

Drip Irrigation Guide for Growers of Hybrid Poplar

*C.C. Shock, R. Flock, E. Feibert, A. Pereira,
and M. O'Neill*



Figure 1. Two-month-old hybrid poplars grown from 8-inch cuttings (foreground) and 7-year-old hybrid poplars (background).

Malheur Experiment Station, Oregon State University: *Clint C. Shock, director and professor; Rebecca Flock, former research aide; Erik Feibert, senior faculty research assistant; Andre Pereira, visiting professor (associate professor, Department of Soil Science and Agricultural Engineering, UEPG, Parana, Brazil)*

New Mexico State University: *Mick O'Neill, associate professor and superintendent, Agricultural Science Center, Farmington, New Mexico*

Over the past 15 years, the Oregon State University Malheur Agricultural Experiment Station in Ontario, Oregon, and New Mexico State University Agricultural Science Center at Farmington, New Mexico, have evaluated hybrid poplar production, including irrigation criteria, irrigation amounts, irrigation systems, cover crops, and pruning. This research has found distinct advantages for water use and wood productivity when drip irrigation is used.

Drip irrigation provides control and precision of irrigation timing, as well as the amount of water applied, while assuring high yield. As a result, drip irrigation causes significantly less erosion, less deep percolation, and less leaching than furrow irrigation. Drip irrigation can be managed to protect the environment, avoiding off-site losses of fertilizer and water.

Drip systems can be tailored to each crop and field. Growers have many options for custom fitting drip irrigation to their specific situation.

It is difficult to describe in a short publication all of the factors that affect irrigation. Thus, this publication provides a framework, general recommendations, and rationales to aid growers interested in maximizing their land use and wood production through drip irrigation. Consult your local Extension agent or other agricultural professional for additional information.

Initial interest

As native timber supplies become less available, alternative sources of wood products are needed. Hybrid poplar wood has proven to have desirable characteristics for many nonstructural timber products. Growers have made experimental plantings of hybrid poplar for saw logs, peeler logs, and other uses.

Poplar is the common name given to all species of the genus *Populus*. Conventional hybridization among poplar species has resulted in trees that combine desirable characteristics of different species. Hybrid poplars are grown as short-rotation woody perennials.

Site selection

Hybrid poplars grow best in fertile, productive agricultural soils. Poplars need adequate moisture. The best sites have annual precipitation close to the water use of the trees or access to groundwater or irrigation.

Poplar prefers a soil pH of 5.5 to 8 and does not do well in excessively acid or alkaline soils. Poplar clones vary in their growth rates and tolerance to alkaline soils (pH > 8). Select clones based on their adaptation to soil pH and climate.

Medium-texture soils are preferred. Avoid soils subject to flooding during the summer growing season. While it is not always possible to use the best site, avoid very poor sites because they result in low productivity and high operating costs.

Also consider operational factors such as the plantation location in relation to markets and easy access within the field for efficient operations and harvest. Consider field shape, topography, and drainage for efficient mechanization.

Plant population and planting

It is difficult to predict the optimum tree population. Generally, as tree population decreases, tree size increases. High tree populations, as used for pulp production, produce high yields of very thin trees. In the Treasure Valley, hybrid poplar grown for saw logs is planted at a 14-foot by 14-foot spacing (222 trees per acre). The minimum marketable tree size for saw logs is 12-inch diameter at breast height (4.5 feet from the ground).

In the Treasure Valley, poplar trees normally are planted at leaf-out in mid-April as 8-inch dormant sticks. Some producers find that 13- to 14-inch sticks result in young trees with stronger root systems that are less subject to being uprooted by wind. The ideal small-end diameter of sticks is ½ to 1½ inches. Leave one leaf bud of the stick above ground. Irrigate the

newly planted sticks immediately, and keep the soil wet until after bud break and rooting.

Rather than planting sticks, some producers plant poles. Poles are grown on a “stool bed” of stumps. One-year-old poles are 9 to 12 feet tall. Two-year-old poles are 15 to 18 feet tall. Before planting, all side branches are trimmed from the poles. Only very straight poles are used. The poles are inserted into vertical holes three feet deep. Starting trees from poles is more expensive but has the advantage of developing very straight trunks.

Keep the plantation free of weeds or other vegetation. Weeds or crops growing between the tree rows can significantly reduce tree growth, especially during the first 3 years (Shock et al., 2002a).

Getting started with drip irrigation

When designing a drip system, first determine the different irrigation zones. Irrigation zones are based on factors such as topography, field length, soil texture, optimal tape run length, and filter capacity. An irrigation engineer and system supplier may need to determine these factors and design the drip system. Once the zones are assigned and the drip system designed, it is possible to schedule irrigation to meet the unique needs of each zone.

Daily crop water use

Irrigation application must reflect crop water use. Therefore, it is crucial to plan how much water to apply and when to apply it to optimize efficiency.

One aim of irrigation is to replace the daily crop water use. Estimated daily hybrid poplar water use in the Treasure Valley is available on the Malheur Experiment Station website (<http://www.cropinfo.net>). Daily water use for hybrid poplar can be as high as 0.55 inch per day. Average growing season water use for 3-year and older hybrid poplar is 45 or more acre-inches/acre.

Water applied at any one irrigation should not exceed the soil water-holding capacity. Customize irrigation intensity, frequency, and flow rates to meet the specific water needs of the crop and soil water-holding capacity of each field.

Drip system characteristics

Typically, poplar plantations use drip tubing laid on the ground along the tree row. Do not bury the drip tubing because roots can grow into the emitters and cause plugging.

The drip tubing emitters determine the flow rate of the water onto the soil. Ideal emitter flow rates depend on the soil type. Coarser soils usually require higher emitter flow rates.

At the Malheur Experiment Station, poplar research is conducted on silt loam with a slope of about 3 percent. The drip irrigation system uses two drip tubes along each tree row, with emitters spaced 12 inches apart. Low-flow emitters (0.132 gal/hour or 0.5 liter/hour) provide uniform wetting without runoff. This system applies 0.03 acre-inch/hour.

In the Columbia Basin of Oregon, commercial plantings on sandy soils use one drip tube along each tree row, with emitters spaced 3.75 feet apart. This system applies 0.03 to 0.06 acre-inch/hour using 0.42 to 0.75 gal/hour emitters.

With older trees, drip tubing can be moved between the rows of trees to stimulate the growth of wider root systems. Wide root systems help avoid uprooting of trees during windstorms.

Irrigation scheduling

Why measure soil water tension?

Soil water tension (SWT) is economically and environmentally important because it is the measure of how strongly water is held in the soil. Tree growth is related to the amount of energy needed for plant roots to remove water from the soil.

SWT indicates the best moment to irrigate to maximize yield. SWT also provides information on soil saturation, which can help growers avoid saturating the soil, thereby maintaining aeration of plant roots and reducing leaching losses of water or nutrients. Viewed on a graph, the SWT readings clearly indicate the relative soil moisture condition in the tree root zone.

The use of granular matrix sensors and tensiometers to determine crop water needs is discussed in *Irrigation Monitoring Using Soil Water Tension*, EM 8900 (Shock et al., revised 2013).

Recommended SWT

Based on a 3-year study at the Malheur Agricultural Experiment Station (Shock et al., 2002b), it is recommended that drip-irrigated hybrid poplar in the Treasure Valley of eastern Oregon and southwestern Idaho be irrigated when SWT at an 8-inch depth reaches 25 cb. This threshold for irrigation onset prevents yield reductions under the experimental conditions of the Malheur Experiment Station.

Intensity and frequency

Growers can expect to irrigate drip-irrigated fields more frequently than furrow-irrigated fields. One reason is simply that less water is applied per irrigation cycle with drip irrigation.

Poplar drip-irrigation systems inherently have low water application rates because of the wide spacing of the drip tubing and because water application is calculated based on the whole area between trees. Installing more drip tubes along the tree row would raise the system cost, and water application could exceed the intake rate of the soil. Installing more drip tubes between the tree rows would also complicate equipment traffic.

In research plots at the Malheur Experiment Station, optimum tree growth is achieved if 1 inch of water is applied when the soil water tension reaches 25 cb (Shock et al., 2005). With this schedule, the interval between irrigations (the time between the end of one irrigation and

the start of the next) is about 1 to 3 days during July and August.

In the Columbia Basin, with systems using one drip tube per row of trees, plantations are irrigated daily, applying the amount of water used the previous day.

With an application rate of 0.03 acre-inch/hour, it takes 17 hours to apply 0.5 acre-inch of water.

Pumps and filters

Every trickle counts when you are battling a water shortage. An ineffective or improperly managed filter station can waste a lot of water and threaten a drip system's fitness and accuracy.

In the West, sand media filters have been used extensively for microirrigation systems. Screen filters and disk filters are common as alternatives or for use in combination with these filters.

Sand media filters provide filtration to 140 to 200 mesh, which is necessary to clean surface water and water from open canals for drip irrigation. These water sources pick up a lot of fine grit and organic material, which must be removed before the water passes through the drip tape emitters.

Sand media filters are designed to be self-cleaning through a "back flush" mechanism. This mechanism detects the drop in pressure due to the accumulation of filtered particles. It then flushes water back through the sand to dispose of clay, silt, and organic particles.

Sand used for filters should be between mesh size 16 and 20 to prevent excessive back flushing. To assure enough clean water for back flushing, several smaller sand media filters are more appropriate than a single large sand media filter (Gelski, 2003).

In addition to a sand media filter, a screen filter can be used as a prefilter to remove larger organic debris before it reaches the sand media filter, or as a secondary filter before the irrigation water enters the drip tube (Figure 2,

page 5). For best results, filters should remove particles four times smaller than the emitter opening, as particles may clump together and cause clogs. Screen filters can act as a safeguard if the main filters fail, or may act as the main filter if a sufficiently clear underground water source is used.

System maintenance

The drip hose should be lifted periodically so that leaves, soil, and debris do not cover the hose. If the drip hose is not lifted, roots will grow over the hose, anchor it to the ground, and eventually pinch off the flow of water.

Flow meter

Place a water flow meter between the solenoid valve and each zone and record its gauge daily. This provides a clear indication of how much water is applied to each zone. Records of water flow can be used to detect deviations from the standard flow of the system, which may be caused by leaks or by clogged lines.

Watch for leaks

Leaks can occur unexpectedly as a result of damage by insects, animals, weeding crews, or farming tools. Systematically monitor the lines for physical damage. It is important to fix holes as soon as possible to prevent uneven irrigation.

Chlorine clears clogged emitters

If the rate of water flow progressively declines during the season, the tubes may be slowly plugging, resulting in severe damage to the crop. In addition to maintaining the filtering stations, regular flushing of the drip tube and application of chlorine through the drip tube will help minimize clogs. Once a month, flush the drip lines by opening the far ends of a portion of the tubes at a time and allowing the higher velocity water to wash out the sediment.

Because algae growth and biological activity in the tape are especially high during June, July, and August, chlorine usually is applied at

2-week intervals during these months. Buffering the irrigation water to below pH 5.0 increases chlorine activity significantly.

If drip lines become plugged in spite of maintenance, many cleaning products are available through irrigation system suppliers. Choose a product appropriate for the specific source of contamination.

Chemigation

Manage irrigation and fertilization together to optimize efficiency. Chemigation through drip systems efficiently delivers chemicals in the root zone of the receiving plants. Because of the precision of application, chemigation can be safer and use less material. Several commercial fertilizers and pesticides are labeled for delivery by drip irrigation.

Injection pumps with backflow prevention devices are necessary to deliver the product through the drip lines. These pumps allow for suitable delivery rate control, while backflow prevention protects both equipment and the water supply from contamination. Remember that in Oregon, water belongs to the public, not the landowner. Other safety equipment may be required; contact a drip-irrigation system supplier for details.

Fertilizers

Fertilizer can be injected through the drip system. Typically, less nitrogen fertilizer is needed with drip irrigation than with furrow irrigation because the fertilizer is spoon-fed to the root system and little is lost to leaching. Leaf tissue analysis performed by a qualified agricultural lab can help determine poplar nutrient needs during the season.

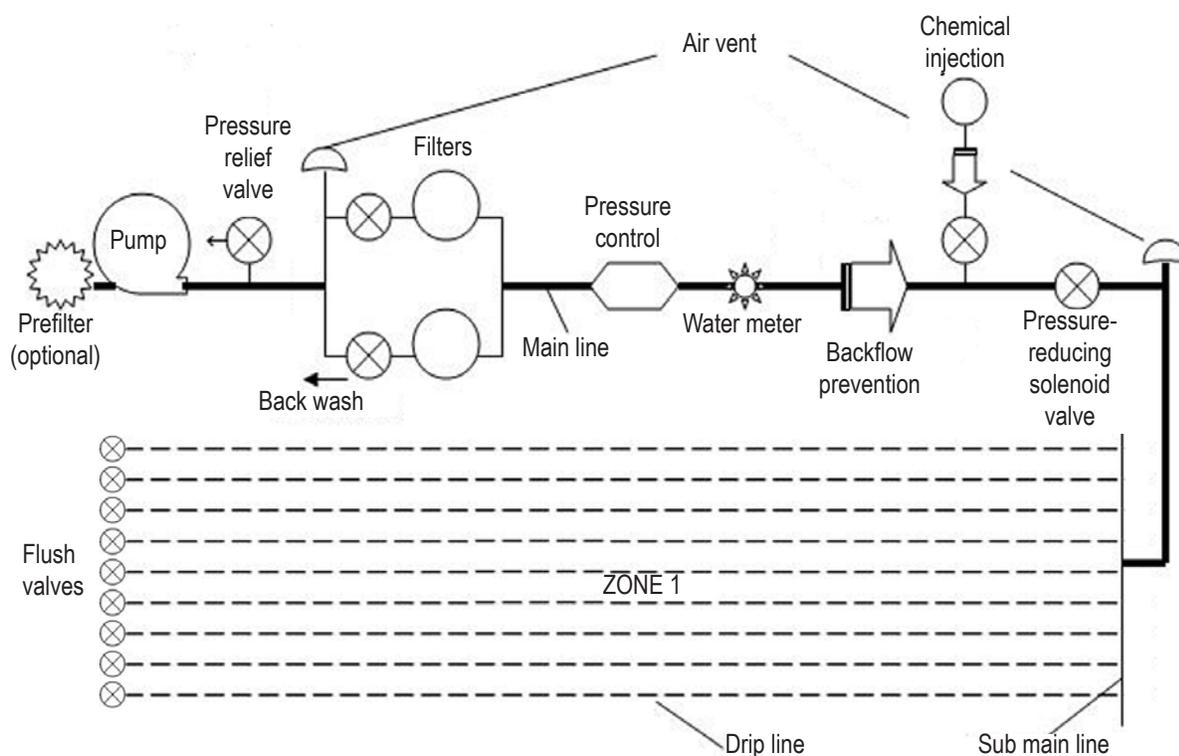


Figure 2. Drip irrigation system with a prefilter, pump station with backflow prevention, and chemical injection site. A pressure control valve is recommended to adjust the water pressure as desired before it enters the drip lines. A water meter can be placed after the pressure control or between a solenoid valve and each zone. An air vent provides vacuum relief. Vacuum relief is necessary between the solenoid valve and the drip tapes to avoid suction of soil into the emitters when the system is shut off.

For more information

Burt, C.M. and S.W. Styles. 2011. *Drip and Micro Irrigation Design and Management for Trees, Vines, and Field Crops*. Cal Poly, San Luis Obispo, CA.

Gelski, J. 2003. Avoid Filter Frustration. Available online at <http://www.growermagazine.com/home/02-03filters.html>

Lamm, F.R., J.E. Ayars, and F.S. Nakayama (eds.). 2007. *Microirrigation for Crop Production—Design, Operation and Management*. Elsevier Publications. <http://www.elsevier.com/books/microirrigation-for-crop-production/lamm/978-0-444-50607-8>

Schwankl, L.J. and T. Prichard. 2001. *Chemigation in Tree and Vine Microirrigation Systems*. Agriculture and Natural Resources Publication 21599. University of California, Davis, CA.

Schwankl, L.J. 2013. Maintenance of Microirrigation Systems (website). <http://ucanr.org/sites/Microirrigation>

Shock, C.C., E.B.G. Feibert, L.D. Saunders, and M. Seddigh. 2002a. Initial growth of irrigated hybrid poplar decreased by ground covers. *Western Journal of Applied Forestry* 17:61–65.

Shock, C.C., E.B.G. Feibert, M. Seddigh, and L.D. Saunders. 2002b. Water requirements and growth of irrigated hybrid poplar in a semi-arid environment in Eastern Oregon. *Western Journal of Applied Forestry* 17:46–53.

Shock, C.C., E.B.G. Feibert, and L.D. Saunders. 2005. Micro-irrigation Alternatives for Hybrid Poplar Production. 2004 Trial. Oregon State University Agricultural Experiment Station. Available online at <http://www.cropinfo.net/AnnualReports/2004/poplar%20irrigation04.php>

Shock, C.C. Revised 2013. *Drip Irrigation: An Introduction*. Oregon State University Extension publication EM 8782. Available online at <http://ir.library.oregonstate.edu/xmlui/bitstream/handle/1957/20206/em8782-e.pdf>

Shock, C.C., F.X. Wang, R. Flock, E.B.G. Feibert, and C. Shock. Revised 2013. *Irrigation Monitoring Using Soil Water Tension*. Oregon State University Extension publication EM 8900. Available online at <http://ir.library.oregonstate.edu/xmlui/bitstream/handle/1957/20424/em8900.pdf>

For more Extension publications on irrigation management, visit the OSU Extension website at <http://extension.oregonstate.edu>.

Acknowledgments

Funding to help prepare this publication was provided by an Oregon Watershed Enhancement Board Grant.

Quick Facts

- Drip irrigation is the slow, even application of low-pressure water to soil and plants using plastic tubing placed directly at the plants' root zone.
- Drip irrigation causes little evaporation or runoff, saves water by directing it more precisely to the root zone, reduces the transmission of pathogens, and produces fewer weeds.
- Drip irrigation systems facilitate water management in fields that are difficult to irrigate due to variable soil structure or topography.
- Poplar wood productivity responds very sensitively to irrigation management. Recommended soil water tension at an 8-inch depth for irrigation onset for drip-irrigated poplar is 25 centibars (cb).
- "Soil water potential" is the negative of "soil water tension." A soil water potential of -20 cb is the same as a soil water tension of +20 cb. Also, cb is the same as kPa (kilopascals).
- Drip systems require careful design and maintenance.

© 2013 Oregon State University.

Extension work is a cooperative program of Oregon State University, the U.S. Department of Agriculture, and Oregon counties. Oregon State University Extension Service offers educational programs, activities, and materials without discrimination based on age, color, disability, gender identity or expression, genetic information, marital status, national origin, race, religion, sex, sexual orientation, or veteran's status. Oregon State University Extension Service is an Equal Opportunity Employer.

Trade-name products and services are mentioned as illustrations only. This does not mean that the Oregon State University Extension Service either endorses these products and services or intends to discriminate against products and services not mentioned.

Published December 2005. Revised January 2013..