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Extension Note

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The Silviculture of Hybrid Poplar Plantations

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The objective of this extension note is to provide general information on hybrid poplar management, highlighting key areas and topics to consider when establishing a poplar plantation.

Introduction

As demand for wood products and fibre increases, forest managers face the challenge of growing more wood on less land. Shorter rotations and diversification of products may help mitigate this pressure.

Hybrid poplars grow quickly. The rotation age ranges from 10 to 26 years in British Columbia depending on a number of factors, including climate, site, and management regime. The more intensive the management, the shorter the rotation.

Hybrid poplar is used primarily for pulp, but can also be used for lumber and plywood. Markets for the latter products are developing and need to be encouraged. Non-wood uses include ornamental plantings, soil stabilization, and conservation. In British Columbia, hybrid poplar plantations are being grown in the interior, and on the south coast, mid-coast, and Vancouver Island.

Site Selection

Hybrid poplars have a high demand for moisture and nutrients. Poplars prefer moist, well-drained sites, and grow well on fluvial floodplains where water and nutrients are abundant. They are also tolerant of periodic flooding, especially in the winter when they are not actively growing (Figure 1). Best growth and the shortest rotations occur on the south coast of British Columbia, where there is a long growing season and ample rainfall.

FIGURE 1 *Salmon left in poplar plantation following periodic flooding of a river, near Crofton, B.C.*

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The colder and drier the climate, the longer the rotation age. However, given adequate water and nutrients through irrigation, poplar grows well on coarse soils and in drier climates in British Columbia. Frost and winter cold are factors to consider because they can severely damage hybrid poplar trees. Frost-tolerant hybrids should be grown in these colder areas.

Site Preparation

Site preparation is critical to successful establishment of hybrid poplar plantations, and has a significant impact on the productivity and subsequent rotation age. In general, productivity increases with site preparation by reducing competition from non-crop species during the establishment phase of the plantation.

The intensity of site preparation depends on several factors, including the zoning of the land (agriculture or forestry), accessibility, topography, soil type, and drainage. The zoning will determine the appropriate type of site preparation. For example, land classed as forest will be subject to different regulations than agricultural land, as well as to different environmental constraints with respect to soil disturbance. Flat and accessible sites have the greatest number of options for mechanical site preparation, and remote and/or difficult topography the least. Soil type (clay, loam, or sand) and drainage determine the type of equipment to be used (if any), and the appropriate time of year for site preparation. In general, these factors determine the choice of management regime.

Management Regime

On the south and mid-coast of British Columbia, rotation ages are 10–26 years, depending on the management regime and site productivity. Poplar are grown from unrooted stem or branch cuttings (45 cm long, with a basal diameter of 10–20 mm) or unrooted whips (cuttings 1.0–2.0 m long, with a basal diameter of 10–20 mm). These cuttings and whips are harvested and processed during January and February and placed in cold storage until planting in March and April. It is common practice to obtain whips from nurseries. However, cuttings and whips can be obtained from existing stands or during harvesting operations.

Cuttings are hand-planted with the basal end inserted deeply into the soil, leaving about 20 cm showing above the soil surface. A planting bar (dibble) is typically used to create planting holes. When long whips are used, they are planted to a depth of at least 40 cm. Whips and cuttings are generally planted at 3 m or wider spacing, with total densities ranging from 600 to 1100 trees/ha. During the first year, poplar will grow about 1.5 m in height, and from 3 to 5 m for each of the following 5 years. The target piece size is usually 32–40 cm diameter at breast height (Figure 2), and 24 m long with a 10-cm top.

FIGURE 2 *Eight-year-old hybrid poplar (TxD) near Kilby, B.C.*

Short rotation intensive culture (SRIC)
High-intensity management of hybrid poplar is often referred to as "Short Rotation Intensive Culture (SRIC)." In south coastal British Columbia, a realistic rotation age for this type of management is 10–12 years with yields of approximately 300–400 m^3/ha. Sites suitable for this regime are productive land with easy terrain and access that are close to urban centres and mill facilities (e.g., lower Fraser Valley, Vancouver Island, parts of southern interior).

This management regime involves pre-planting site preparation to remove competing vegetation. In order to maximize tree growth and reduce vole damage, vegetation management is required for the first two to four growing seasons, or until canopy closure. There are several tools available to the poplar manager that can be used alone or in combination. These include cultivation (disking, furrowing), herbicides (e.g., glyphosate), mulches (e.g., polyethylene mats), and fertilization. Fertilizers are usually applied during the third growing season. In the western United States, SRIC plantations are irrigated with nutrient solutions on a regular basis and have rotation ages of 5–8 years.

Medium-intensity management
Medium-intensity management is best suited to productive lands that have easy terrain, but that may have constrained access. For example, the islands at the confluence of the Harrison and Fraser rivers have limit-

ed access during part of the year when water flow is high, but, during periods of low flow, vehicular access to some islands is possible.

This form of management is less intensive than SRIC and has a rotation age of 15–20 years with potential yields of 300–400 m^3/ha. The only real difference between the two is the amount of vegetation management during the first 3 years. There is usually some form of pre-planting site preparation to reduce weed competition during the first growing season and then some basic vegetation control (mowing) or selected vegetation removal around trees (1 m^2 area). The main purpose of vegetation management in this regime is to reduce tree girdling by voles and to reduce competition from non-crop vegetation. Fertilization, if done, is usually with low-cost or free organic wastes such as manure, fish compost, or biosolids (Figure 3).

FIGURE 3 *Biosolids being applied to a 4-year-old medium-intensity hybrid poplar plantation on an island at the confluence of the Harrison and Fraser rivers, British Columbia.*

Low-intensity management

The low-intensity management regime is best suited to sites that have difficult terrain and/or access (e.g., mid-coast, Bute and Kingcome inlets) (Figure 4). This type of management is often used on forest land that was clearcut. As a result, larger whips are used so that post-planting vegetation control is unnecessary. This is because the return from the crop is usually not realized for 25–30 years following planting, and, as a result, forest managers need to minimize the number of entries prior to harvest. Potential yields for this management regime could range from 250 to 450 m^3/ha. There is usually no site preparation nor weed control, and inputs prior to harvest are kept to an absolute minimum.

FIGURE 4 *Newly planted hybrid poplar plantation in Kingcome Inlet, British Columbia.*

Clonal Selection

Hybrid poplars are crosses between different species of poplar. There are many crosses, but *Populus trichocarpa* x *P. deltoides*, often referred to as TxD (TD cross), and *Populus trichocarpa* x *P. maximowiczii*, often referred to as TxM (TM cross), are two of the more common ones used in British Columbia. Within each cross there are many clones that have been selected for various growth characteristics, including frost hardiness, disease resistance, drought resistance, stem form, and branching. Some genetic work is currently under way to create poplar clones that are resistant to glyphosate herbicide.

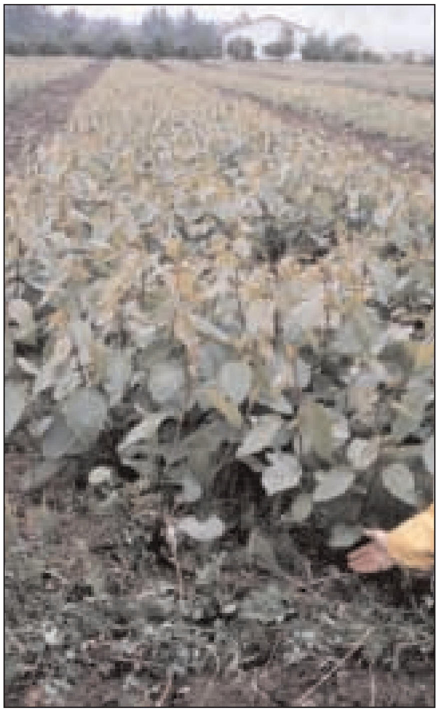

FIGURE 5 *Nursery stock being grown in the Fraser Valley, British Columbia.*

Planting material (Figure 5) is available from a number of sources within British Columbia. It is best to use only those clones that have been proven adaptable to the area. For example, in areas where *Venturia* spp. (shepherd's crook) may be an issue, planting clones resistant to this fungus would be beneficial. Companies and forest managers who are currently growing poplar in these areas should be consulted in order to benefit from their experience.

Vegetation Management

Hybrid poplars are sensitive to competition from non-crop vegetation, especially grasses, for resources other than light. SRIC and medium-intensity culture often require vegetation management for the first 3–4 years, or until canopy closure. Vegetation management improves tree growth and minimizes damage from rodents, such as voles, which girdle the root collar (Figure 6).

However, in low-intensity management regimes, vegetation management may not be an option due to site constraints or site access. In these instances it is recommended that larger (> 1.5 m) whips be planted to give the poplars additional competitive advantage.

Vegetation management tools include manual weeding, mowing, mechanical cultivation, herbicide, and mulching. Numerous studies have demonstrated the benefits of vegetation management and its positive effect on poplar growth.

Manual weeding

Manual weeding is labour-intensive and expensive. It is best suited to small, privately managed plantations where forest managers do not charge for their labour, or to plantations where there is proven damage from voles and/or competition from non-crop vegetation, and where it is not possible to get cultivation equipment on site or to apply herbicides.

Mechanical cultivation

Mechanical cultivation (disking, furrowing) between plantation rows provides some control of competing vegetation, and tree growth is greater than in non-cultivated areas. A study by Thomas et al. (2000) found that the vegetation remaining when the land was cultivated in only one direction significantly reduced tree volume (Figure 7).

Due to physical limitations of cultivation machinery and the need to minimize tree damage, the area immediately around each tree is left uncultivated and the surrounding vegetation competes with poplar whips for soil moisture and nutrients.

In addition, mechanical cultivation can be constrained by terrain and may cause soil compaction of finer-textured soils. Another consideration is that the shallow feeder roots of the poplar can be severed with each pass of the cultivator, which can have a negative effect on tree growth. On sites with easy access and terrain, cultivation costs are approximately $100/ha per treatment. It is common practice to cultivate twice yearly

FIGURE 6 *Four-year-old hybrid poplar girdled by voles.*

(spring and fall). Efficiencies can be made by reducing cultivation to once a year (in mid-spring), thereby reducing the 3-year cost from $600/ha to $300/ha. This practice will also reduce the frequency of severing feeder roots.

Mulching
Mulches used in plantations are usually opaque polyethylene mats, and are best-suited to high- and medium-intensity management regimes. They are an effective method of weed control in hybrid poplar plantations. The mats slow evaporation of soil moisture and increase soil temperature. The combination of these factors leads to increased root production, nutrient uptake, and tree shoot growth. Mulch mats are best suited to SRIC plantations where input costs are offset by the shorter rotation age and greater yields. The larger the mat, the greater the growth response. Data suggest that mats of at least 180 × 180 cm are needed to significantly improve poplar growth (K. Thomas, B.C. Min. For., unpubl.) (Figure 8).

FIGURE 7 *Non-crop vegetation left between trees when the land is cultivated in only one direction can reduce tree growth.*

Herbicide
Herbicides can be used alone or in combination with cultivation to control weeds (Figure 9). Thomas et al. (2000) found that herbicide (glyphosate) treatment of vegetation in non-cultivated strips between trees provided effective control of non-crop vegetation (Figure 10) and increased fifth-year stand volume by 30% over plantations that were only cultivated.

Application of herbicides is relatively inexpensive. However, hybrid poplar clones are sensitive to some herbicides, hence timing of application is critical to minimize damage to crop trees.

In addition, herbicide application is not permitted near streams or standing water, precluding their use on wetter sites (sites often most suitable for hybrid poplar plantations).

FIGURE 8 *A 240 x 240 cm polyethylene mat around a 2-year-old poplar.*

Fertilization

The purpose of fertilization is to accelerate poplar growth and shorten rotation age. Fertilizer is typically applied to plantations with high- and medium-intensity management during the third or fourth growing season when the canopy is closing and the poplars have established large root systems.

In general, hybrid poplars growing on intermediate to poor site classes will have a longer response to fertilization than poplars growing on nutrient-rich sites. Studies suggest

FIGURE 9 *Glyphosate herbicide (1% solution) being applied by backpack sprayer in a 2-year-old poplar plantation near Menzies Bay, B.C. Bucket shields were used to protect poplar foliage.*

that there is clonal variation in growth responses to fertilization, and research is under way to investigate the appropriate ratios of nutrients with different clones.

In recent studies on Vancouver Island, stem volumes increased up to three-fold through one growing season and up to two-fold through four growing seasons when sufficient quantities of nitrogen and phosphorus, along with potassium, sulphur, and trace elements, were added shortly after planting (van den Driessche 1999; K. Brown, B.C. Min. For., unpubl.).

To maximize the effect of fertilization, fertilizer should be applied before canopy closure, and in conjunction with vegetation management. Fertilization may have little effect if the site is relatively dry or fertile, if the fertilizers added do not contain all the required elements, or if the nutrients are not added at sufficient rates. For example, the addition of only nitrogen and phosphorus at sufficiently high quantities may lead to deficiencies of other elements such as sulphur and zinc.

The addition of trace elements, such as zinc, may increase the growth of poplars on calcareous soils, and liming has increased growth of poplars on acidic, upland soils. Specific deficiencies are best determined through elemental analysis of recently matured foliage.

Fertilizer is most commonly available in granular form and is usually a mixture of nitrogen, phosphorous, and potassium. The nitrogen is usually applied at a rate of 100–300 kg/ha and is site specific. It can be banded and then disked into the soil or broadcast from a helicopter, from the back of a tractor, or by hand.

Use of organic sources of nutrients such as animal manure, fish processing waste, or municipal sewage effluent and biosolids is beneficial to poplar growth. However, it is more difficult to control application rates of specific elements when using organic fertilizers, given the variability in moisture content and chemical composition. The organic matter added may improve water-holding capacity on relatively dry sites, and the use of such wastes may help alleviate waste-disposal problems that might otherwise occur.

Insect and Disease Problems

Although several species of insects are found on hybrid poplars, few of these have caused consistent damage to plantations. However, fungal diseases are a serious concern. Leaf rust caused by the fungus *Melampsora occidentalis* causes premature leaf drop and reduced growth. Shepherd's crook (*Venturia* spp.) (so named because of the characteristic blackening and bending of shoots to resemble a shepherd's crook) can also be a problem. These diseases are best managed by planting poplar clones that are genetically selected for resistance.

FIGURE 10 *Dead non-crop vegetation 1 month after herbicide application.*

Acknowledgements

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