genovese pers. comm.). The extracted seeds were stored dry (Shoemaker and Hargrave 1936, Swingle 1939). Seeds may be stored for up to five years with little loss in viability (Neill 1982).

Although Hartmann and Kester (1975) stated that this species had a water impervious seed coat, a number of authors recommended soaking in tepid water for two to 48 hours. However, other authors (Genovese pers. comm., Neill 1982) stated that while they have used this procedure in the past, it had been not found to significantly improve germination.

TABLE 2

CARAGANA ARBORESCENS

SEED PROPAGATION SUMMARY

Author	Location	Time of Collection	Ripeness Criteria and Seed Handling	Imbibing and Pretreatment	Germination Test Conditions	Germination Success (%)	Comments
Alberta Agriculture 1980	Alberta	August	Not given	Not given	Not given	Not given	Sow seeds in fall
Cram & Vaartaja 1955	Indian Head, Saskatchewan	Not given	Not given	Stratify 15 days in moist sand at 5°C	Flats of finely screened sand in greenhouse	Not given	Various fungicides applied before and after stratification; fungicides applied prior to stratification showed no influence on germination with the exception of Ceresan M; some post-stratification treatments proved detrimental
Dietz & Slabaugh 1974 (Review article)	Not given	July - August	Seeds ready for collection when pod ripens to amber or brown	Stratify in moist sand (5-10% moisture) or perlite for 12-15 days at 5°C or vermiculite for 40 days at 1-5°C	Sand flats, perlite or Jacobsen germinators for 14-60 days; best germination obtained by diurnal alternating temperatures of 20°C and 30°C; lowest germinations at constant 20°C	45 - 100	No improvement in germination obtained with rhizobial innoculation; drill or broadcast seed in late summer or spring; in spring, germination of dry seed has improved if soaked in lukewarm water 10-12 hours
Flemion 1948	New York	Excised embryo method of testing germination compared to conventional methods; excised embryos show 94% germination after two to ten days; conventional methods show 81% germination in 10 to 21 days					Considerable time and care is taken in excising embryos
Genovese pers. comm.	Fort McMurray, Alberta	August	Collect just before pods open; air dry until they open	None (water soak has been used in past)	23°C for 24 hours until germination begins then 23°C day; 18°C night; seed sown into Spencer Lemaire containers	95	Seed kept in cold storage until sown
Lindquist 1960	Indian Head, Saskatchewan	Not given	Not given	Stratify in sand for 15 days at 5°C (% moisture content):	Seed moisture content after 25 days:		Maximum germination obtained when seed stratified in sand at 5-10% moisture content
				Ottawa sand 5	53.4%	87.5	
				Ottawa sand 10	53.8%	86.5	
				Local sand 10	54.8%	85.5	
				Ottawa sand 20	56.7%	52.0	
				Ottawa sand 25	58.0%	25.0	

TABLE 2 (continued)

CARAGANA ARBORESCENS

SEED PROPAGATION SUMMARY

Author	Location	Time of Collection	Ripeness Criteria and Seed Handling	Imbibing and Pretreatment	Germination Test Conditions	Germination Success (%)	Comments
Neill 1982 pers. comm.	Indian Head, Saskatchewan	Fall	Cleaned seed can be stored dry for up to five years; seeds less than 2.5 mm diameter should be culled	Stratify for 12-15 days at 5°C in moist sand (10% moisture content)	Field sown in June	High	Cold storage of seed over winter at 0°C; sow seed at a rate of 0.02 kg/ha at 1.4 cm deep in moist conditions and 2.5 cm deep in dry conditions; field sprayed with Chloroxuron at 5.6 kg/ha then irrigated; bare root stock lifted in second year
Sheat 1948 (Review article)	Not given	Fall	No ripeness criteria given; store overwinter in a dry place	Soak in tepid water two to three hours	Watered, compost-filled pans in a warm seed house	Good	Does not state temperature of winter storage
Shoemaker & Hargrave 1936	Edmonton	Late summer	Seed stored dry	Soak seeds for 48 hours before spring sowing; sow dry in fall	Sown directly in field.	Not given	Without soaking before spring sowing seed may remain dormant
Swingle 1939 (Review article)	Various	June - August	Seed stored dry	Water soak or no treatment	Fall or spring seed	60 - 93	
SEAM Undated	Utah	Not given	Not given	Soak in water at 29°C for 24 24 hours followed by stratification in moist vermiculite at 5°C for 60 - 90 days	Hillson Root-trainers or Ray Leach Super Cells; peat: vermiculite (1:1) medium; temperature constant at 19°C; artificial light in winter; mist twice/day, after germination once/day; water soluble 20:20:20 fertilization	80 - 100	Some seeds began to germinate after 53 days in stratification

Several of the references suggested a cold stratification pregermination treatment which ranged from 12 to 90 days with a median of 15 days. However, Neill (1982) stated that stratification is impractical for large-scale nursery operations and presently at the Indian Head tree nursery non-stratified seed is field sown in June. Lindquist (1960) has shown that optimum germination occurred if the moisture content of the sand stratification medium was kept between five and ten percent and that germination declined considerably at higher moisture contents.

2.1.3 Interpretation of Results

Caragana possesses an embryo-imposed dormancy mechanism. Consequently, germination can be enhanced by stratifying the seed for 12 to 15 days at 5°C in moist sand or perlite (Neill 1982). The moisture content of the stratifying material should be five to ten percent. However, cold storage (at 0°C) of the seed over winter and sowing in spring (Genovese 1982, Neill 1982) or fall sowing have proven satisfactory (Dietz and Slabaugh 1979, Shoemaker and Hargrave 1936).

It appears that if the cold requirements are met, there is no difficulty in obtaining high germination levels. If the seed has been cold-stored, moist seedbed conditions are required for high germination levels (Dietz and Slabaugh 1974, Neill 1982, Shoemaker and Hargrave 1936).

2.1.4 Recommendations

No further work is required for the successful propagation of this species. The type of cold treatment selected by the nurseryman depends upon the requirements of his operation. If stratification is used, the moisture content of the medium should be kept below 10 percent. Soaking in tepid water may be required prior to cold stratification.

If the seed is to be field sown, soaking in tepid water may be required if the soil is particularly dry. This applies to both fall and spring sowings.

2.2 *Prunus pensylvanica* L.f. - Pin Cherry

2.2.1 General Biology

Pin cherry occurs from Newfoundland to British Columbia and southward to North Carolina and eastern Tennessee (Fulton 1974). It is a shade-intolerant pioneer species which often invades roadsides and old fields. Soils may range from infertile sand to rich loam. Best growth is obtained on slightly acid soils with a pH between 5.0 and 6.0. Pin cherry is an important species for wildlife browse.

Pin cherry flowers from early April to early June. The fruit is a sour, thinskinned, red drupe which ripens from July to September but may persist on trees until October or later.

2.2.2 Summary of Results

Table 3 summarizes the review of the propagation of pin cherry from seed.

The time of fruit collection ranged from July until early September with August being the median period. All authors agreed that the fruit should be picked when the berries are soft and with a light red to red colour. Two researchers maintained the fruit at a cool temperature from the time of picking (Fedkenheuer and Heacock 1980, Genovese 1981) but Neill (1982) suggested a two-week fruit storage period at 20°C before the pulp is removed. Fedkenheuer and Heacock (1980) soaked the fruit for four days prior to extraction.

TABLE 3

PRUNUS PENSYLVANICA

SEED PROPAGATION SUMMARY

Author	Location	Time of Collection	Ripeness Criteria And Seed Handling	Imbibing and Pretreatment	Germination Test Conditions	Germination Success (%)	Comments
Alberta Agriculture 1980	Alberta	Early September	Not given	5 months of stratification in peat	temperatures of 25°C day and 10°C night	Not given	60 days required for germination
Auchmoody 1979	Pennsylvania			Control (no nitrogen fertilizers applied)	Field conditions	No Seedlings	Experiment was an in situ treatment of existing seed on forest floor; estimated 0.25 to 4.3 million seeds/ha. nitrate was responsible agent for breaking seed dormancy; density estimates based on 1.5 m^2 field plots replicated three times
				Nitrogen ferilizers applied in early November	Field conditions	Up to 67,000 seedlings/ha	
Babb 1959	Alaska	Not given	Not given	Stratify for 150 days at 25°C then 90 days at 5°C	Not given	Not given	-
Barton 1939	Boyce Thompson Institute, New York	Not given	Not given	Concentrated sulphuric acid scarification; best germination obtained by stratifying at 10°C for 60-90 days in moist granulated peat moss (effective temperature range 1-10°C)	Greenhouse flats	Not given	
Fedkenheuer and Heacock 1980; Genovese 1982 pers. comm.	Fort McMurray, Alberta;	August 24	Collect fruit when red; store in fridge ASAP; pulp removed after fruit soaked for 4 days	Stratify at 3°C for 235 days	Greenhouse	0	Sown in Spencer-Lemaire containers
		August 17	As above	As above	Germinator[1]	2.7	
		September 12	As above	No stratification	Greenhouse	0	Sown in Spencer-Lemaire (Hillson) containers

(continued)

Quest. - questionnaire respondent

[1] The germinator was kept at a relative humidity of 50 to 60 percent and the trays were moistened daily. The temperature was set at 25°C for the

TABLE 3 (continued)

PRUNUS PENSYLVANICA

SEED PROPAGATION SUMMARY

Author	Location	Time of Collection	Ripeness Criteria And Seed Handling	Imbibing and Pretreatment	Germination Test Conditions	Germination Success (%)	Comments
Fulton 1974 (Review article)	U.S.A.	Late summer	Pulp is removed; can be sown in fall or cold stratified over winter	Soak in water; scarification not necessary; if held overwinter stratify in moist sand for 60 days at 20-30°C then 90 days at 5°C	Greenhouse flats	Not given	Seed available commercially; seeds have remained viable stored for 10 years in sealed containers at 1-3°C
Grainger Provincial Tree Nursery 1981; Quest., 1982 pers. comm.	Edmonton, Alberta	August	Fruit is light red when ripe; store in fridge ASAP	Scarify for 15 minutes in H_2SO_4 then cold stratification for 4 months at 4°C in peat	Nine weeks in greenhouse;	28	
				Stratify for 5.5-6 months in wet moss at 4-5 °C	Greenhouse flats; germination time 14 days	<60	
Grisez 1974 (Review article)	U.S.A.	Not given	Fruit is light red when ripe; hammermill fruit at low speed into water and screen seed from pulp	Stratify for 60 days at 20°C then 90 days at 3 to 5°C	Germination at 25°C day/10°C night temperature for 60 days	62	Seeds have embryonic dormancy and require a period of after-ripening in the presence of moisture and oxygen; endocarp may offer some resistance to germination but is permeable to water; species is not hard seeded; scarification methods often harmful
Hargrave 1937	Brooks, Alberta	Mid Augsut	After ripened in refrigerator at 1.5 - 3°C	Stratify at 1.5 to 3°C for up to 9 months	Seeds placed in Petri dishes between layers of cheese cloth in granulated peat; mold cleared periodically	0	Some seeds planted monthly and germination recorded; all results are after 9 months; after 9 months, the embryos of all seeds were still in good condition
			Stored dry until mid November (3 months) then after-ripened in fridge	Stratify at 1.5 to 3°C for up to 8 months	As above	34	
			After-ripened in root-cellar	Root cellar at 2 to 4°C for up to 9 months	As above	0	
			Dry storage	None		0	

(continued)

Quest. - questionnaire respondent

TABLE 3 (continued)

PRUNUS PENSYLVANICA

SEED PROPAGATION SUMMARY

Author	Location	Time of Collection	Ripeness Criteria And Seed Handling	Imbibing and Pretreatment	Germination Test Conditions	Germination Success (%)	Comments
Hilton *et al.* 1965	Northern Ontario	Not given	Not given	Control, stratify at 2°C for 120 days	Incubation at 20°C; fungal control - 30 minutes in 1000 ppm $HgCl_2$	8	Trials are means of 4 replicates with 20 seeds each; hypothesizes coat dormancy and suggests longer stratification or longer acid treatment
				Treatments, scarification by: Concentrated H_2SO_4 (20 minutes)	As above	6	
				Saturated NaOH (20 minutes)	As above	2	
				Mechanical abrasion	As above	2	
McTavish 1982 pers. comm. 1981 Quest.	Fort McMurray, Alberta	As ripe as possible	Seed extracted by maceration after two weeks of fruit storage at room temperature	Cold storage overwinter preceded by: 50 minutes acid scarification	Paper pot greenhouse	20	
				90 minutes acid scarification	As above	30	
Mahadeva 1981 Quest.	Alberta Horticultural Research Centre, Brooks, Alberta	July or August	Considered ripe when fruits soft and red; seeds cleaned and dried	Cold stratify August to May (9 months)	Seeded into nursery flats	Fair to good	Seedlings emerge in two to three weeks
Neill 1982 pers. comm. 1981 Quest.	Indian Head, Saskatchewan	July - August	Considered ripe when most fruit red and soft; two weeks of fruit storage at 20°C; then fruit macerated in water and pulp floated off; seed dried and sealed in polyethylene bags	Stratify for two months at -2°C	Sown in field September - October	Not adequate for commercial production	Susceptible to leaf spot disease
Shoemaker and Hargrave 1936	Edmonton, Alberta	Early fall	Store moist or dry at 1°C	Stratify at 1° to 10°C for 90 to 150 days	Not given	Not given	Sow in fall or stratify seed for spring sowing

Quest. - questionnaire respondent

Several methods of extracting the seed were suggested. Neill (1982) and Fedkenheuer and Heacock (1980) suggested macerating the berries in water and then floating off the pulp. The Woody Plant Seed Manual (Schopmeyer *et al.* 1974) suggested using a hammermill set a low speed with the pulp being floated off with water or screened out.

A number of authors stored the seeds before use. Fedkenheuer and Heacock (1980) suggested storage in a refrigerator. Hargrave (1937) stored the seeds dry at an unspecified temperature, while Shoemaker and Hargrave (1936) suggested either dry or moist storage at 1°C. Fulton (1974) stated that seeds have remained viable for 10 years when stored at 2-4°C in sealed containers.

Cherry seeds have embryonic dormancy (Grisez 1974) and require a period of stratification in the presence of moisture and oxygen to overcome it. Because of the stony endocarp, the seeds have often been thought to have seedcoat dormancy (Grainger 1982, Hilton *et al.* 1965). However the Woody Plant Seed Manual (Grisez 1974) stated that the cherries are not truly hardseeded although the endocarp may offer some mechanical resistance to germination. Authors who have envisioned the existence of an impermeable seed coat have attempted a number of mechanical and chemical scarification methods which have been of little benefit or have proven detrimental (Grisez *et al.* 1974, Hilton *et al.* 1965).

Pin cherry seeds may require a long cold stratification period, although this treatment is no guarantee of success. Cold stratification durations ranged from 60 days (Barton 1939) to as long as nine months (Fedkenheuer and Heacock 1980, Hargrave 1937). Temperatures used were from 1°C (Shoemaker and Hargrave 1936) to 10°C (Barton 1939) with 3°C being the median.

Since a long period of cold stratification does not ensure a high level of germination some authors have concluded that it alone is not a sufficient treatment. Others have suggested a warm stratification prior to the cold treatment (Fulton 1974, Grisez 1974, Hargrave 1937). The latter sources recommended 60 days of warm stratification at 20 to 30°C followed by 90 days cold stratification at 3 to 5°C. Hargrave (1937) used a three month warm, dry storage followed by six months of cold stratification at 1.5°C. The results from these methods appear to be somewhat more successful than simple cold stratification but still do not appear to provide a final answer.

Germination success with pin cherry seeds ranged from 0 to the 62 percent summarized by Grisez (1974). However, many authors reported no success or limited success. Hall (1982) followed the methods reported by Grisez and obtained similar results.

An interesting and potentially significant piece of work was undertaken by Auchmoody (1979) in Pennsylvania. He estimated that the hardwood forest floor in northwestern Pennsylvania contained up to 4.5 million viable pin cherry seeds per hectare. These seeds may remain viable for up to 30 years (Marquis 1975). Auchmoody (1979) tried various treatments and found that the application of nitrogen fertilizer, particularly in the form of nitrate, stimulated the production of up to 675,000 seedlings per hectare. Germination did not occur until the year after fertilization so it appears a period of natural stratification is also required to break dormancy. This may consist of a warm or cold stratification or some combination of these.

2.2.3 Interpretation of Results

A number of conclusions can be drawn from the data assembled.

a) The time of fruit collection and their ripeness criteria appears fairly fixed and, therefore, this has not been considered a major influence in the success achieved. However, the drupes persist on the shrubs for a considerable period (Fulton 1974) and delayed collection may provide a required extended ripening period.

b) Scarification of seeds whether by acid, sodium hydroxide, mechanical abrasion or most other usual forms did not result in higher germination (Grisez 1974, Hilton *et al.* 1965, McTavish 1981). This suggests that a seed coat impermeability is not present.

c) Cold stratification has had mixed success. There does not appear to be an increase in germination with the length of stratification. However, Hargrave (1937) tried monthly germination tests following four to nine months of stratification at 1.5°C. No germination was obtained before six months. After that the percentage germination slowly rose until 34 percent was obtained after nine months. However, only those seeds which had had an initial three-month period of warm, dry storage showed any germination. The relative lack of success using cold stratification suggests other factors are also involved and that additional treatments may also be required.

d) There does not appear to be a relationship between the success of the stratification treatment and the type of stratifying medium.

e) Warm temperature treatment followed by a cold stratification shows promise (Fulton 1974, Hargrave 1937, Schopmeyer *et al.* 1974) but needs more investigation.

f) The use of a nitrate-nitrogen fertilizer (Auchmoody 1979) treatment in breaking dormancy is intriguing and deserves more investigation. Seed lying on the forest floor is subject to a wide variety of environmental conditions and a number of these have been postulated as being instrumental in breaking dormancy. The use of nitrogen fertilizer appears to create a condition which mimics the prerequisite conditions required to break dormancy.

2.2.4 Recommendations

The requirements to break the dormancy of pin cherry are still unknown and basic research is required in all areas of seed handling, pretreatment and germination conditions.

a) The ripeness criteria of the berries and the treatment following picking (extended ripening and soaking) require further investigation.

b) The use of a nitrate treatment prior to or in combination with stratification should be tested.

c) Different stratifying regimes should be tested. These might include:

   i) the use of wet stratification vs. dry storage;

   ii) cold stratification at various temperatures and for differing times. The literature mentions a temperature range from 1 to 10°C and stratification time up to nine months as being used;

   iii) the use of a warm storage period prior to cold stratification should be tried using various durations and temperatures; and various stratifying media should be tried.

d) Different germination test conditions could be tried. They include:

   i) various temperatures (constant or diurnally fluctuating);

   ii) various light and day length regimes;

   iii) variations in gas exchange controlled by using differing germination media;

   iv) various moisture contents of seed and stratification media; and

   v) the duration of germination test. Pin cherry seems to require an especially long germination period.

3. VEGETATIVE PROPAGATION

3.1 *Amelanchier alnifolia* - Saskatoon

3.1.1 General Biology

Saskatoon is a shrub or small tree, one-to-six metres high which often spreads by stolons and forms colonies (Moss 1977). The blue-purple fruit is edible and the shrub is a highly desirable browse species for ungulates. It is native from the southern Yukon and Northwest Territories to Newfoundland. It is a common species of open woodlands in Alberta. *Amelanchier alnifolia* is recommended for planting on coarse textured soils. It thrives on moist to fairly dry sites from the plains to the subalpine region (Watson *et al.* 1980).

3.1.2 Summary of Results

A total of sixteen sources were reviewed which gave detailed methodologies and results for the vegetative propagation of saskatoon. Methods include propagation using roots and root suckers, hardwood, softwood, semi-hardwood stem cuttings and leaf bud cuttings (Table 4).

Root Cuttings. Six sources discussed the propagation of *Amelanchier* by root cuttings and attained success ranging from 30 to 91 percent. The cuttings were taken in early spring (April - May). Cuttings were five to 10 mm in diameter, 10 to 20 cm long and planted with the distal end uppermost. Generally, no treatment was given although Davidson (1981) treated with Seradix 1. Rooting media included various mixtures of vermiculite, perlite, sand and peat. Mist was used in about one-half of the citations. A comparative study by Harris (1976) indicated that the use of mist did not improve rooting. Only Harris (1976) mentioned using bottom heat, the other sources either stated it was not used or did not mention its use. Cuttings were rooted in greenhouse flats and transplanted after rooting.

Cumming (1976) had excellent success using etiolated root cuttings. Five centimetres long root cuttings were stored at 4°C for two months and then wrapped in peat moss and stored in the dark at 21°C for two to four weeks. When shoots formed they were removed to a light soil in the greenhouse.

McConkey (1979) mentioned the use of suckers or root sprouts for propagation. The sprouts were dug retaining as many fine roots as possible. The stems were cut off five centimetres above the roots and nursery planted. No success rate was given.

Leafbud Cuttings. Harris (1961) collected *Amelanchier alnifolia* leafbud cuttings every two weeks from the end of May until the middle of August. The cuttings were placed either in a glass-covered cold frame and watered or placed in an uncovered polyethylene mist propagating frame. Bottom heat

TABLE 4

AMELANCHIER ALNIFOLIA

VEGETATIVE PROPAGATION SUMMARY

Author	Location	Type of Cutting	Time of Collection	Treatment	Propagation Method	Rooting Time	Success Rate (%)	Comments
Alberta Horticultural Research Center 1977	Brooks, Alberta	Softwood	May 17	Not given	Sharp sand:peatmoss (1:1) medium; mist	Not given	37	Highest rooting success obtained when cuttings were taken prior to May 24
			May 24	As above	As above	As above	38	
			May 31	As above	As above	As above	24	
			June 7	As above	As above	As above	24	
			June 14	As above	As above	As above	22	
			June 21	As above	As above	As above	18	
Bishop and Nelson 1980, 1976 Bishop 1979	Saskatoon, Saskatchewan	Mainly semi-hardwood	June 26	None	Bed covered with 6 mil-polyethylene; sharp coarse sand: sphagnum peat (3:1) medium	Not given	85	Smoky and Pembina cultivars used in trial; these results refer only to the methods having the highest overall success; polyethylene covered frame did better than bottom heat or no bottom heat treatments
				0.3% IBA in talc	As above	As above	95	
				0.3% IBA in talc	As above	As above	75	
Casement 1982 pers. comm.		Softwood	As early as possible	Seradix No. 1	Granite medium; bottom heat; mist	Not given	38	
Coffin *et al.* 1976	McDonald College, Quebec	Callus culture from 1 year old hardwood	July	3% sucrose and nutrient solution	Peel outer bark; sterilize in ethanol solution; propagate under fluorescent light (3000 lux) in growth room at 27-29°C	Five weeks	Very vigorous	
				3% sorbitol and nutrient solution	As above	As above	Poor	

(continued)

Quest. - questionnaire respondent

TABLE 4 (continued)

AMELANCHIER ALNIFOLIA

VEGETATIVE PROPAGATION SUMMARY

Author	Location	Type of Cutting	Time of Collection	Treatment	Propagation Method	Rooting Time	Success Rate (%)	Comments
Cumming 1976	Morden, Manitoba	Etiolated cuttings from root pieces; 5 cm lengths	When dormant	Stored at 4°C for two months in moss	Cuttings bagged in peat moss and stored in dark at 21°C for 2 to 4 weeks; when shoots form, remove roots to flats of light soil in greenhouse	Two weeks	Excellent	Plants are produced as sprouts on root pieces
			Spring; softwood	As above	As above, when shoots form move to root bed	As above	As above	
			Summer; softwood	Not given	As above, when shoots form move to outdoor mist frame	-	12 - 36	Cuttings must be harvested when tissues are succulent; further investigation of this factor is needed
Davidson 1981 Quest.	Sparwood, B.C.	Root cuttings and root suckers	Early to mid May	Seradix 1	Vermiculite:perlite (1:1) medium; intermittent mist	Not given	76	
Doran 1957 (Review article)	Russia	Softwood	Summer	IAA 50 mg/l for 24 hours	Not given	Not given	25	Success not as high without IAA.
Everett *et al.* 1978	Nevada	Semi-hardwood	During seeding stage	Cuttings wounded then 0.8% IBA in talc	Cuttings kept moist; intermittent mist; coarse perlite medium; no bottom heat; fungicide captan 50 WP applied to mist bench	-	0	No success after four weeks
Fedkenheuer & Heacock 1980 Fedkenheuer 1982 pers. comm.	Fort McMurray, Alberta	Softwood	May-June	Seradix 2	Moss:perlite (1:1) medium; collect with leaves attached; bottom heat; mist; 70% RH	Not given	0-8	Success too low for feasible cutting propagation; stored outside in moist peat moss until ready for spring planting
		Hardwood; 8-10 cm long, 0.3-4 cm diameter	September-April	Rootone F	As above excepting that cuttings were leafless	As above	0	

(continued)

Quest. - questionnaire respondent

TABLE 4 (continued)

AMELANCHIER ALNIFOLIA

VEGETATIVE PROPAGATION SUMMARY

Author	Location	Type of Cutting	Time of Collection	Treatment	Propagation Method	Rooting Time	Success Rate (%)	Comments
Fung 1982 pers. comm.	Fort McMurray, Alberta	Hardwood	March	Control	Peat moss:vermiculite (1:1) medium in Spencer-Lemaire containers; no bottom heat; no mist	Three months	0	Frozen until June; partially rotted when planted
				Hormex 0.8%	As above	As above	0	
				Hormex 3%	As above	As above	0	
		Semi-hardwood; distal half	June (last week)	Control	Peat moss:vermiculite (1:1) medium in Spencer-Lemaire containers (Hillson); no bottom heat; no mist	As above	0	Cuttings planted immediately after collection
				Hormex 0.8%	As above	As above	0	
				Hormex 3%	As above	As above	0	
		Semi-hardwood; proximal half	June (last week)	Control	As above	As above	1.6	
				Hormex 0.8%	As above	As above	1.6	
				Hormex 3%	As above	As above	3.9	
Grainger 1981 Quest., 1982 pers. comm.	Northern Alberta	Softwood	Fall	Seradix 1	Peat:vermiculite:perlite medium; 25°C, bottom heat; mist 22 seconds every two hours	Not given	50	
		Hardwood	Fall, spring	Concentrated IBA then water	As above	As above	0	
				Concentrated IBA then alcohol	As above	As above	0	
				Seradix 3	As above	As above	0	
		Root	April	None	Peat:vermiculite:perlite medium; no mist; no bottom heat	As above	30	

(continued)

Quest. - questionnaire respondent

TABLE 4 (continued)

AMELANCHIER ALNIFOLIA

VEGETATIVE PROPAGATION SUMMARY

Author	Location	Type of Cutting	Time of Collection	Treatment	Propagation Method	Rooting Time	Success Rate (%)	Comments
Grotefend 1976	Spokane area, Washington	Hardwood	April	Hormodin 2	Sand medium; sweatbox; mist	30 weeks	3.3	Low success after 30 weeks attributed to high uncontrolled temperature in sweatbox
			November	Rootone 10	Sand medium; sweatbox; mist; 18°C	-	0	
		Hardwood; breaking dormancy	April	Hormodin 2	As above	-	0	
		Softwood	August	Hormodin 2	Sand medium; sweatbox; mist; 15°C	-	0	
		Semi-hardwood	September	Hormodin 1	As above	-	0	
Harris 1961 1976, Quest. 1981	Beaverlodge, Alberta Var. Smoky	Hardwood	Mid-October to February (collection at monthly intervals)	Not given	Stored in sealed polyethylene bags at 0°C till February; propagation bed; bottom heat 20-21°C; mist; sand:peat (2:1) medium	-	0	Some callusing was observed
			February - April (collections at intervals)	Not given	Propagation bed; bottom heat (20-21°C); mist; sand:peat (2:1) medium	-	0	
		Root; 10 mm diameter	Every two weeks May to mid-August	Nil	As above	Not given	91.6	
					Propagation bed; bottom heat (20-21°C); peat (2:1) medium; no mist	As above	90.4	
		Softwood; 8-15 cm diameter	June 10 and 15 gave optimum results	Hormodin 1	Bottom heat (20-21°C); mist; sand:peat (2:1) medium; use new growth; 15 cm cuttings	As above	42-87	Good rooting of softwood cuttings is dependent on correct stage of development and maintaining a moist atmosphere until rooting occurs

(continued)

Quest. - questionnaire respondent

TABLE 4 (continued)

AMELANCHIER ALNIFOLIA

VEGETATIVE PROPAGATION SUMMARY

Author	Location	Type of Cutting	Time of Collection	Treatment	Propagation Method	Rooting Time	Success Rate (%)	Comments
Harris 1961, 1976, 1981 Quest. (continued)		Leafbud	June 10 to 26 (most successful period)	Not given	Mist; bottom heat (20-21°C)	Not given	13.3	
		Apical bud	All seasons	6 Benzl - amino purine 2-3 mg/l	in vitro	As above	Variable	High rate of root and shoot production
Hartman and Kester 1968	Not given	Softwood		IBA 0.3% in talc	Readily propagated when new growth is several cm long; mist	Not given	Not given	
McConkey 1979 (Review Article)	Not given	Suckers or root sprout	Early spring	None	Remove root sprouts with as many fine roots as possible and cut tops 5 cm above the roots	Not given	Not given	
		Root	Early as possible	None	10-20 cm x 5 mm; keep proximal end of root up and 5 mm below surface; shade; mist	As above	As above	
McTavish 1981 Quest., 1982 pers. comm.	Fort McMurray, Alberta	Hardwood	End of October	Seradix 3	Sand:peat:perlite (3:1:1) medium; bottom heat; 22°C; no mist	1 season	about 80	Cold storage over winter; grown in green-house flats first summer
Mahadeva 1981 Quest.	Brooks, Alberta Brooks	Root	Early May	None	Peat:sand:vermiculite (1:1:1) medium	Not given	50-60	Success achieved on some cultivar selec-tions only
		Softwood	September; cuttings from container grown seedlings	Seradix 1	Peat:vermiculite medium; bottom heat; mist	As above	80	Cuttings have good ini-tial success, then go dormant
			June	Seradix 1	Peat:vermiculite medium; bottom heat; mist	As above	5	Alta Glow cultivar
			June	Seradix 1	Peat:vermiculite medium; bottom heat; mist	As above	5	Jumping Pound cultivar

(continued)

Quest. - questionnaire respondent

TABLE 4 (continued)

AMELANCHIER ALNIFOLIA

VEGETATIVE PROPAGATION SUMMARY

Author	Location	Type of Cutting	Time of Collection	Treatment	Propagation Method	Rooting Time	Success Rate (%)	Comments
Mahadeva 1981 Quest. (continued)		Hardwood	April	Seradix 3	Peat:vermiculite medium; bottom heat; mist	Not given	0	
Ure 1937	Edmonton, Alberta	Softwood	Mid-June	None	Basal cut below node; 15-21°C; bottom heat; mist; place in water immediately after cutting	As above	0	No rooting after ten weeks
		Semi-hardwood	Mid-July		As above	-	0	

Quest. - questionnaire respondent

at 20-21°C was applied in both cases. Maximum rooting was obtained in the polyethylene mist propagating frame where 13.3 percent of the leafbud cuttings rooted when taken between June 10 and 26. The rooting of leafbud cuttings declined considerably when taken at later dates.

Hardwood Cuttings. Eight sources reported on trials using hardwood cuttings. Good results were obtained by McTavish (1982) and Coffin (1976). Poor success was obtained by Fung (1982) and the remainder had no success (Table 4). The cuttings were taken throughout the dormant period from September through April. Treatments included controls (no treatment), Seradix 1, Seradix 3, IBA, Rootone F, Hormodin 2, Hormex 0.8 percent, and Hormex 3.0 percent. Winter cuttings were stored at 1°C until spring (Fung pers. comm., Harris 1976, McTavish pers. comm.) while early-spring cuttings were planted directly into propagation beds. Bottom heat, intermittent mist and a sweatbox were variously used.

The low success (3.3 percent) reported by Grotefend (1976) was attributed to high, uncontrolled temperatures in a sweatbox. McTavish (1982) reported a success rate of about 80 percent and stated he has no difficulty in propagating *Amelanchier* from hardwood cuttings. Fung (1982) partially attributed his failure to rotting of the cuttings while in cold storage.

Coffin (1976) propagated *Amelanchier alnifolia* using callus culture from one year old hardwood cuttings. Stem cuttings were surface sterilized by 95 percent ethanol, flaming and removal of the outer bark. Callus cultures were initiated from internodal explants (tissue) one to two centimetres long on a standard nutrient solution with three percent sucrose or three percent sorbitol as the carbon source. Very vigorous rooting was noted on the sucrose treated cuttings after five weeks.

Semi-hardwood Cuttings. Two of the reported trials attempted to root semi-hardwood cuttings collected in September (Everett *et al.* 1978, Grotefend 1976) while another used cuttings taken in June (Fung 1982). All used similar hormone treatments and rooting media. Grotefend had no success. Fung had 1.6 to 3.9 percent success using the proximal portion of a divided cutting but no success with the distal half. Everett *et al.* (1978) had no success using 0.8 percent IBA and placing the cuttings in a mist bench for four weeks.

Softwood Cuttings. Propagation of *Amelanchier alnifolia* by softwood cutting was reported by 11 authors. Results ranged from 0 to 95 percent rooting success. Cuttings were taken at various times from early spring until late fall. Treatments included controls, Seradix 1, Seradix 2, IAA, IBA 0.3 percent, Hormodin 2 and cold storage.

Propagation methods included bottom heat, mist or no mist. Rooting was in polyethylene beds, greenhouse flats and a sweatbox. Rooting media included sand, perlite, moss and vermiculite and combinations of these.

3.1.3 Interpretation of Results

Root Cuttings. Root cuttings and root suckers appear to root readily but are difficult to obtain in sufficient quantity and their removal frequently damages the parent plant (Harris 1976). These difficulties have led to continued searches for a method of propagation by stem cuttings.

Leafbud Cuttings. This method shows potential; however, the restricted period of collection (mid-June) tends to make the use of this method impractical for large-scale propagation.

Hardwood Cuttings. Apart from isolated successes, *Amelanchier* hardwood cuttings have proven almost impossible to root. Various hormone treatments, cold treatments, vacuum treatment, rooting media and the use or absence of mist or bottom heat have been of no avail. Hardwood cuttings have been taken at all seasons with equally poor success.

Callus culture in a three percent sucrose and nutrient solution is the only bright spot in this propagation method. However, Coffin *et al.* (1976) are the only ones who have reported this method and it certainly requires further work.

Semi-hardwood Cuttings. Bishop and Nelson (1980) attributed their success (75-95 percent) in rooting semi-hardwood cuttings to the use of a polyethylene tent. Other authors have had limited success. Variations in time of cutting, in the hormone treatment used and propagation methods have produced few changes in the results obtained.

Softwood Cuttings. Propagation by softwood cuttings shows the greatest feasibility for *Amelanchier alnifolia* but the reported results are extremely variable. For large-scale propagation, a method needs to be developed which will ensure a uniformly high level of success. Using Smoky and Pembina cutivars, Bishop (1979) determined which factors affect rooting success. These factors are discussed below (Bishop 1979 unless otherwise cited).

a) The use of various IBA levels did not affect the cutting rooting success. This finding is not in agreement with that of Harris (1961) who found a significant increase in the rooting of IBA-treated cuttings over the controls.
b) The use of a larger cutting size (13 cm versus a 9 cm length) tended to result in better rooting although the differences in results were not statistically significant.
c) The use of nodal cuttings significantly increased rooting percentage over non-nodal cuttings.
d) The use of a heavy wound significantly increased rooting.
e) The use of material collected in Saskatoon, Saskatchewan at a later collection date (26 June) resulted in significantly higher rooting percentages and root production than material collected earlier in the spring. This generally agrees with the results of the Alberta

Horticultural Research Center (1977) in which there were successive drops in root production on cuttings taken after mid-June. Questionnaire respondents Mahadeva (Brooks) and Grainger (Alberta Provincial Tree Nursery, Oliver) had good to moderate success with later cuttings. Cumming (1976) at Morden, Manitoba, took cuttings in summer and had a 12 to 36 percent success rate.

f) Bishop (1979) found that the use of intermittent mist with bottom heat resulted in significantly better rooting than intermittent mist without bottom heat. However, Harris (1961) found that the use of mist did not affect rooting, with optimal root development occurring on both heated and unheated beds. However, although not a guarantee of success, most authors who reported a high rate of rooting success used either mist, bottom heat or both.

g) Bishop (1979) found that while a high percentage of rooting was often attained, the actual root development tended to be weak. The generally poor root development suggests low transplant survivability.

The problems of rooting of *Amelanchier* softwood cuttings are not solved and the results to date have often been contradictory. A number of factors which may account for this are listed below.

a) The age or condition of the shoots may be more critical than the time of year at which they are taken. There is considerable evidence that the nutrition of the stock plant exerts a strong influence on the development of root and shoot cuttings taken (Hartman and Kester 1975).

b) The age of the parent plant may be important. The ability of many plants to form roots from cuttings often decreases with an increase in age of the plant.

c) Meteorological conditions during the year in which the cuttings were taken may affect cutting physiology and hence rooting ability.

d) Variation in rooting ability may be due to clonal and varietal differences.

3.1.4 Recommendations

Root Cuttings. Small-scale production of plants by this method appears feasible. Large scale production may be impractical due to excessive damage to the parent plant and the labour involved.

Leafbud Cuttings. A short budding period may affect the potential for large-scale propagation by this method. Due to the limited study done to date, further work is required to better define the parameters under which leafbud cuttings can be used.

Hardwood Cuttings. To date, propagation of *Amelanchier* by hardwood cuttings has met with only isolated success under a wide variety of treatments and conditions. Further work does not seem warranted at this time. However, the use of callus culture may offer potential (Coffin *et al.* 1976).

Semi-hardwood Cuttings. No further work is warranted on these cuttings due to the universal lack of success.

Softwood Cuttings. Softwood cuttings appear to offer the greatest potential for use in large-scale propagation. However, to ensure a uniformly high success rate in rooting some fundamental research is required. Such research should include the conditions listed below.

a) Various cultivars and wild clones should be tested with those showing promise being selected for future propagation.

b) Careful attention should be paid to the condition of shoots when collected for rooting. Only non-hardened young healthy shoots should be selected. In experiments to determine the optimum condition and age of shoots for propagation, comparisons should be made only between cuttings from the same plant or clone.

c) Propagation trials should be repeated over several seasons to account for the effect of climatic variables on the parent stock.

d) The decrease in the ability of cuttings to produce roots as the parent plant ages should be taken into consideration. This effect could easily be quantified using parent stock of known ages.

e) All experimental work should be done on a statistical basis under repeatable and well defined conditions.

3.2 *Elaeagnus commutata* Bernh. - Silverberry, Wolf Willow

3.2.1 General Biology

Elaeagnus commutata is an upright shrub growing to a height of four metres (Moss 1977). It is native to much of Canada and the northern United States, occuring in scattered thickets on dry hillsides and in pastures. A nitrogen-fixer under most conditions, it spreads by underground stems (Hoag 1965) and seed. It prefers well drained soils of medium texture. Occasionally it is used in erosion control and is found on mine spoils in British Columbia (Mennell 1974).

3.2.2 Summary of Results

Very little information is available on the vegetative propagation of *Elaeagnus commutata* (Table 5). The best results have been obtained on softwood cuttings from Fort McMurray, Alberta (McTavish 1982). These cuttings were taken in August and treated with Seradix 2. They were planted in a mixture of sand:peat:perlite (3:1:1) and given bottom heat (22°C) and mist. A success rate of about 80 percent was obtained.

Fung (1982) has used varying levels of hormone on three types of cuttings. Hardwood cuttings were collected in March and stored in a refrigerator at 1-1.5°C until June. Cuttings were then treated with 0, 0.8 and

TABLE 5

ELAEAGNUS COMMUTATA

VEGETATIVE PROPAGATION SUMMARY

Author	Location	Type of Cutting	Time of Collection	Treatment	Propagation Method	Rooting Time	Success Rate (%)	Comments
Fung 1981 pers. comm.	Fort McMurray, Alberta	Hardwood	March	Control	Peat:vermiculite (1:1) medium; no mist; no bottom heat; Spencer-Lemaire containers	Three months	3.1	Cuttings stored until June; rot and fungal infection may account for low rooting
				Hormex 0.8%	As above	As above	8.5	
				Hormex 3%	As above	As above	2.3	
		Semi-hardwood; distal half	End of June	Control	As above	As above	0	Cutting planted immediately after collection
				Hormex 0.8%	As above	As above	0	
				Hormex 3%	As above	As above	7.8	
		Semi-hardwood; proximal half	End of June	Control	As above	As above	1.5	
				Hormex 0.8%	As above	As above	1.5	
				Hormex 3%	As above	As above	10.1	
McTavish 1981 Quest. 1982 pers. comm.	Fort McMurray, Alberta	Softwood	August	Seradix 2	Sand:peat:perlite (3:1:1) medium; bottom heat 22°C; mist	Not given	80.0	
Peepre 1978	Jasper, Alberta	Stem	Summer	IBA 0.8%	Flats on heated bench; temperature 21°C	Not given	4.4	Need additional trials

Quest. - questionnaire respondent

3.0 percent Hormex and planted in a peat:vermiculite (1:1) medium in Spencer-Lemaire containers. Mist and bottom heat were not used. A maximum rooting success of 8.5 percent was obtained using 0.8 percent Hormex. Fungal rot had infected the cuttings and this may account for the low rooting success.

Similar trials used semi-hardwood cuttings taken at the end of June. These trials separated the top and bottom halves of the cutting but maintained the treatments outlined above. Rooting success ranged from 1.5 to 10 percent. The best results were obtained using three percent solution of Hormex.

Peepre (1978) collected 225 stem cuttings of *Elaeagnus* from Jasper National Park. They were dipped in 0.8 percent IBA and propagated on a heated bench. Only 4.4 percent of the plants rooted.

3.2.3 Interpretation of Results

Few conclusions can be drawn from the limited amount of work done on this species. One observation made on the semi-hardwood cuttings at Fort McMurray (Fung 1982) is that rooting percentage may rise with hormone concentration.

3.2.4 Recommendations

Before any large-scale vegetative propagation become feasible, basic research in all areas of vegetative propagation is required. Such research should include the factors listed below.

a) Propagation should be tried using underground stems (rhizomes) and suckers.

b) Further trials should be carried out using cuttings of wood taken at different physiological stages.

c) Trials should test the use of bottom heat and/or mist versus the absence of both.

d) There should be trials using different types and concentrations of hormone treatments. The use of wounding to increase hormonal effectiveness should be tested.

3.3 *Prunus pensylvanica* L.f. - Pin Cherry

3.3.1 General Biology

Prunus pensylvanica is a slender shrub or small tree with a height of up to 8 m. It is common in Alberta in dry woods and thickets (Moss 1977). In Canada, it extends from Newfoundland to central British Columbia and northward to about 63° latitude. It establishes rapidly on burned and cleared forest land (Hall *et al.* 1981), and provides important wildlife browse (Fulton 1974).

3.3.2 Summary of Results

Six sources reviewed have had experience with the vegetative propagation of *Prunus pensylvanica* (Table 6). Of these, Laidlaw (1981) and Neill (1982) have indicated that they have discontinued their work on the vegetative propagation of this species due to the lack of success. Favorable results have been obtained using semi-hardwood cuttings (Fedkenheuer and Heacock 1980, Fung 1982), softwood cuttings (Mahadeva 1981) and root cuttings (Hall *et al.* 1981).

Semi-hardwood cuttings have been taken in late June (Fung 1982) or in July and August (Fedkenheuer and Heacock 1980). The best reported results (31 percent rooting) were obtained by Fedkenheuer and Heacock (1980) using a Seradix 2 hormone treatment followed by planting in a peat moss : perlite (1:1) medium in Spencer-Lemaire containers. No bottom heat was applied but air temperatures were maintained at 25°C day and 20°C night. Fung (1982) obtained maximum results using 0.8 percent Hormex on distal and proximal semi-hardwood cuttings (7.8 and 8.6 percent rooting respectively). Mahadeva (1981) obtained a five percent rooting success on softwood cuttings from a commercial cultivar. Fedkenheuer and Heacock (1980) had no success with softwood cuttings treated with Rootone and propagated in a rootbox.

TABLE 6

PRUNUS PENSYLVANICA

VEGETATIVE PROPAGATION SUMMARY

Author	Location	Type of Cutting	Time of Collection	Treatment	Propagation Method	Rooting Time	Success Rate (%)	Comments
Fedkenheuer and Heacock 1980	Fort McMurray, Alberta	Softwood	May-June	Rootone	Peat moss:perlite (1:1) medium; mist; temperatures 25°C day, 20°C night; 70% RH	Six weeks maximum	0	Propagated in rootbox
		Semi-hardwood	July - August	Seradix 2	As above	As above	31	As above
		Hardwood	September-April	Rootone	As above	As above	0	As above
		Root	September-April	None	As above	As above	0-1	Propagated in Spencer-Lemaire containers
Fung 1982 pers. comm.	Fort McMurray, Alberta	Hardwood	March	Control - none	Peat moss:vermiculite (1:1) medium; no bottom heat; no mist	Three months	0	Maintained in cold storage until end of June; by that time wood had partially rotted
				Hormex 0.8%	As above	As above	0	
				Hormex 3%	As above	As above	0	
		Semi-hardwood; distal half	Late June	Control - none	As above	As above	1.6	Cuttings planted immediately after collection
				Hormex 0.8%	As above	As above	7.8	
				Hormex 3%	As above	As above	2.3	
		Semi-hardwood; proximal half	Late June	Control - none	As above	As above	3.9	
				Hormex 0.8%	As above	As above	8.6	
				Hormex 3%	As above	As above	4.7	
Hall *et al.* 1981 Hall 1982 pers. comm.	Nova Scotia	Root; 10 cm long	Early spring when dormant	None	Soil; favorable conditions in greenhouse; plant 1 cm deep; mist; bottom heat	Three to four weeks	33	Proximal end produces shoots, distal end produces roots; plant as bare root stock in flats
Mahadeva 1981 Quest.	Alberta Horticultural Research Centre, Brooks, Alta.	Softwood	June	Seradix 1	Sand, bottom heat, mist	Not given	5	

Quest. - questionnaire respondent

Fedkenheuer and Heacock (1980) and Hall *et al.* (1981) used root cuttings. Although the methods used appear similar, Fedkenheuer and Heacock (1980) achieved 0 to 1 percent while Hall *et al.* (1981) had a 33 percent success rate. Hall (1982) indicated that plants having strong lateral roots, 1.3 - 2 m long (to be cut into 10 cm lengths) should be used. When dug during dormancy and planted in the greenhouse, these rooted readily.

3.3.3 Interpretation of Results

The rooting of softwood cuttings has not met with success (Fedkenheuer and Heacock 1980, Mahadeva 1981). Semi-hardwood cuttings taken at Fort McMurray (Fedkenheuer and Heacock 1980, Fung 1982) had the highest success rate in the propagation of pin cherry. Tests of hormone treatments indicate that the application of 0.8 percent Hormex may be optimal (Fung 1982).

The use of root cuttings holds some promise. However, the contradictory results obtained by Hall *et al.* (1981) and Fedkenheuer and Heacock (1980) need to be investigated.

3.3.4 Recommendations

Basic research is required on the vegetative propagation of pin cherry. Future experiments should be designed to determine which factors most influence the success of rooting. Such studies should include the factors listed below.

a) The use of treatments such as wounding, and different types and concentrations of hormone treatments should be tried.
b) Various rooting media should be tested.
c) Testing of propagation methods should include the need for misting and bottom heat.
d) Trials should be carried out on various types of cuttings taken at various physiological stages.

3.4 *Rosa acicularis Lindl.* - Prickly Rose
Rosa woodsii Lindl. - Common Wild Rose

3.4.1 General Biology

In Alberta *R. acicularis* is common in forested regions, while *R. woodsii* is a species of woods, ravines and sandhills. The two often grow together in woody areas (Moss 1977). They are bushy shrubs, 0.5 to 1.5 m high.

The native range of *R. acicularis* extends from Alaska to Labrador, south to West Virginia, Minnesota, New Mexico, Idaho and British Columbia and is found throughout the boreal forest region. *Rosa woodsii* is a native of the plains of North America (Hoag 1965).

3.4.2 Summary of Results

Root Cuttings. Several of the sources reviewed (Fedkenheuer and Heacock 1980; Lane 1982, 1981; McTavish 1982, 1981) have had experience with large-scale native rose propagation by root cuttings (Table 7). All have obtained high levels of success. The roots were dug during dormancy, either before ground freeze-up or after the spring thaw. No treatment was required. Successful rooting occurred in approximately one month in a variety of media.

Fedkenheuer and Heacock (1980) stated that propagation from roots was labor-intensive, costly and would only be used if plants cannot be propagated in other ways. Lane (1982) and McTavish (1982) stated that root cuttings are the preferred method of propagating this species. At Elkford B.C., (Lane 1982) the rose roots are dug in the fall with a backhoe which provides easy access to the cutting material.

Stem Cuttings. The results of nine separate stem trials are reviewed in Table 8 and abstracted in Table 9. A number of cutting types have been tested. Success rates ranged from 30-100 percent for hardwood cuttings and from five

TABLE 7

ROSA spp.

ROOT CUTTINGS SUMMARY

Author	Location	Time of Collection	Treatment	Propagation System Used	Rooting Time	Success Rate (%)	Comments
Fedkenheuer and Heacock 1980	Fort McMurray, Alberta	During dormancy in early spring or late fall	None	Stored in polyethylene bags in fridge until ready for planting; cut 8-15 cm long and planted with proximal end up; peat moss:perlite (1:1) medium	One month	91	Root cuttings are labor intensive and used only if plants cannot be obtained in other ways; transplant to containers after roots established
Lane Quest., 1981 1982 pers. comm.	Elkford, British Columbia	Late October before freezing	None	Bare root stock in greenhouse flats; sand:peat:vermiculite, (1:1:1) medium; mist	Several weeks	86	When shoots appear they are removed with a piece of root and planted into a styroblock container; these are placed in a tent under mist until spring transplanting
McTavish 1981 Quest., 1982 pers comm.	British Columbia Interior	During dormancy in early spring or late fall	None	Roots dug up and stuck into pots; peat:sawdust medium; mist; no bottom heat	One month	90	Easily propagated from roots

Quest. - questionnaire respondent

TABLE 8

ROSA WOODSII - ROSA ACICULARIS

STEM CUTTINGS SUMMARY

Author	Location	Type of Cutting	Time of Collection	Treatment	Propagation System Used	Rooting Time	Success Rate (%)	Comments
Everett *et al.* 1978	Nevada	Hardwood	At dormancy	Basal end wounded and dipped in talc 0.8% IBA	15-30 cm stem; submersed in water and wrapped in wet newspaper 4-72 hours; coarse perlite medium; mist	Four weeks	65	Results are for best treatment; other treatments yielded as low as 2%; Captan 50 WP fungicide used to wash the propagation bench
Fedkenheuer and Heacock (1980) Fedkenheuer 1982, pers. comm.	Fort McMurray, Alberta	Softwood	New growth; collected May or June	Seradix 1, Rootone; recut base before dipping	Rooting box 61 X 122 X 30 cm; peat:perlite (1:1) medium; temperatures 25.5°C day 20°C night; 70% R.H.	One month	6-63	
		Semi-hardwood	July and August	Rootone; recut base before dipping	Rooting box 61 X 122 X 30 cm; peat:perlite (1:1) medium; temperatures 25.5°C day 20°C night; 70% R.H.	As above	0	
		Hardwood	At dormancy; from September to April	Rootone; recut base before dipping	Rooting box 61 X 122 X 30 cm; peat:perlite (1:1) medium; temperatures 25.5°C day 20°C night; 70% R.H.	As above	3-20	
		Root/stem	At dormancy; late fall to spring	Seradix 3, Rootone; recut base before dipping	Spencer-Lemaire container 172 cm^3; peat:perlite (1:1) medium; temperatures 25.5°C day 20°C night; 70% R.H.	As above	0	
Fung 1982 pers. comm.	Fort McMurray, Alberta	Hardwood	March	None	Peat:vermiculite (1:1) medium; no mist; no bottom heat; Spencer-Lemaire containers	-	0	Planted at end of June after storage; stems partly rotted; duration of experiment 3 months
				Hormex 0.8%	As above	-	0	
				Hormex 3%	As above	-	0	
		Semi-hardwood; distal half	End of June	None	Peat:vermiculite (1:1) medium; no mist; no bottom heat; Spencer-Lemaire Hillsons	Three months	11.7	Cuttings planted immediately after collection
				Hormex 0.8%	As above	As above	11.7	
				Hormex 3%	As above	As above	1.5	

(continued)

Quest. - questionnaire respondent

R.H. - Relative humidity

TABLE 8 (continued)

ROSA WOODSII - ROSA ACICULARIS

STEM CUTTINGS SUMMARY

Author	Location	Type of Cutting	Time of Collection	Treatment	Propagation System Used	Rooting Time	Success Rate (%)	Comments
Fung 1982 pers. comm. (continued)		Semi-hardwood; proximal half	End of June	None	Peat:vermiculite (1:1); no mist; no bottom heat; Spencer-Lemaire Hillsons	Three months	10.2	Cuttings planted immediately after collection
				Hormex 0.8%	As above	As above	34.4	
				Hormex 3%	As above	As above	13.3	
Grotefend 1976	Coeur d'Alene, Idaho	Dormant hardwood-stem	April	Disbud tip; Hormodin #2; stored 1-9 days in fridge then re-treated with Hormodin #2	Sweat box four weeks, then mist bed; sand; temperatures 24°C day 18°C night	Eight weeks	60	The treatments given are those that resulted in the highest rooting for each type of cutting. The variables tested were the use of sand, peat or perlite
		Dormant hardwood tips	October	Remove twigs Rootone #10	Sweat box, mist; temperatures 15.5°C day and night; 60% R.H.	16 weeks	43	
		Softwood-tips	August	Remove tips and excess leaves, Rootone #10	Sand, mist; temperatures 22°C and 15.5°C night	Nine weeks	26	
		Semi-hardwood tip	September	Remove excess leaves, Hormodin #2	Sweat box; mist; perlite; temperatures 22°C day and 15.5°C night	15 weeks	33	
Lane 1982 pers. comm. 1981 Quest.	Elkford, British Columbia	Semi-hardwood	October	Seradix applied lightly at one side of base	Sand:peat:vermiculite (2:2:1); bottom heat; mist	One month	17	Root cuttings preferred for reclamation, much easier and more successful
McTavish 1981 Quest. 1982 pers. comm.	British Columbia Interior	Softwood		NO INFORMATION		Not given	Good	Not used due to ease of root cutting method

(continued)

Quest. - questionnaire respondent

R.H. - Relative humidity

TABLE 8 (continued)

ROSA WOODSII - ROSA ACICULARIS

STEM CUTTINGS SUMMARY

Author	Location	Time of Cutting	Time of Collection	Treatment	Propagation System Used	Rooting Time	Success Rate (%)	Comments
Marchant 1980, 1982 pers. comm.	British Columbia, Interior	Hardwood	October to December	Stim-Root 3, or Seradix 3	Cuttings were overwintered in a cold frame at ambient temperature; they were laid diagonally in beds of sawdust, and watered as necessary during cold free periods	Four months approximately	85	No noticeable improvement was made by bark wounding (pers. comm.)
	Slocan Valley, British Columbia	Hardwood	October to December	Stim-Root 3	Cutting overwintered in poly bags and peat moss. Hormone to be applied prior to lining out	As above	-	Work not complete at this time
Native Plants Incorporated 1982 pers. comm.	Utah	Softwood; stem and tip	Collections made from new growth of seedlings in greenhouse	Hormodin #2	Washed, fine sand medium; misted; bottom heat at 24°C	Two weeks	90-95	This information was not included in the text of report because of late receipt
Peepre 1978, 1982 pers. comm.	Jasper Park, Alberta	Root/stem		0.4% IBA	Nursery flats; coarse sand:perlite (3:1); bare rootstock; transplanted to pots when cuttings established	Not given	1.5	Limited data - softwood and hardwood cuttings not successful

TABLE 9

ROSA spp.

SUMMARY OF TREATMENTS USED

Hardwood cuttings :	taken September to April - success 30-100 percent
Softwood cuttings :	taken May to late October - success 5-63 percent
Hormone Treatments: used:	IBA 0.8 - 3.0 percent Stimroot 3 Hormodin 2 Rootone 10 Seradix 3
Rooting Media:	Coarse sand and perlite (3:1) Peat and perlite (1:1) Peat and vermiculite (1:1) Coarse perlite Sand
Propagation Frames:	Rooting box, sweatbox
Mist:	Used by three sources
Bottom Heat:	Used by two sources
Cold storage:	Used by two sources

to 63 percent for softwood cuttings. Peepre (1982) tried a root-stem cutting obtaining a success of 1.5 percent.

Fung (1982) tested three different hormone levels on both hardwood and softwood cuttings and found that 0.8 percent Hormex generally gave results better than or equal to 0 percent and 3.0 percent Hormex. The use of mist or bottom heat did not guarantee success. None of the rooting media appeared better than any other.

3.4.3 Interpretation of Results

Root Cuttings. Large-scale propagation by root cuttings appears feasible provided there is an easily accessible source. For example, at Fording Coal's minesite at Elkford, *Rosa* roots are dug with a backhoe. Hand digging of roots is expensive and time-consuming (Fedkenheuer and Heacock 1980).

Stem Cuttings. Four sources have reported rooting success rates of 60 percent or better (Everett *et al.* 1978, Fedkenheuer and Heacock 1980, Grotefend 1976 and Marchant 1980). The successful propagation techniques involved the following:

a) all were hardwood cuttings taken at dormancy;
b) all used a hormone treatment;
c) all used mist or heavy watering to maintain high humidity levels;
d) the rooting media varied but were always a coarse material;
e) none used bottom heat although warm air temperatures were maintained;

3.4.4 Recommendations

Propagation of roses using root cuttings is feasible on a large scale provided that the cuttings can be obtained and propagated in an economical manner. No further work on root cutting propagation is warranted.

Propagation of roses from stem cuttings needs further work to refine the methodology. A series of trials should be undertaken including those parameters listed below which appear to be prerequisite for successful propagation.

a) The cuttings should be from dormant hardwood.
b) A hormone treatment should be included.
c) Coarse rooting media such as peat:perlite (1:1) should be used.
d) Mist should be used to maintain high humidity levels.

Other factors may affect rooting success but their influences remain unknown. The effect of these factors, listed below, should be tested.

a) The use of a cold treatment (seven to 14 days) should be compared to no cold treatment;
b) The use of a double hormone treatment both before and after cold treatment should be compared to the use of a single hormone treatment.
c) The use of wounding of the cutting end should be compared with no wounding treatment given.

3.5 *Salix bebbiana* Sarg. - Beaked Willow

3.5.1 General Biology

Beaked willow (*Salix bebbiana*) is a shrub or small tree growing from one to 10 m high. It is common throughout Alberta from the plains to the subalpine. It is found mainly in moist locations such as woods, thickets and the borders of slopes on moist, sandy or gravelly soils (Moss 1977, Stringer 1976). It is adapted to well to poorly drained soils and is found over a range of soil textures (Alaska Rural Development Council 1977). It tolerates moderately alkaline and saline soils but does poorly in extremely acidic or alkaline conditions (Rawson 1974).

3.5.2 Summary of Results

Only four sources were found which referred specifically to *Salix bebbiana* and only three of these contained data (Table 10).

Two authors (Densmore and Zasada 1978, Holloway and Zasada 1979) had no success with hardwood cuttings taken in the spring or fall. However, in the case of Densmore and Zasada (1978) the study was not an attempt at propagation but was designed to test rooting under selected environmental conditions. Hollaway and Zasada (1979) had considerable success with softwood cuttings.

Everett *et al.* (1978) had 89 percent success with semi-hardwood cuttings collected in Nevada. The cuttings were dipped in 0.8 percent IBA in talc and rooted in coarse perlite. Maintenance of high moisture conditions from the time of cutting was considered to be of prime importance.

Holloway and Zasada (1979) did an extensive series of trials in Fairbanks, Alaska. Hardwood and softwood cuttings were given one of five treatments and then planted in sand or perlite. The treatments used were as follows:

1. Control
2. Powdered auxin treatment; the proximal portion of each cutting was dipped into Hormodin #3
3. Wounding treatment; 2-3 cm length of the proximal end of each cutting was severed upward from the base
4. Powdered auxin-wounding treatment; a combination of treatments 2 and 3 above
5. Liquid auxin-wounding treatment; following wounding as in 3 above, cuttings are dipped for five minutes in 2 000 ppm liquid IBA

TABLE 10

SALIX BEBBIANA

VEGETATIVE PROPAGATION SUMMARY

Author	Location	Type of Cutting	Age	Time of Collection	Treatment[1]	Propagation System Used	Rooting Time	Success (%)	Comments
Densmore and Zasada 1978	Fairbanks, Alaska	Hardwood section; 19 cm length	Two years	Mid-September - (after leaf senescence	None	Placed in distilled water with 2 to 3 cm exposed; continuous white fluorescent light; 20-24°C air temperatures with water 2-3°C cooler	-	0% (after 60 days)	This is from a study comparing rooting of riparian & non riparian willow species rooting potential
				May (after leaf expansion	None	As above	30 days	0%	
Everett 1978	Nevada	Semi-hardwood; 15-30 cm length; 0.3-2 cm diameter	Not given	At flowering stage (early spring)	Cutting wounded and treated with 0.8% IBA in talc; Captan 50 WP fungicide applied to mist bench	Immersed in water after cutting then wrapped in wet newspaper (4-72 hours); intermittent mist; no bottom heat; coarse perlite rooting medium	Four weeks	89	Considered rooted if 1 cm of root was produced; rooted cut tings placed in paper containers with sandy loam soil and transfer-red to a lathhouse
Holloway and Zasada 1979	Fairbanks Alaska	Hardwood base	Eight years	September 17 - October 15	#1; 2; 3; 4; and 5	Sand; two weeks cold storage; mist; 22°C air temperature; 26.7°C bottom heat	Two weeks	<1	Material moistened, wrapped in plastic bags and placed in cold storage at 4.5°C for two weeks - mist 5 seconds every 15 minutes - lighting by 40 watt fluorescent bulbs, 1 m above bench - experiment on statis-tical basis using randomized plot design - 82 cuttings per treat-ment
		Hardwood tip	Two years	As above	#1; 2; 3; 4; and 5	As above	As above	<1	

(continued)

[1] <u>Treatment Designations For Holloway and Zasada (1979)</u>

#1 Control (no treatment)
#2 Powdered auxin, Hormodin #3 dip
#3 Wounding only
#4 Wounding-auxin-combination of treatment 2 & 3
#5 Liquid auxin (2 000 ppm IBA for 5 minutes) plus wounding

TABLE 10 (continued)

SALIX BEBBIANA

VEGETATIVE PROPAGATION SUMMARY

Author	Location	Type of Cutting	Age	Time of Collection	Treatment[1]	Propagation System Used	Rooting Time	Success (%)	Comments
Holloway and Zasada 1979, (continued)	Fairbanks, Alaska	Softwood base	Not given	September 17 - October 15	#1	Two weeks cold storage; sand medium; mist; 22°C air temperature; 26.7°C bottom heat	Two weeks	54	Treatment differences are negligible; rooting was most prolific on part of stem immediately below surface of medium; good rooting of softwood may be a favorable response to heavy pruning; average softwood results: Tip 42% Base 51%
					#2	As above	As above	62	
					#3	As above	As above	46	
					#4	As above	As above	46	
					#5	As above	As above	54	
					#1	Two weeks cold storage; perlite medium; mist; 22°C air temperature; 26.7°C bottom heat	As above	50	
					#2	As above	As above	54	
					#3	As above	As above	30	
					#4	As above	As above	42	
					#5	As above	As above	72	

(continued)

[1] Treatment Designations For Holloway and Zasada (1979)

#1 Control (no treatment)
#2 Powdered auxin, Hormodin #3 dip
#3 Wounding only
#4 Wounding-auxin-combination of treatment 2 & 3
#5 Liquid auxin (2 000 ppm IBA for 5 minutes) plus wounding

TABLE 10 (continued)

SALIX BEBBIANA

VEGETATIVE PROPAGATION SUMMARY

Author	Location	Type of Cutting	Age	Time of Collection	Treatment[1]	Propagation System Used	Rooting Time	Success (%)	Comments
Holloway and Zasada 1979, (continued)	Fairbanks, Alaska	Softwood tip	-	September 17 - October 15	#1	Two weeks cold storage; sand medium; mist; 26.7°C bottom heat	Two weeks	44	
					#2	As above	As above	46	
					#3	As above	As above	40	
					#4	As above	As above	30	
					#5	As above	As above	66	
					#1	Two weeks cold storage; perlite medium; mist; 26.7°C bottom heat	As above	50	
					#2	As above	As above	38	
					#3	As above	As above	34	
					#4	As above	As above	34	
					#5	As above	As above	42	
Rawson 1974 (Review article)	North-eastern U.S.A.	Stem 20-25 cm	Two years	February	Not necessary	Planted 15-20 cm deep in rooting medium with two buds above surface; if necessary stored in moist sand in cool, dark place	Not given	Not given	Review article

[1]Treatment Designations For Holloway and Zasada (1979)

#1 Control (no treatment)
#2 Powdered auxin, Hormodin #3 dip
#3 Wounding only
#4 Wounding-auxin-combination of treatment 2 & 3
#5 Liquid auxin (2 000 ppm IBA for 5 minutes) plus wounding

Few hardwood cuttings rooted while rooting was near 50 percent for the softwood cuttings. The authors stated this difference was possibly a response to pruning. The stem cuttings collected during the summer were thin and short. The collection of hardwood cuttings resulted in a pruning of the growing tips and appeared to have stimulated prolific shoot growth: these shoots being the source of the softwood cuttings shoots provided the bulk of the softwood cuttings. Differences in results among softwood cutting treatments were negligible. The softwood cuttings taken from both tip and base performed equally well. Rooting was random and most prolific on that part of the stem located immediately below the surface of the rooting medium.

3.5.3 Interpretation of Results

In beaked willow the best results were obtained using softwood cuttings rooted in sand or perlite. Various treatments including hormones and wounding did not appear to affect rooting success significantly. The use of mist and the prevention of stem drying after cutting may play an important role in ensuring good success. "Semi-hardwood" cuttings taken in early spring by Everett (1978) also showed very promising results.

3.5.4 Recommendations

Further studies to confirm available data are required prior to setting up large-scale production. Several recommendations are listed below.

a) The use of hardwood cuttings from the previous year's growth gathered in early spring versus semi-hardwood cuttings taken in midsummer and softwood cuttings taken in early spring should be compared.

b) The use of several concentrations of IBA as well as various forms of this hormone should be compared.

c) Softwood cuttings should be kept moist from time of cutting until planting.

d) Softwood cuttings should be taken from new growth on old wood which was severely pruned the previous year.

e) Comparisons should be made between cuttings which received a two-week cold storage and those which had not.

3.6 *Shepherdia canadensis* (L.) Nutt. - Canadian Buffalo-berry

3.6.1 General Biology

Shepherdia canadensis is widespread throughout the forested regions of Alberta (Moss 1977), particularly in dry, well drained locations. It is an invader of minespoil in British Columbia (Mennell 1974). *Shepherdia* is a nodulated, nitrogen-fixing species.

3.6.2 Summary of Results

Eight sources were reviewed (Table 11). Results have been variable although Peepre (1978), Marchant (1980) and Sherlock (1982) had success rates of over 40 percent. Holloway and Zasada (1979) did not have any success using softwood and hardwood cuttings treated as listed in Section 3.5.2. Fung (1982) tried three levels of hormones on both hardwood and softwood cuttings with uniformly low results.

Work currently being carried out by Sherlock (1982) as part of a thesis at the University of British Columbia involved the use of softwood cuttings taken in early August at an elevation of 1 120 m between Hope and Princeton, B.C. Treatments used included Stimroot #2 and #3, 25 percent Synergol and 50 percent Synergol. All treatments had some degree of success.

Holloway and Zasada (1979) have had 100 percent rooting using root cuttings dug during September and immediately planted in moist peat in a mist tent. However, only 24 percent of these roots later produced shoots. When the roots were given cold treatment prior to propagation, there was no root or shoot production.

3.6.3 Interpretation of Results

With the considerable amount of work presently being carried out on this species, it is too early to discuss which methods may prove to be the most successful. Great progress has been made on this species and the two on-going Masters theses should provide additional positive results.

3.6.4 Recommendations

In view of the thesis research currently being done on the propogation of *Shepherdia canadensis*, any further research work should await the final results of Sherlock's and Shopik's work.

TABLE 11

SHEPHERDIA CANADENSIS

VEGETATIVE PROPAGATION SUMMARY

Author	Location	Type of Cutting	Time of Collection	Treatment	Propagation Method	Rooting Time	Success Rate (%)	Comments
Fedkenheuer and Heacock 1980	Fort McMurray, Alberta	Softwood	Early spring	Seradix 2	Peat moss:perlite (1:1) medium; mist; 25.5°C day - 20°C night temperature	Not given	1	Vegetative propagation methods abandoned due to lack of success
		Hardwood	Fall	Rootone	As above	As above	1	
Fung 1982 pers. comm.	Fort McMurray, Alberta	Hardwood	March	None	Spencer-Lemaire Hillson containers; peat moss:vermiculite (1:1) medium; no mist; no bottom heat	-	0	Kept in cold storage until June before setting out; stems had partly rotted by this time; duration of experiment three months
				Hormex 0.8%	As above	-	0	
				Hormex 3%	As above	-	0	
		Semi-hardwood; distal half	Late June	None	As above	-	0	Cuttings planted immediately after collection
				Hormex 0.8%	As above	As above	4.7	
				Hormex 3%	As above	As above	3.7	
		Semi-hardwood; proximal half	Late June	None	As above	As above	1.8	
				Hormex 0.8%	As above	As above	0	
				Hormex 3%	As above	As above	1.5	
Holloway and Zasada 1979	Fairbanks, Alaska	Hardwood 16 cm	September 17 to October 15	Two weeks cold storage at 4.5°C then given various treatments[1]	In sand or perlite medium; mist; 22°C air temperature; 26.7°C bottom heat	-	0	Treatments investigated included wounding, wounding plus powdered IBA, wounded and liquid IBA, powdered IBA, no treatment
		Softwood with heel	July 5-19	As above	As above	-	0	
				No cold storage, various treatments[1]	As above	-	0	

(continued)

[1] Treatments are those footnoted in Table 10

TABLE 11 (continued)

SHEPHERDIA CANADENSIS

VEGETATIVE PROPAGATION SUMMARY

Author	Location	Type of Cutting	Time of Collection	Treatment	Propagation Method	Rooting Time	Success Rate (%)	Comments
Marchant 1980, 1982 pers. comm.	British Columbia	Softwood	May 23	Rootone F or Stimroot 1 given interchangeably	Peat:perlite:pumice (1:1:1) medium; greenhouse misting system	63 days	21	Fungicide included with Rootone F
			June 17	As above	As above	58 days	43	
			August 6	As above	As above	47 days	4	
Peepre 1978	Jasper, Alberta	Root and Stem	Summer	0.8% IBA bottom heat, 21°C	Sand:peat (3:1) medium; heated bench (21°C)	Not given	5-45	When rooted, cuttings transplanted into pots with a mixture of sawdust, peat and sand (15:5:3)
Sherlock 1982 pers. comm.	Hope-Princeton, British Columbia (1 120 m)	Softwood	Early August	Stimroot #2 five seconds dip; mist bench; inoculated	Surface Sterilize with Physan (2.5 ml/l), perlite:peat: sterilized soil (5:4:1) medium; micronutrients; mist bench	Not given	60	September 25 to November 3 in cutting medium on greenhouse bench; transferred to outside frame November 3; potted following spring; little or no nodulation occurred
				Stimroot #3	As above	As above	76	
				25% Synergol	As above	As above	96	
				50% Synergol	As above	As above	96	
				Stimroot #3; mist bench; no inoculated	Surface sterilized with Physan (1 tsp/gal); perlite:peat (1:1) medium; mist bench	As above	88	
				25% Synergol	As above	As above	90	
				50% Synergol	As above	As above	56	

(continued)

TABLE 11 (continued)

SHEPHERDIA CANADENSIS

VEGETATIVE PROPAGATION SUMMARY

Author	Location	Type of Cutting	Time of Collection	Treatment	Propagation Method	Rooting Time	Success Rate (%)	Comments
Shopik 1982 pers. comm.	Edmonton, Alberta	Hardwood tip	Every two months September-May	IBA 10,000; 5,000; 2,500; 1,250 ppm. concentrations	Bottom heat at 22°C versus no bottom heat; mist for cuttings collected August - September	Callus formation after two months	<10%	At end of four months less than 10% rooted in all trials
		Semi-hardwood tip	July - September	As above	As above		As above	
		Softwood tip	May - July	As above	As above		As above	
Ure 1937	Edmonton, Alberta	Softwood	Mid-June	None	Sand, peat, and sand:peat (1:1) media; media temperatures at 15° and 27°C	Not given	0	Basal cuts made at, above, and below nodes

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