Beaver Plastics

Technical Bulletin

Buffer Zone
Copperblock Nursery : Fertigation

INTRODUCTION

A Copperblock buffer zone nursery relies on fertigation for control of loblolly seedling growth – essentially an outdoor hydroponic system. Fertigation provides:

- water for germination and plant metabolism
- water for transpiration
- water for evaporative cooling
- nutrients for assimilation and growth
- mechanics for re-oxygenation of the growing medium
- a means for applying pesticides
- frost protection

There are two application categories:

1. **Mist application** – to wet above the root collar
   - for frost protection
   - for heat alleviation
2. **Drench** – application – to wet the root plug
   - to replenish water and oxygen
   - to replenish the soil nutrients

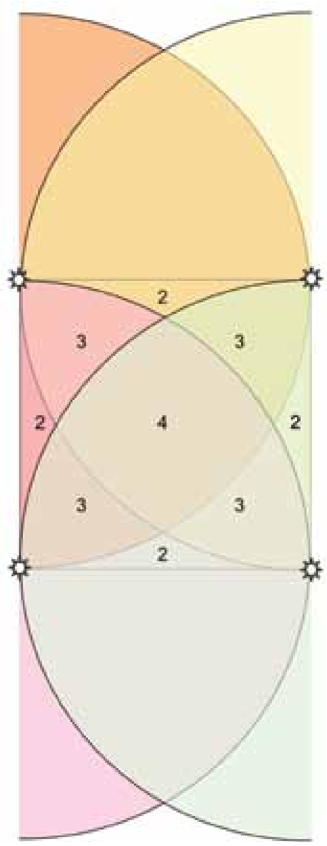
Irrigation system

The objective of the irrigation system in a Copperblock buffer zone nursery is to:

- apply uniform watering to each individual cavity
- apply water in time to satisfy needs

A buffer zone Copperblock nursery irrigation system may be:

- static
  - impact sprinkler
  - micro sprays
- moving booms
  - linear
  - center pivot



Sprinklers and Micro sprays:

System design must consider:

- Irrigation pattern – this may have zones covered by 2, 3 or 4 sprinklers. (See diagram).
- Water pressure (in PSI) at the sprinkler must be greater than the sprinkler spacing (in feet)
- Max application rate 0.8gal/hr/ft^2 (1¼"hr) [4X coverage].

Set out a cup test to determine the irrigation pattern and locate critical zones (single coverage). Irrigation must be targeted to the critical zones.

Misting – a static irrigation system can treat the entire nursery at one time (depending on pumping capacity).

Drench – to return to field capacity (FC) :

Design the system to be able to deliver 30 - 60 minutes of irrigation throughout the nursery, in one day

Boom systems:

Must be capable of cycling once per hour

Linear booms apply the most uniform distribution. In a buffer zone nursery the power unit may travel on the ground dragging the water hose or may travel on a low rail with the water hose suspended from the rail.

The limiting factor in the design of a linear boom irrigator is the length of hose to haul. Common booms span 15 ft a side and run 200 ft.

Example: 40 plants/ft^2; 6in^3/cavity; 36% WHC; 40% dry down target.
This will require 40 x 6 x 0.36 x 0.4 in^3/ft^2 irrigation to return to FC.
= 0.15 gals/ft^2.
Therefore if the application rate is 0.4 gals/hr/ft^2 (2X coverage) it will take 23 minutes of irrigation to reach FC (about ¼").

Linear booms may be fitted with misting nozzles (0.067 gpm at 40 psi) and drench nozzles (0.8 gpm at 40 psi) spaced 14" to 20" apart, and travel at variable speeds (6 ft/min for drenching).

A WET BOOM (SKDESIGN)

Center pivots are not restricted by a delivery hose, but by the edge application rate (max 0.8gal/hr/ft^2) and the rotation limit of 1 hour. A common layout holds about 16,000 Copperblock trays per pivot (100ft) and can deliver 18,000 gph (= ¾" per rotation), traveling 5 ft/min at the edge. A double-span center pivot (200ft) would have to cover 10 ft/min at the outer edge – the average application rate (AAR), at the edge, would double and the instantaneous application rate (IAR) may exceed the infiltration rate (IR) of the growing medium. A rotator sprinkler provides the widest throw distance and reduces IAR.

Max infiltration rate (for a sand soil) = 1¼/hr

A Copperblock cavity may have a 2X catchment area – so the max IAR ≤ 0.5 x IR

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IRRIGATION REGIME

For germination

The objective is firstly to provide a continuously humid environment for the seed without depriving it of oxygen through extended saturation. Secondly to ensure the surface layer (where sunlight can penetrate) dries out between irrigations to prevent the growth and development of algae. (This objective can be met with algaecides).

The growing medium is thoroughly drenched in the initial irrigation so only misting irrigations are required during germination.

The seed cover material should be selected to have a high AFP and preferably a low WHC.

The frequency of misting will depend on the rate of evaporation, which is a function of relative humidity (RH), temperature, wind and … The best advice is to inspect

Example: ½" of Styrogrit covering the seed in a Copperblock 98/105ml will hold only 16 in3/ft2 H2O. Using the 2X catchment figure only 8 in3/ft2 should be applied. (1/16"). At a maximum application rate of 1¼"/hr (on a 4 X coverage zone) this would be a 6 minute misting for the 2X coverage zone.

For frost protection

The objective is to provide sufficient irrigation to maintain a covering of ice on the seedlings at 32ºF (0ºC) during a period when ambient temperature may fall below freezing (The technique is good to about 25ºF (-4ºC) with wind speeds below 5mph). Once the process is started the seedling and deeper layers of ice (at 32ºF) are prevented from getting colder due to the latent heat of fusion released by the continuing freezing of the following misting irrigations.

The latent heat of fusion releases 80 calories for every 1 gram of water that freezes. A misting rate of ⅓"/hr will be sufficient in winds up to 5mph. If misting is interrupted, the accumulated ice layers will begin to evaporate – and the latent heat of vaporization will draw 600 calories/g of water evaporated from the surroundings, including the crop. Misting must resume before the heat loss gradient reaches the seedling tissues. Non-misting periods should be limited to 60 seconds.

If the ice is cloudy or milky white the water application rate is not fast enough

Misting must be initiated at 33ºF (0.5ºC) [wet bulb] because RH will be low and evaporative cooling of the mist will immediately lower ambient temperature. Misting must continue after the ambient temperature rises above 32ºF until the ice is melting and loose, then the heat required to melt the ice will be drawn from sunlight.

For heat alleviation

Heat stress can adversely affect seedling growth. Extreme heat from seed cover materials can damage seedling stems. The objective of heat alleviation misting irrigation is to harness the latent heat of vaporization. The seedling will be utilizing this phenomenon in transpiration but needs help.

The **wet bulb temperature** of the air is the lowest temperature that can be reached by evaporative cooling.

The evaporation of 1g water requires 600 calories. The heat absorbed by the seed cover is directly related to the density of the material. Light materials such as PBC(~12lbs/ft^3) will not become as hot as dense materials such as granite grit (92lbs/ft^3).To reduce the temperature of the material heat can be extracted by evaporative cooling.

For water replenishment

The objective is to provide sufficient moisture for plant growth at all stages of development. Water is required for transpiration and translocation of metabolites.

Block weight: Place top-loading scales under Copperblock trays at select locations throughout each irrigation area. Record block weight at FC. Irrigate at 20% to 40% weight loss – as per growing phase.

A drenching irrigation will return the growing medium to field capacity (FC). This must be monitored in the zone of lowest application rate – Copperblock trays in high application zones will receive more water but will drain to FC immediately after irrigation (with a well designed growing medium). The frequency of application will depend on the dry down regime (see Tech.Bull: Growing) and the weather.

FROST PROTECTION BY IRRIGATION

TOPLOADING SCALE

For nutrient replenishment

A drenching regime is applied to replenish oxygen and nutrients taken up by the roots from the soilless medium. The objective is to provide a uniform condition throughout the root plug.

It may be necessary to leach a buildup of salts due to high evaporation, or to replenish nutrients leached by rainfall. A full replacement requires a fertigation application equivalent to the WHC of the root plug.

FERTIGATION REGIME

Fertilizers for a Copperblock Buffer Zone nursery may be applied:
a) as solids – premixed in the growing medium.
- elemental or controlled release fertilizers (CRF)

b) as solubles – injected into the irrigation water.
- as concentrates or
- as a partially prediluted mix

c) a combination

The principles and processes for loblolly pine seedling nutrition are well known to experienced growers. Some points for Copperblock Buffer Zone nurseries are worth noting:

STARTUP Pre-mixed CRF is a simple approach, requiring no special equipment. The higher fertilizer cost is offset by equipment savings. CRF does not permit close control of seedling growth.

Loblolly fertilizer regimes are generally set in 4 phases:

1. **Germination**
Use only pure water – until cotyledon shed

2. **Starter**
High N (100ppm) – low EC

3. **Feeder** (exponential growth phase)High N (100ppm) – high EC (max 2,000µmho)

4. **Hardener**
Low N (50ppm) – high P

The selection of fertilizer sources and the formulation of mixes to achieve the desired nutrient solutions depend on water quality, growing medium and experience. The Copperblock Buffer Zone Nursery grower should be familiar with The Container Tree Nursery Manual Vol.4 Ch.1
USDA Hdbk 674.

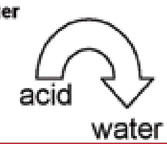
Note: Injection equipment may be required for other purposes e.g. pH adjustment

Refer to a compatibility table when formulating a stock solution for injection to avoid precipitation.

Two stock solutions are common. e.g. with calcium nitrate separate from magnesium sulphate, potassium sulphate or carbonate.

Iron chelate must be separate from sulphuric, nitric or phosphoric acid.

When diluting acid remember:
Add acid to water



The options for fertigation are:
- apply continuous feed of the target nutrient solution – ignore CEC : a simple, safe approach.
- apply alternately pure water or dilute fertilizer mix – rinse foliage – utilize CEC: requires storage tanks
- apply alternately pure water or inject fertilizer mix – rinse foliage – utilize CEC : monitor closely.

The Copperblock Buffer Zone Nursery must have the capacity to apply supplemental nutrition as a correctional treatment:

Loblolly pine seedlings grown in Copperblock trays may require increased iron nutrition – to avoid chlorosis due to iron deficiency. Apply Fe^{++} at 10ppm (Fe chelate) in the soil solution.

INJECTION

Copperblock Buffer Zone Nurseries may consist of widely separated sections – the primary concern will be delivery of clean water when necessary (leaching, misting). The nursery design will have to weigh up the advantages of central injection versus distributed injection.

STARTUP Water-powered injectors (e.g. Dosatron®) are suitable for positioning at independent buffer zone sections.

Injection rates should lie between 1:100 and 1:400 (it is more difficult to dissolve fertilizers in a more concentrated stock solution). Therefore, the flow rate of the system may govern the injector selection.

Example: a center pivot delivering 18,000 gph will need injectors capable of injecting 1 gpm of a 1:300 solution.

MONITORING

URGENT LEACH if:
$EC_{leachate}$ is > $EC_{applied}$ + 1,000 µmho/cm

The Copperblock nursery grower's constant companion should be an EC meter.

Fertigation solutions should be routinely tested. Leachate from Copperblock trays should be collected from select positions throughout the nursery (2X coverage zones) and tested on a regular schedule. (Tape over vent holes and position a clean flask below the Copperblock tray). Simple EC meters require immersion of an electrode in the solution to be measured.

Recently developed pin type meters can be inserted directly into the moist growing medium in a Copperblock cavity.

(Right: Field Scout® EC Probe)

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