Seabuckthorn Propagation

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Introduction

Seabuckthorn (*Hippophae rhamnoides*) is an easy-to-propagate, multipurpose and highly adaptable fruit-bearing shrub. The shrub suckers well to fill in space quickly and can be used in shelterbelts and conservation plantings to capture agri-environmental benefits (e.g. control soil erosion, trap snow, maintain pollinator and wildlife habitats). Because it fixes nitrogen, is winter hardy, salt tolerant and drought tolerant, seabuckthorn is a good option for low-input, sustainable operations. Environmental benefits aside, the shrub's fruit is of great interest: it is very nutritious and contains high levels of antioxidants. As a fruit crop, seabuckthorn is well suited for managed orchards or high production plantations.

Bill Schroeder has been the lead researcher at Agriculture and Agri-Food Canada (AAFC) and is recognized as the North American expert on seabuckthorn. His breeding program has focused on improving yield, fruit characteristics, harvest efficiency and thornlessness. He has worked with this crop for almost 30 years and over this time has released eight high-yield cultivars that are extremely hardy and adapted to cold, semi-arid continental climates. These cultivars are further distinguished as the only North American bred cultivars.

> "*Thanks to its high concentrations of carotene, vitamins C and E, flavonoids, amino acids and essential oils, the value-added opportunities for seabuckthorn products are numerous – food and drink, nutrition supplements, cosmetics, veterinary care and dyes to name a few.*"
>
> Bill Schroeder, lead seabuckthorn researcher (retired)
> at Agriculture and Agri-Food Canada

Bill Schroeder with 'AC Harvest Moon' seabuckthorn

Fruiting branch of 'AC Harvest Moon' seabuckthorn

Propagation Methods and Procedures

The easiest way to propagate seabuckthorn is by seed. Seabuckthorn is a dioecious species meaning that there are separate male and female plants. Expect that half of all seedlings will be male (pollen source) and half will be female (fruit bearing). You may have to wait up to five years for seedlings to start flowering to distinguish between male and female plants. Another consequence of propagating seabuckthorn from seed is that seedlings will be different from their parents with considerable variation in growth and fruit characteristics among plants. Seed propagated seabuckthorn shrubs are well suited for conservation plantings or low intensity managed orchards.

Vegetative propagation involves rooting softwood cuttings, hardwood cuttings, root cuttings and suckers. Vegetatively propagated plants are genetically identical (i.e. clones) to their parent plants. In addition, vegetatively propagated plants may flower/fruit sooner than seed propagated plants. Vegetative propagation is the best method for propagating named cultivars and field selections with superior traits for commercial orchard establishment. Initially, you will have limited supply of propagation material from your own orchard until plants become established.

Tissue culture, the most technically challenging method, is a special type of vegetative propagation. You can potentially create hundreds to thousands of identical plants in a relatively short period of time. The cost per plant is low, but the start-up costs (e.g. lab facilities, greenhouse, supplies) can be high and special skills and training are required. Tissue cultured plants are usually supplied by specialty growers. At this time, tissue culture procedures for seabuckthorn are not well developed.

'AC Harvest Moon' seabuckthorn mature shrub

Seed Propagation

Seed Collection and Extraction

Figure 1: Harvested fruit

Harvest, timing: Harvest fruit from late August to mid-winter. Protect hands from thorns with gloves. Strip or clip off fruit clusters from branches (Figure 1).

Seed extraction, small batch processing: Extract the seed using a blender – wrap the blades with tape to prevent damage to the seed. Place the berries in the blender with an equal amount of water. Run the blender at low speed for 30 seconds. Pour off the pulp/juice, leaving the seed behind. Rinse several times until the seed is clean. Spread the seed on a screen. Allow to air dry (Figures 2, 3 and 4).

Figure 2: Extract seeds with a blender

Drying: Keep at room temperature until moisture content reaches 6%. To measure seed moisture content, weigh a subsample of seed (wet weight), dry the subsample at 105°C for 24 hours and reweigh the subsample (dry weight).

$$\text{Moisture content (\%)} = 100\% \bullet \frac{\text{(wet weight} - \text{dry weight)}}{\text{(wet weight)}}$$

Figure 3: Remove pulp

Storage: Store in sealed containers at -18°C.

Yield: Fifty kilograms of fruit will yield 4-5 kilograms of cleaned seed (30,000-40,000 seeds/kg; 33,000 seeds/kg average).

Greenhouse Seeding and Transplanting

Seed pre-treatment: Soak seeds in water for 48 hours at room temperature. Replace water several times to prevent stagnation/low oxygen conditions. After soaking, the seeds should have expanded (imbibed water). Minimize fungal problems by surface sterilizing seed in a 10% household bleach solution (one part bleach to nine parts water) for five minutes prior to seeding. Some seed sources (cultivars, unimproved species) may not germinate (are dormant) if planted without treatment (Figure 5).

Figure 4: Seeds ready for drying

Timing: Plant pre-treated seabuckthorn seed indoors in January or early February.

Planting medium: Use a vermiculite:peat moss (2:3) mixture.

Seeding depth: Cover seed with 1-2 cm planting medium.

Germination: Germination should start within 5-10 days.

Lighting: Use bright, full-spectrum fluorescent lighting or high-pressure sodium lighting to maximize growth. 16 hour day and 8 hour night.

Air circulation: Provide good airflow.

Temperature: 22°C during the day/18°C at night.

Relative humidity: 90%.

Damping off, control: Apply a registered fungicide immediately following germination and prior to the appearance of true leaves.

Figure 5: Soak seeds in water as pre-treatment

Starting fertilizer (Weeks 1-3): Apply a moderate rate of a soluble complete fertilizer (20-8-20 at 100 ppm) with each irrigation.

Maintenance fertilizer (starting in Week 4): Increase the fertilizer rate (20-8-20 at 150 ppm) with each irrigation.

Acclimation (before transplanting outdoors): Four to six weeks before planting out, reduce the fertilizer rate (20-8-20 at 30 ppm), restrict water, switch to natural light, and lower the temperature to 15°C (Figure 6).

Transplant outdoors: Plant in spring or late August. Irrigate at planting. Space 2.0 m apart if in final planting site.

Figure 6: Seabuckthorn plants grown from seeds

Direct Seeding Outdoors

Seabuckthorn seed can be sown outdoors in the field although environmental factors and soil conditions may limit success.

Timing, fall (recommended): Sow fresh, non-treated seed in late September.

Timing, spring: Sow moist, stratified seed (30 days moist at 5°C) in the spring when soil temperature reaches 15°C.

Soil: The ideal nursery site has loamy soil with pH = 6.0-8.0 and 3-4% organic matter.

Sowing depth: Sow seed 1-2 cm below the soil surface.

Germination: Germination should start within 5-10 days for spring planted, stratified seed.

Seeding rate: Seed at 150 seeds/meter.

Weed control: Apply a registered herbicide to control weeds in dormant 1-year-old seedling beds. Optional: use tillage for between-row weed control. Avoid deep tillage to minimize damage to root system.

Seedling harvest, timing: Lift seedlings once they reach a height of 25 cm and have a minimum root collar diameter of 4 mm (after one or two growing seasons). Lift seedlings *after* they have dropped their leaves in the fall. Healthy, high quality seedlings will have several root nodules. Gently shake off the majority of soil.

Seedling harvest, storage: Bag bare-root seedlings in polybags immediately following lifting to prevent root desiccation and reduced seedling quality. Store at -2°C.

Vegetative Propagation

The Cutting Bed

Seabuckthorn cutting production (in a cutting bed) should be a separate operation from fruit production to maximize the growth potential of the mother plants. First, it allows growers to efficiently manage fertility, irrigation and weeds to maintain mother plants at optimal health and productivity levels. Second, it allows growers to maximize stem production (future cuttings) by using specific pruning techniques and/or applying growth regulators. The resulting cuttings will have a greater ability to root due to increased vigor.

Cutting beds for producing female clones (i.e. fruiting varieties) must be planted at least 300 m from male plant to prevent fruit set. Stems with fruit will produce lower quality cuttings (i.e. less vigorous, lower rooting capacity).

Depending on its age, each mother plant can produce 2-20 or more cuttings. You can expect 1-2 cuttings in the second year after planting, 3-6 cuttings in the third year, 6-12 cuttings in the fourth year and 10-20+ cuttings in subsequent years.

If a cutting bed is not available or producing enough to satisfy demand, cuttings can be taken from high-quality fruit shrubs. Up to 30% of the shoots can be removed from 3 to 7-year-old shrubs while still allowing fruit harvest. However, as noted above, the rooting rate of these cuttings will be lower than for those taken from an isolated cutting bed.

Cutting Bed Establishment

Spring is the best time to establish a cutting bed under Canadian conditions. Start with healthy, vigorous foundation stock. Space plants 0.5 m apart within rows and space rows 2 m apart (10,000 plants per hectare). During planting, adjust the planter to set seabuckthorn transplants at the bottom of an open furrow, 5-8 cm deep. As the furrow fills in over time, adventitious roots form on the now buried portion of stem resulting in a more vigorous mother plant.

Pruning to optimize cutting production starts at planting (Figure 7).

Year 1 (at planting): Cultivar is planted and pruned to 25 cm.

Year 2 (spring, before budbreak): Growth is pruned to 3 or 4 buds.

Year 3: Shoots are available for cuttings.

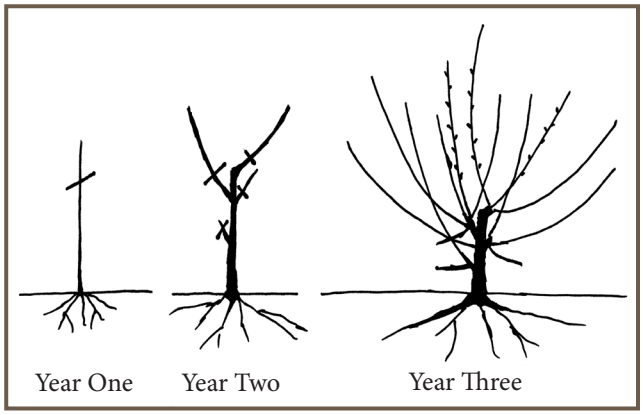

Figure 7: Cutting bed establishment

Propagation Facility

Hardwood and softwood propagation beds can be established in a greenhouse or an outdoor lathe house. Propagation beds are composed of two separate layers. The bottom or base layer is 7-10 cm of coarse gravel with heating cables running through. The top layer is 10-15 cm of rooting medium (see *Preparing and rooting softwood cuttings – Rooting medium*, p. 12). Use an intermittent mist or fogging system to supply initial irrigation needs. Intermittent mist reduces the total water volume applied to the cuttings and prevents excess moisture accumulation in the media. Brass mist nozzles supply a fine spray of water to maintain high relative humidity. Control misting frequency with an electronic timer connected to a solenoid to turn the system on or off. For softwood cuttings, cover the propagation bed with a polyethylene tunnel. Hardwood cuttings do not require a polyethylene tunnel. Provide adequate air circulation to prevent disease development (Figure 8).

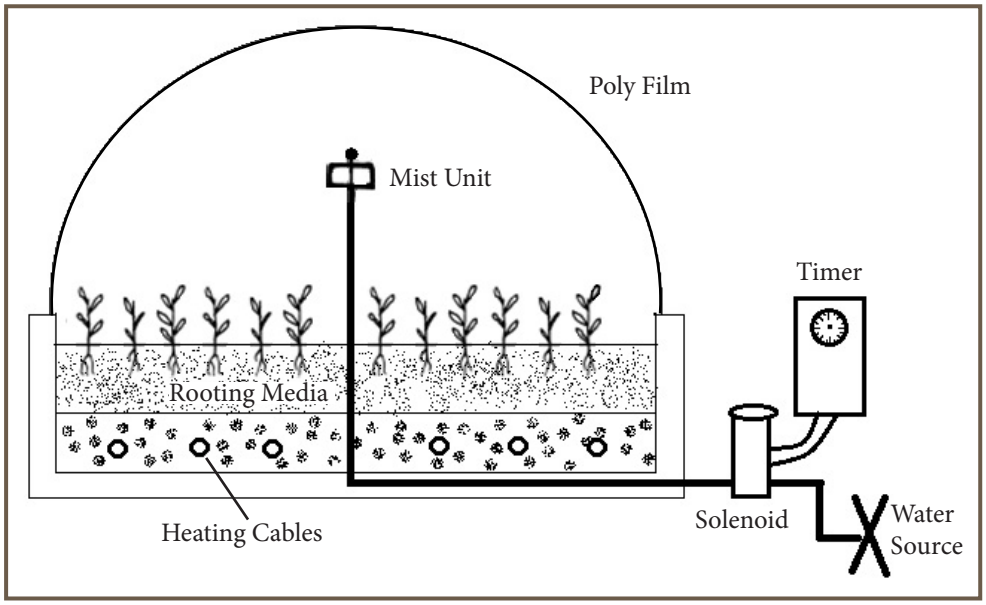

Figure 8: Misting bed for rooting hardwood or softwood cuttings

Hardwood Cuttings

Shoot maturity and physiological condition of the cuttings are important factors that affect root formation. The lower, lignified part of the shoot has a large nutrient reserve and can therefore easily form roots. The upper part of the seabuckthorn shoot is not lignified, cannot form roots and should not be used for cuttings.

One of the main factors determining shoot quality and the rooting ability of hardwood cuttings is the age of the parent plant. Younger plants, up to 5 years old, grow for a longer time during the season and produce longer shoots (30-100 cm depending on the cultivar) with longer internodes than older plants. In addition, cuttings from younger plants root more readily than those from older plants.

Harvesting hardwood cuttings

Timing: Before budbreak. Early spring is best. Winter cuttings often have poorer growth and produce fewer good quality transplants by the end of the season

Shoot removal for cuttings: Previous season's growth (1-year-old whips). IMPORTANT: leave a stub behind on the mother plant with 2 or 3 well-developed buds to produce the next crop of cuttings. If the whole shoot is removed, the tiny, dormant buds that are left behind at its base of may not develop for several years. When they do start to grow, these buds produce weak, small shoots that are unsuitable for cutting material.

Tools: Sharp knife or pruning shears. Pneumatic pruning shears speed up harvest.

Storage, in-field (during harvest): Cover cuttings with damp burlap to reduce desiccation. Take care to identify and keep male and female cuttings separate as they are indistinguishable when not flowering/fruiting.

Storage, short-term (until processing): Shoots can be stored whole or cut up into 15 cm lengths (see *Preparing hardwood cuttings* below). Bundle and label with cultivar name. Store at -4°C.

Preparing hardwood cuttings

Cutting length: Cut the 1-year-old shoots into 15 cm lengths. Make the lower cut under the bud and the upper cut above the bud.

Tools: Manual or mechanical/pneumatic pruning shears.

Smooth cuts are important: Regardless of the tool, the blade must be sharp for a smooth cut. Rough cuts do not heal quickly and often decay.

Male cuttings: Remove all except the top two buds.

Female cuttings: Leave all buds.

Rooting hardwood cuttings

Soaking: Submerge cuttings in room temperature water (18°C-25°C), leaving 2 or 3 buds above the water surface, for six days until the buds swell. Change water daily.

Wounding: Remove a 1-2 cm slice of bark at the base on one side of each cutting to expose the cambium – do not cut into the wood.

Rooting hormone: Dip base of each cutting in 4000 ppm liquid IBA or No. 3 rooting hormone powder (Figure 9).

Rooting medium: Use a perlite:vermiculite (1:1) mixture.

Planting: Stick cuttings 7-8 cm deep in a large tray filled 15 cm deep with rooting medium (Figures 10 and 11).

Temperature: Keep the greenhouse temperature low (15°C-17°C), but use bottom heat to maintain soil temperature at 23°C-25°C.

Lighting: Using bright natural light is sufficient until growth starts. After budbreak, extend natural day length to 16 hours of light (8 hours of dark).

Air circulation: Maintain good airflow.

Irrigation: During the day, mist cuttings for 4-5 seconds every hour. No misting at night. Do not allow the media to become too wet (Figure 8).

Transplanting: Cuttings should root in 3-4 weeks and can be potted after 6-7 weeks (Figures 12 and 13).

Fertilizer: Apply a moderate rate of a soluble complete fertilizer (20-8-20 at 100 ppm) to rooted cuttings with each irrigation.

Figure 9: Dip hardwood cutting first in water then in rooting powder

Figure 10: Stick hardwood cutting in propagation bed

Figure 11: Hardwood cuttings ready for transplanting

Figure 12: Rooted hardwood cutting ready for transplant

Figure 13: Transplant hardwood cuttings into root trainers

Softwood Cuttings

Propagating seabuckthorn with softwood cuttings has a very high success rate. By preparing and rooting cuttings early in the summer, plants can become well established in time for fall which improves their chances of overwintering success.

Harvesting softwood cuttings

Timing: Late June to mid-July, when shoots have stopped growing and are slightly lignified.

Shoot removal for cuttings: Terminal or side shoots.

Cutting length: 10-15 cm, usually with more than two nodes.

Tools: Sharp knife or pruning shears.

Field conditions: Best if collected on cool, dull days in the morning or late afternoon.

Storage, in-field (during harvest): Place cuttings in polybags or moist burlaps sacks immediately after cutting. Transport the cuttings as quickly as possible from the field to the rooting facilities/greenhouse. Quality and propagation success declines rapidly if cuttings are allowed to wilt at any stage between harvest and rooting. Take care to identify and keep male and female cuttings separate as they are indistinguishable when not flowering/fruiting.

Preparing and rooting softwood cuttings

Cut a fresh end: Use a sharp knife or pruning shears to remove the bottom 0.5 cm of the cutting.

Remove lower leaves: Remove enough of the lower leaves so none will be in contact with the rooting medium or buried after planting (Figure 14).

Rooting hormone: Dip base of cutting in 4000 ppm liquid IBA or No. 3 rooting hormone powder [same as for hardwood cuttings].

Rooting medium: Use a perlite:vermiculite (1:1) mixture.

Containers: Start cutting directly in a mist bed (see *Propagation Facility*, p. 7). Although more expensive, start cutting in individual containers to reduce transplant shock (Figures 8, 15 and 16).

Planting: Make sure at least two leaf nodes are below the surface of the rooting medium.

Temperature: Not to exceed 30°C.

Relative Humidity: Essential to prevent wilting. 80-90%.

Lighting: Use bright natural light.

Air circulation: Maintain moderate airflow.

Irrigation: Intermittent mist. Initially, apply 10 seconds of mist every 30 minutes, day and night. Use the minimum amount of mist necessary to prevent wilting (Figure 8). Gradually reduce the amount of mist after roots begin to form. Discontinue misting after four weeks. Afterwards, water as necessary until repotted or planted in the field.

Fertilizer (weekly): Apply water soluble 20-20-20 fertilizer at 100 ppm as soon as initial roots form. Continue for the remainder of the growing season.

Repotting/planting in field: Cuttings should root in 4-6 weeks. At this point, they can be transplanted into small pots or planted into the field nursery (Figure 17).

Figure 14: Softwood cutting with lower leaves removed

Figure 15: Plant softwood cutting in rooting medium

Figure 16: Rooted softwood cuttings

Figure 17: Rooted softwood cutting ready for transplant

Root Cuttings and Suckers

Root cuttings with nodes (15 cm in length and 5 mm in diameter) can be an effective seabuckthorn propagation method. Dig up roots in early spring as soon as soil thaws. Plant in pots and keep in greenhouse for 6-8 weeks before transplanting to the field.

Suckers are shoots that develop on roots from adventitious buds. As with hardwood or softwood cuttings, plants grown from suckers are genetically identical to the mother plant. Dig up suckers in early spring while plants are still dormant (i.e. before budbreak). Do not simply pull the sucker out of the ground as this will damage the base of the sucker. Remove suckers as close to the root as possible with a pruning knife or a sharpened shovel. Treat as you would a hardwood cutting. Optional: dig down and include as large a root mass as is practical. Do not allow the root mass to dry out prior to transplanting. Plant immediately into your field nursery (Figure 18).

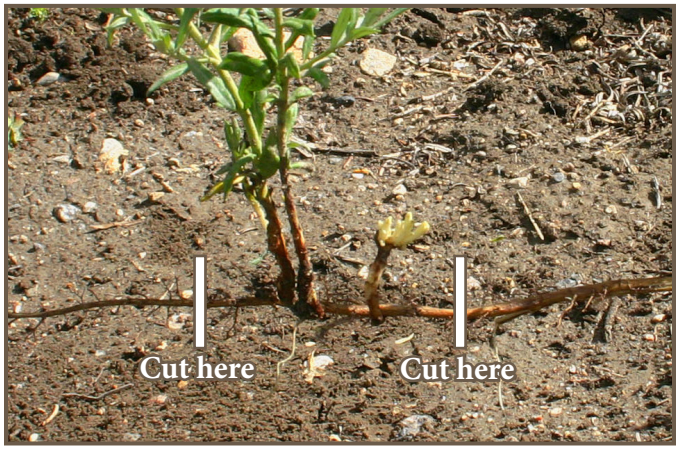

Figure 18: Carefully dig up sucker and cut root on either side of sucker

Post-Rooting Treatment

Rooted cuttings must be acclimated and hardened off prior to planting outside the propagation bed or when storing indoors (cold storage).

There are three options for preparing rooted cuttings for overwintering.

In propagation bed (lathe house): At freeze up, cover the rooted seedlings with microfoam or organic mulch (e.g. peatmoss or woodchips).

Bare root plants: Lift and store bare root plants in polybags at -2°C.

In field: Transplant to field in late August when roots are well developed. This method works well if cuttings were rooted in individual containers. Keep transplants moderately well irrigated until late September. Control weeds, but avoid deep cultivation close to plants.

Comparison of Propagation Methods

Propagation Method	Comments
Seed	Inexpensive and simple procedure. Seeds contain a mix of genetic material from two parents. Consequently, seedlings are not identical to their parents. Impossible to distinguish between male and female plants until they start to flower five years following germination. In addition, desirable characteristics common to the parents may be lost.
Hardwood Cuttings	Inexpensive and simple procedure, but rooting success rates are not as high as softwood rooting success rates. These plants may fruit earlier than sexually propagated plants. This method produces genetically uniform plants. Initially, availability of propagation material may be limited.
Softwood Cuttings	Inexpensive, simple and successful procedure, but some initial capital expenditure is required. These plants may fruit earlier than sexually propagated plants. This method produces genetically uniform plants. Initially, availability of propagation material may be limited.
Suckers	Simple and inexpensive technique, but available material may be limited. Suckers have poor root mass and may be susceptible to transplant shock.
Tissue Culture	Complex procedure. Techniques are not well developed at this time. Produces genetically uniform plants. Potential quick production of large numbers of plants.

Notes:

Seabuckthorn Propagation