IRRIGATION REGIMES IN A BARE-ROOT NURSERY

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"Irrigation is an important nursery management tool for modifying the seedling *environment and influencing seedling behavior" (Cleary et al. 1978). Adequate irrigation* is essential to maintain sufficient water in plants. Soil moisture supply and atmospheric demand play important roles in limiting the water supply available to the plants. The basic purpose of irrigation is to uniformly distribute water with a minimum of waste, while producing a succcessful, economical crop.

I believe that in the past, and to some extent even now, some nursery managers used more irrigation than was needed to produce stock. Too much water can produce stock that is morphologically and physiologically unable to survive early fall frosts in the nursery. They will also be unable to maintain vigor during refrigerated storage periods and may not survive and grow on droughty planting sites similar to the steep, shallow, soiled slopes that face south and west in southern Oregon. The application of too little water produces its own problems. Seedlings can be droughted-stressed in the nursery to a point where the shoot and root mass is reduced and/or the plant is damaged or killed.

The best irrigation regime for any given nursery cannot, and should not, be extrapolated and used in its pure form at another nursery. The type of soil, time of year, climatic conditions, species of seedlings, seedling size specifications, and stage of stock development must be evaluated before and during the establishment of an irrigation regime. As stock specifications and nursery cultural techniques are altered, it will be necessary to modify the scheduling and amount of irrigation applied. To determine the "best" irrigation regime, you may use the following system.

I. Determine irrigation demands

A. Irrigation needed to enhance germination of tree seed

B. Irrigation needed to control soil temperatures after germination

C. Irrigation needed for plant growth to meet stock specifications, both shoot and root

D. Irrigation needed to compensate for losses from evaporation and/or evapotranspiration

E. Availability of water, amount, and timing (some have irrigation district water)

F. Climatic conditions
1. Temperature
a. High (heat damage)
b. Low (frost damage)
c. Diurnal fluctuations (cooler nights may result in heavier dew, which results in better recovery from day's moisture losses)

2. Wind speed (consider when windy and calm periods occur)

    a. Calm (less than 6 mph)
    b. Windy (more than 6 mph)

3. Humidity
    a. High (requires less evapotranspirative cooling)
    b. Low (increases solar intensity and requires more evapotranspiration by the plant)

G. Determine growth periods for different species (plants require more water during active growing periods)

H. Soil type (this can profoundly affect plant's ability to take up water, storage capacity, penetration rate)

I. Irrigation needed to accomplish cultural practices

1. Pesticide applications--incorporation in soil
    a. Fungicides (control of root rotting organisms)
    b. Herbicides (pre-emergents)
    c. Insecticides (control of soil-borne insects)
2. Fertilizer applications
    a. Flush fertilizer from foliage
    b. Incorporate into soil
    c. Distribute fertilizer through irrigation system
3. Root pruning, plowing, disking, and root wrenching
4. Development and breakdown of cover crop
5. Facilitation of hand weeding
6. Prepare soil for sowing, fumigation, and lifting

11. Determine monitoring method to ensure adequacy of irrigation. To accomplish this it will be necessary to research different monitoring methods and determine the applicability to your situation.

A. Gravimetric: Oven drying--most basic and most accurate of all methods. System is used to calibrate other methods.

B. Neutron Probes: This system is quick and accurate and can be economical. Some agricultural crop growers report a 50% reduction in the amount of water used. Others report increases in yield; sometimes more water was needed to obtain these increases.

C. Electrical Resistance Methods: Gypsum blocks--accuracy is hard to maintain, problems are great.

D. Visual and Tactile (see and touch) Method: Does not give quantitative results, but may be needed at such times as post-sowing for seed germination.

E. Tensiometers: Easy to operate, accurate in lower tension ranges, and excellent when high soil moisture levels (near field capacity) are maintained. When soil is dried to induce dormancy, units lose tension and are inaccurate.

F. Pressure Chambers: A quick, foolproof method of measuring plant water potential in seedlings. Readings should be taken pre-dawn. Plants recover at night but must have adequate moisture to permit recovery.

G. Computers: This is a method of monitoring that is really coming on. There are groups in Idaho and California that offer irrigation sheduling services.

H. Temperature of Crop Canopy: A concept that measures the temperature of the foliage and relates that temperature to the temperature of surrounding air. The theory is that when soil moisture levels are reduced below the plant's needs, the plant becomes stressed and its temperature rises.

After 3 full years of operation, we are using an irrigation regime that utilizes the pressure chamber and the visual and tactile techniques. We are also testing a heat sensing device and evaluating a neutron probe. The neutron probe that we are using can also determine soil compaction. We have conducted limited tests to monitor compaction created during the turning under of the cover crop. An example of the irrigation regime we use is:

2-0, 3-0, and Transplants

Prior to Irrigation Scheduling by PMS 2 hours three times per week

This schedule should be adjusted to keep soil moisture at or near field capacity. Soil samples should be taken randomly throughout the area twice weekly.

Irrigation Scheduling by PMS

June 1 - July 15: Irrigate when average pre-dawn PMS reaches 5 bars.

July 16 - October 1 (or beginning of fall rains): irrigate when average pre-dawn PMS reaches 10 bars.

All irrigation for PMS relief should be as early in the morning as possible to provide immediate relief and to take advantage of lower evaporation rates and to alleviate poor distribution patterns caused by later day winds. Duration of irrigation should be 2 hours, but a longer period may be necessary to wet the soil profile and reduce the incidence of moisture-related soil compaction.

Irrigation for Cooling

Because more water will be available to the seedlings this season, a need for cooling irrigation is not anticipated. Should stock conditions indicate a need for cooling, guidelines will be issued at that time.

1-0 Stock

After sowing and until germination is complete, keep the soil surface moist to prevent buildup of surface crust. This may require two, three, or four irrigation periods a day. Generally, irrigating for one-half hour is sufficient, but when the wind speed exceeds 5 or 6 mph, 45 to 60 minutes may be needed to provide adequate coverage over all areas.

Douglas-fir and True Firs

After germination is complete, irrigation for cooling should provide all the water necessary, but soil samples should be taken twice weekly to ensure that the soil profile is moist through the rooting depth (6-12") and that moisture related soil compaction is not occuring; if necessary, additional irrigation will be scheduled.

Cooling irrigation is done according to the following schedule:

Soil Surface Temperature	Period
35°C	6/1-6/14
36°C	6/15-6/30
38°C	7/1-7/14
40°C	7/15-7/31
43°C	8/1-8/14
46°C	8/15-end of season

Irrigation Period

Thirty minutes when wind speed is 6 mph and below, 45-60 minutes when wind speed is above 6 mph. Note that as the seedlings grow they are able to withstand higher soil surface temperatures and therefore we irrigate at increasing higher temperatures through the growing season.

Pines and Cedars

After germination is complete, irrigate according to the following schedules:

Lodgepole, Sugar, Western White, Ponderosa Pine, and Cedars

To August 15 - 1.5 hours daily in the early morning August 16 to end of season - 2 hours twice weekly

Irrigation schedule should be adjusted to maintain a proper level of soil moisture and to prevent moisture-related soil compaction. No irrigation for cooling is planned for the pines and cedars.

I encourage all of you to monitor new technology. It is too easy to become locked into a given regime when there may be more efficient ways to obtain desired results.

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