

TECHNICAL NOTES

USDA-Natural Resources Conservation Service
Boise, Idaho

TN PLANT MATERIALS NO. 37

January 2001

Hybrid Poplar

An Alternative Crop for the Intermountain West

This Technical Note by Loren St. John, Aberdeen PMC Manager, describes the uses and potential demand for hybrid poplar. Information is provided on establishment, irrigation, fertilization, weed control, thinning and pruning, pests and diseases and harvesting.

File this Technical Note in the Plant Materials Section of the Field Office Technical Guide (FOTG), Section 6.

Hybrid Poplar - An Alternative Crop for the Intermountain West

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Uses and Potential Demand

The current demand for wood products is strong. Demand is increasing both domestically and internationally while at the same time, the natural resource base (native forests) is declining. Most of the wood products from the intermountain west have come from public land and harvest has declined significantly in recent years due to political and social pressures to limit harvest of native ecosystems.

Poplar (*Populus* L.) has been used and cultivated by man since historical times. Poplar grows fast, is easy to propagate and can be grown on many sites (Zsuffa, et al. 1996). In the early 1900s work began to develop hybrid poplar for its rapid growth and other characteristics (Heilman, et al. 1995). Hybrids are produced when plants of different species are crossed and they are usually more widely adapted or tolerant of environmental extremes. Hybrid vigor is the term typically used to describe the faster growth of hybrids when compared to either parent. Parent poplars commonly used to produce hybrids are black cottonwood (*Populus trichocarpa*) X eastern cottonwood (*Populus deltoides*) which are commonly referred to as TD accessions and eastern cottonwood X European cottonwood (*Populus nigra*) commonly referred to as DN accessions. The TD accessions may also be referred to as Interamerican accessions because both parents are native to North America. DN accessions may also be known as Euroamerican accessions as one parent is native to North America and the other native to Europe. Another poplar being used for crossing is Japanese poplar (*Populus maximowiczii*). Accessions produced from *deltoides* x *maximowiczii* (DM) accessions are showing good growth and resistance to melampsora rust (G. A. Kuhn, personal communication).

Hybrid poplar can be used to produce: pulp for paper; lumber and building products; as fuelwood; and in conservation plantings. Hybrid poplar pulp makes excellent paper. Current market conditions however, indicate a weaker demand for paper products (Mater Engineering, 1998). Hybrid poplar will yield straight boles resulting in more useable wood than native cottonwood, is easy to debark and has a light colored heartwood which is an advantage for lumber and plywood products. Hybrid poplar can also be used to make furniture, cabinetry, molding and other specialty wood products such as picture frames, caskets, toys and in log home production. Hybrid poplar makes a desirable fuelwood pellet that combusts thoroughly and creates a glowing coal.

Marketing studies indicate a growing demand that is greater than projected production. The strongest, potential demand appears to be saw logs that can be processed into non-structural products such as pallets, molding, paneling and furniture products (Mater Engineering, 1998). However, as with any new crop or product, absolute commitment from wood processors to purchase poplar is difficult at this time (Wearstler, 1999).

Because hybrid poplar is a special type of product, potential producers should arrange for selling before establishing plantations.

With ideal growing conditions and good cultural practices, a 20 foot saw log with 14 to 18 inch diameter can be produced in 10 years in eastern Oregon and western Idaho. Budget estimates using custom rates show costs of production to average about \$450 per acre per year and returns are estimated at \$10,000 per acre at the end of a 10-year growing cycle (Moore, M. 1997).

Hybrid poplar can be used in conservation plantings such as buffer strips because of its ability to uptake high levels of nitrates and water as well as having potential economic value (U. S. Environmental Protection Agency, 1999). The following table taken from Heilman et al. (1996) shows biomass, nutrient content, and annual uptake of nitrogen N in 4 year old clones of *Populus*:

	<u>Black cottonwood</u>		<u>Hybrids</u>	
	<u>Low-yielding</u>	<u>High-yielding</u>	<u>Robusta</u> (Euroamerican)	<u>T X D</u> (Interamerican)
Number of clones studied	3	3	1	2
Aboveground leafless biomass at 4 years (tons per acre)	13-26	29-32	20	49
Nutrient content of above (pounds per acre)				
N	84-132	150-199	215	365-375
P	12-22	26-30	36	68-94
Ca	71-161	162-182	142	239-257
Leaf fall in 4 th year (tons per acre)	1.9-2.3	2.2-2.5	2.2	2.6-2.9
Nitrogen content of leaf fall in 4 th year (pounds per acre)	55-65	61-71	73	71-75
Annual uptake of N in aboveground biomass in 4 th year including leaves* (pounds per acre)	84-103	119-142	149	241-246
Annual uptake of N in above- and below-ground biomass in 4 th year** (pounds per acre)	111-134	156-187	196	312-321

* Based on leaf fall N; thus, considered 'net' uptake since considerable translocation of N occurs prior to abscission.

** Based on the estimate of roots containing about 30 % of the nutrients present in aboveground leafless biomass.

Total annual uptake of N in productive 4 year old hybrid poplar was estimated to be about 312 pounds per acre which is probably close to the maximum uptake because by that age the plantation canopy is fully developed and production is high (Heilman, et al. 1996). Most plantation sites will require addition of fertilizer, or if poplars are being used in a buffer, additional nutrients from the water being buffered.

Black, Narrowleaf, and Fremont cottonwood are native, common, and desirable in many Intermountain West riparian zones, but hybrid poplar may establish more readily in streamside environments (Heilman et al. 1995). There is concern that planting hybrid poplars in or near riparian zones could harm the native gene pool through hybridization. Yet, widespread planting

of non-native poplars in the western United States has had a limited effect upon the genetics and ecology of native riparian cottonwoods (U.S. Environmental Protection Agency, 1999).

Establishment

The Poplar Council of the United States has listed three rules for success in growing hybrid poplars:

- 1) Use hardy, disease resistant clones
- 2) Plant in good soils. Gravelly soils will not give satisfactory yields
- 3) Control competing vegetation

The most productive sites for hybrid poplar production are well-drained soils on or adjacent to river flood plains that have soil pH values that are slightly acid (6.0-6.9) to neutral (7.0). Hybrid poplar can be successfully grown on upland sites with soil pH values approaching 9.0 but clone selection, nutrient management, and irrigation become extremely important (Wearstler, 1999). A hybrid poplar suitability study utilizing GIS (Geographic Information System) was completed to determine the extent of suitable soils for hybrid poplar in the Pacific Northwest (Idaho, Oregon, and Washington) and is available on the internet at <http://id.nrcs.usda.gov/soils/poplar.html> (Hoover, 1999). The criteria to develop the map was:

Well-drained to moderately drained soils
Deep soils with bedrock below 60 inches
Soil pH values 4.7 – 8.0

The choice of accessions to grow should be determined by the soils and climate. Based on work in eastern Oregon and western Idaho the recommendation is to plant sites with soil pH values below 7.5 with accessions 50-197, 52-225, 195-529 and 311-93. The only accession recommended for soils with pH values above 7.5 is OP-367 (Wearstler, 1999). A hybrid poplar adaptation trial currently underway at the Aberdeen, Idaho Plant Materials Center where the soil pH ranges from 7.4 to 8.4 indicate that OP-367 and 52-225 are performing the best.

New hybrid poplar accessions become available periodically and it is important to obtain information on their suitability to the climate and soils before they are planted. Information on adaptation can be obtained from universities in the Pacific Northwest conducting hybrid poplar suitability trials, reputable nurseries, NRCS plant materials centers, and specialists working in hybrid poplar production. Sometimes accessions have names attached, such as Robusta and Eridano. It is important to understand where they originate. Robusta is an old DN accession and Eridano is a DM accession developed in New Zealand (G. A. Kuhn, personal communication).

Lighter textured soils such as sandy loams and silt loams are generally best, but heavier soils can produce excellent growth if the soil is loose and friable (Heilman, et al. 1995).

The third (and perhaps the most important rule) is controlling competing vegetation. **Successful site preparation and weed control begin by controlling perennial vegetation and cultivation**

of the site during the summer and early fall prior to planting (Wearstler, 1999), (Heilman, et al. 1995). The first consideration is the control of perennial weeds. If the potential site is currently in pasture, a nonselective vegetation killing herbicide should be applied in the spring before pasture plants reach a height of 5 inches. Plow the ground two weeks after herbicide application and summer fallow periodically (Heilman, et al. 1995). If the site has been in annual crop production, a herbicide application of glyphosate (Roundup)* alone or in combination with 2,4-D amine may be applied in the fall prior to planting and ripping on 3.5 foot centers to a depth of 18-24 inches and in two perpendicular directions followed by cultivation to a depth of 9-10 inches prior to planting (Wearstler, 1999).

Spacing of trees for maximum yield should take into consideration the market size of the product, desired rotation length, cost of plantation establishment and design for weed control and harvesting (Heilman, et al. 1995). If trees are harvested for pulp or chips, trees as young as one year old can be used and spacing as close as 2 x 4 feet may be used. Spacing for longer cutting cycles can range up to 14 x 14 feet. Canopy closure for saw log production should occur after 4 years of growth.

<u>Cutting cycle</u>	<u>Spacing</u>
1-3 years	2x4 feet
5	5x5
8	8x8 to 8x10
10	10x10 to 12x12
12	12x12 to 14x14

* Trade names are used solely to provide specific information and should not be considered a recommendation or endorsement by the Natural Resources Conservation Service.

Hybrid poplar plantations are established with cuttings. The standard size is 3/8 inch minimum diameter by 9 inches long with a healthy bud in the top one inch. Cuttings should be from vigorous, disease-free parents and must be dormant and refrigerated at temperatures of 34 –38° F. in plastic bags prior to planting (Wearstler, 1999). Eighteen inch length cuttings are recommended for planting where elk or deer damage could occur or for re-planting replacements during the second growing season.

Planting should begin in the spring as soon as irrigation water is available and after native cottonwoods have begun flowering. Standard size cuttings should be planted to a depth so that the top bud is just above the soil line. If 18 inch cuttings are used, nine inches should be planted below ground. Buds above ground will sprout. Multiple shoots will provide browse for big game and allow at least one shoot to escape predation. To encourage root development, it is helpful to soak the lower ¼ to ½ of the cutting in water at air temperature out of direct sun for 24 hours prior to planting. Soaking initiates root growth processes within the inner layer of the bark. **Cuttings must be planted prior to root emergence** (Hoag, 1993).

Planting the cuttings may be accomplished several ways. If the number of cuttings to plant is small, punching a planting hole with a ½ inch diameter steel rod to a depth of 8 inches could be used. The preferred method is mechanically cutting a slit 8 inches deep with a shank or coultter. This will also facilitate marking of planting rows. Sites should be well irrigated immediately prior to planting and as soon as possible after planting. It is critical to establish firm soil contact around the cutting (Wearstler, 1999). It is also extremely important to ensure that cuttings are planted right side up. To identify which end of the cutting is the top, examine the leaf scar and emerging buds. Buds emerging from leaf scar always point up. And, it may be helpful to mark the tops of the cuttings prior to soaking with a 50:50 mix of light colored latex paint and water (Hoag, 1993).

Management - Irrigation

It is difficult to over-water newly planted hybrid poplar. Newly planted cuttings have been covered by floodwater for four to six weeks without adverse effects. Hybrid poplar should be irrigated at least twice per week during the first four to six weeks after planting and then should be irrigated at least once per week during the growing season (Wearstler, 1999).

The table on the following page was taken from James et al. (1989) and illustrates the comparison of water use of hybrid poplar with common crops:

Crop	Estimated water use (inches/acre/year)
Alfalfa	28-45
Apples w/ cover crop	34-50
Onions (dry)	30-36
Potatoes	28-34
Sweet corn	24-28
Winter wheat	25-31
Hybrid poplar (1 st year)	10-14
Hybrid poplar (2 nd to 3 rd year)	22-26
Hybrid poplar (4 th year to harvest)	32-36

Twenty five percent of the total irrigation water should be applied prior to mid-June, 50 percent should be applied between mid- June and mid-August and the remaining 25 percent should be applied after mid-August. Irrigation should be consistent both in timing and amount during each of the three irrigation periods. Poplars are shallow rooted (most roots are in the upper 3 feet of the soil profile) and optimum growth is achieved when uniformly irrigated (Wearstler, 1999).

The two most common irrigation systems used for hybrid poplar production are micro-spray sprinklers and drip emitters (Kuhn and Nuss, 2000). Both of these systems usually have an above ground lateral line that delivers water to the sprinklers or emitters spaced down the rows. Any buried flexible piping should be used with caution due to the potential for crimping or

plugging by tree roots. Filtration of the irrigation system is essential to protect pumps and sprinklers or emitters. Micro-spray sprinklers should have a minimum of a 50-mesh filtration system and drip emitter systems should have a minimum of 150 mesh. Sand media filtration may be required for irrigation systems when there is a heavy load of suspended organic particles in the irrigation water.

Micro-spray sprinklers achieve irrigation uniformity best. Micro-spray sprinklers are placed between the tree rows and have a wetted diameter ranging from 16 to 26 feet with discharge rates of 5 to 25 gallons per hour. They may be placed on the ground with a stake or threaded into a riser. Pressure ranges from 20 to 60 psi depending upon the size of the wetted diameter (Netafim Irrigation, INC.). Micro-sprinklers are designed to maintain uniform flow with changes in pressure, and are designed to self-flush which aids in preventing clogging. Impact sprinklers have also been successfully used (Kuhn and Ness, 2000).

Corrugate (furrow) irrigation creates difficulty in achieving uniform application of water (Wearstler, 1999). However, if corrugates must be used, it is recommended that corrugates be spaced evenly on 2 foot centers between tree rows and corrugates nearest the tree rows be used to establish the cuttings until July of the first growing season and then all corrugates used for the remaining irrigation applications.

Management – Nutrients and Fertilization

Inadequate soil moisture, especially on highly alkaline sites, can cause severe nutrient imbalances. Nutrient management of poplars is very site specific and needs to be based on soil, water, and foliage analysis (Wearstler, 1999). Foliage analysis from the poplars growing on a site is the most efficient method to determine nutrient needs. Generally, fertilizer application is not recommended until abnormal growth or chlorotic foliage symptoms begin to appear. Poplars grown on well-managed farm land may only require occasional fertilizer applications to maintain optimum growth.

The most serious nutrient management problems occur on alkaline calcareous soils (pH greater than 7.0 (Colt, et al. 1997). Iron chlorosis causes leaves to become yellow to yellow-green color in the areas between the veins, usually causing the leaf veins to be a darker green color. This condition is associated with a lack of available iron and is common in southern Idaho. The chlorosis may affect only a single branch or the entire tree. Iron chlorosis can be corrected by adding available iron or by increasing the soil acidity. Iron sulfate or chelated iron compounds can provide an immediate supply of available iron and are most effective if applied to the foliage. Acidifying irrigation water can also correct chlorosis problems (Wearstler, 1999).

Management – Weed Control

The goal of weed control during the first three years of a poplar planting should be to keep the height of competing vegetation less than 6 to 8 inches using herbicide and flail mowing. Cultivation is not recommended as an effective weed control technique after trees are planted (Wearstler, 1999) because the majority of the roots are very shallow. Immediately prior to planting, a site should be well irrigated and receive a broadcast application of oxyfluorfen (Goal)

herbicide (**read and follow all label directions when using any pesticide**). Glyphosate (Roundup) is usually used following planting but extreme care must be taken to prevent exposure to the newly planted trees. Trees must be covered or shielded from any spray. Other herbicides which may be necessary to use include fluzifop (Fusilade) to control annual and perennial grasses; metolachor (Dual) to control nutsedge; and clopyralid (Stinger) to control Canada thistle. The use of flail mowers are strongly recommended to effectively chop weeds into a form that minimizes habitat for rodents and also dispose of limbs from pruning during the second to fourth year of a planting (Wearstler, 1999). Once a plantation canopy is developed, the shading the canopy provides eliminates most weeds. Between row cover crops should be discouraged.

Management – Thinning and Pruning

Thinning and pruning are essential to produce high-value wood products from hybrid poplar (Wearstler, 1999). Thinning is the removal of double or multiple stems from the tree following the first growing season. The goal is to have a single straight stem. Pruning is the removal of branches from the main stem following the second, third, and fourth growing seasons to eliminate knots in the first 18 feet of the main stem. It is extremely critical to not prune more than 50 percent of the live crown of a tree. Thinning and pruning must be accomplished when the tree is dormant (December to mid-February). Trees are generally side-pruned to a height of 6 feet following the second growing season, 12 feet following the third growing season and 18 feet following the fourth growing season.

When pruning, it is important to avoid injury to the bole (trunk) and the branch collar. The branch collar is the swollen area at the base of the branch. Cut outside the branch collar and never cut flush with the bole. Cutting outside the branch collar will allow the wound to seal faster and will also help reduce decay from entering the bole. Tools need to be sharp and pruning wounds do not need to be treated with a wound dressing or paint (Moore, 1999).

Management – Pests and Diseases

Many insects feed on poplar. The key to minimizing the impacts of pests is to plant disease resistant clones and maintain healthy trees (Wearstler, 1999). Major insects that occur in the Pacific Northwest and feed on poplar include (Heilman et al. 1995):

- Sawfly larvae (*Nematus* or *Hemichroa spp.*)
- Dark brown poplar aphid (*Pterocoma populifoliae*)
- Poplar leaf skeletonizer (*Chrysomela aeneicollis*)
- Leaf-folding sawfly (*Phyllocolpa bozemani*)
- Populus bud midge, Big sticky bud midge (*Contarinia spp.*)
- Poplar gall borer (*Saperda populnea*)
- Poplar leaf beetle (*Chrysomella scripta*)
- Clearwing borer (*Sesidae spp.*)
- Poplar and willow borer (*Cryptorhynchus lapathi*)
- Thrips (*Thysanoptera*)
- Tarnished plant bug (*Lygus elisus*)

The large scale, industrial poplar plantations for paper pulp in eastern Oregon and Washington have routinely been treated for Poplar leaf beetle. When growing poplar for high-valued wood products, concerns for poplar leaf beetle control are only during the first three growing seasons (Wearstler, 1999).

The most common diseases of poplar that occur in the Pacific Northwest include (Heilman et al. 1995):

- Leaf blotch (*Cladosporium herbarum*)
- Black stem (*Cytospora spp.*)
- Leaf spot (*Marssonina spp.*)
- Septoria leaf spot (*Septoria musiva*)
- Leaf blister (*Taphrina populi-salics*)
- Shepherd's crook (*Venturia spp.*)
- Poplar rust (*Melampsora occidentalis*, *M. medusae*, *M. larici-populina*)

In eastern Oregon and western Idaho, deer have been the most important pest of smaller (less than 5 acres) poplar plantings (Wearstler, 1999). Simple, well-maintained electric fence has proven effective. For plantings 5 to 20 acres, planting 18 inch cuttings that produce multiple shoots have enabled the poplar to outgrow deer browsing without fencing. Plantings greater than 20 acres have not had deer problems because feeding is dispersed. Other animals that can cause damage to poplar plantings include domestic livestock, elk, beaver, porcupines, rabbits, pocket gophers and voles or meadow mice (Heilman, et al. 1995).

Coyotes and other predators can help in controlling rodents and rabbits. However, in some hybrid poplar plantations they have caused substantial damage by chewing on drip irrigation tubing (Moser and Witmer, 2000).

Agriculture Handbook 677 “A Guide to Insect, Disease, and Animal Pests of Poplars” describes and illustrates the major insect, disease, and animal pests of poplars and provides information on identification and control of poplar pests (Ostry, et al. 1988).

Harvesting

Most hybrid poplar plantations will be grown to a specific age and harvested as clearcuts. However, interest also exists in growing poplar in up to 20 acre plantations where the trees may be thinned and removed in partial cuts as in production of fuelwood (Heilman, et al. 1995). Felling in a small-scale harvest is usually done with a chainsaw. The best time to cut firewood is personal preference. Harvesting during winter allows for lower moisture content of the wood and leaves are off the trees. If vigorous resprouting is desirable, then winter is the best time to cut. Late summer is probably best on wet sites and others advocate felling fuelwood in early summer to take advantage of better drying weather during the summer.

Most harvesting of large scale plantations in the Pacific Northwest use conventional feller bunchers and grapple skidders (Heilman, et al. 1995). Research in the development of high-speed machines that continuously fell trees and carry them is ongoing. The development of

machines that cut lateral roots and harvest the stump intact with the bole, to obtain more useable chips and leaving the field free of stumps is also underway.

Stump removal is a concern following harvest. Short harvest cycles (4 to 5 years) will allow multiple harvests before replanting is needed. Dormant season harvest ensures maximum sprout vigor and up to three harvests may be possible before replanting is necessary. When harvest cycles exceed 4 or 5 years sprouting becomes less reliable; sprouts are weaker, resulting in trees being susceptible to wind throw; and resprouts are more likely to become infected with wood-decaying organisms. A grower may also want to plant new and improved clones that become available (Heilman, et al. 1995).

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