Ben More Mountain Nursery (BMMN)

Manual of Adopted Best Management Practices For Production of Clean Nursery Container Stock of Native Plants for Restoration Projects

14900 Elkhead Road
Oakland, OR. 97462
Douglas County

August 30, 2024

Greenhouse, New Dual Poly Installation, September 2023

Greenhouse, Shade Cloth, Rollups, Insect Screen, July 2024

Contents

1.0 BACKGROUND

This document outlines the best management practices (BMPs) adopted for piloting and implementation by Ben More Mountain Nursey to prevent establishment of Phytophthora ramorum at the nursery and to support production of clean, healthy, native plants. BMPs to prevent Phytophthora ramorum are effective for prevention and establishment of all plant diseases and pests. BMPs for production of clean nursery stock should also prevent introduction and spread of weeds and pests such as fungus gnats.

Ben More Mountain Nursery is one of the partners of the Umpqua Native Plant Partnership (UNPP). The UNPP is focused on developing a sustainable and stepwise framework to scale-up producers and production of native plants in Douglas County over the next 5 years.

2.0 REFERENCES

Primary references for selection and development of the BMPs are:

1. "Preventing Phytophtora Infestations in Restoration Nurseries, A Key to Protecting Wildland Plant Communities," OSU Extension Service, EM 9330, January 2022. https://extension.oregonstate.edu/sites/default/files/documents/em9330.pdf
2. "Test Your Irrigation Water for Phytophtora," 2018, Dr. Redekar and Dr. Parke, OSU Department of Crop and Soil Science. https://diggermagazine.com/testing-the-waters/
3. "Best Management Practices (BMPs) for Producing Clean Nursery Stock," 3/5/2016 and 2021 updates, Tedmund J. Swiecki and Elizabeth A. Bernhardt, Phytosphere Research. Support provided by the Santa Clara Valley Water District, the California Native Plant Society, and Phytosphere Research. http://phytosphere.com/BMPsnursery/index.htm

3.0 DESCRIPTION OF FACILITIES

3.1 Nursery License, Oregon Department of Agriculture (ODA)

ODA License # AG-L109243ONG. Nursery Stock Growers & Collectors of Native plants.

3.2 Location

Ten miles northeast of Oakland, Oregon. Latitude 43.505475 deg N, Longitude 123.211653 deg W.

3.3 Elevation

1,100 feet

3.4 Greenhouse

a. Dimensions: 30 ft wide, 96 feet long, 16 feet tall (approximately 3,000 square feet)
b. Foundation: 12-minimum depth of imported gravel fill over soil and fabric. Floor graded with 1 percent slope for drainage. Geotextile fabric above gravel layer inside greenhouse.
c. Poly: Dual, 6 ml poly layers with inflation fan
d. Rollups: 6-ft tall
e. Electricity: 100-amp circuit. 12 dual outlets, 6 per each side of greenhouse
f. Exhaust Fans and Inlet Shutters: Two (2) 48" diameter exhaust fans, two (2) 48" motorized shutters. Thermostat controlled.
g. Circulation Fans: Four (4) 20-inch fans.
h. Heat: 30,000 BTU propane heater. Thermostat controlled. 1,000 gallon propane tank.
i. Water: Spring water (drinking water) source, not under influence of surface water. Water rights, Permit 47157, .07 cfs (30 gpm). Measured flow (pipe capacity) at greenhouse: 20 gpm @ 70 psi.
j. Shade Cloth: 50% knitted. Use April through mid-October.
k. Insect Screen: #25 mesh.

4.0 PLANT HEALTH (Table 1, BMPs for Nurseries, OSU Extension Service, EM9330, 2022)

4.1 Healthy Production Stock (*Table 1, BMPs for Nurseries, OSU Extension Service, EM9330, 2022*)

4.1.1. BMP 1. Routinely Monitor and Record Plant Health Throughout All Production Phases and Delivery (Nursery organization and record keeping, page 32, OSU Extension Service, EM9330, 2022 and Section 7, Swiecki and Bernhardt, 2016)

Plant health shall be monitored and recorded in a weekly log. Log will include date, ID# number of block, species, and purchaser, date and location of delivery. Form for log is included as Appendix B. Form: Monitoring Plant Production and Health. Causes of unhealthy plants will be evaluated and testing conducted for Phytophthora if warranted. See BMP 38 for Symptoms of Unhealthy Plants and Test Procedures.

Plant health monitored and recorded in log by block. If sold, the purchaser, date and location of delivery recorded.

4.1.2. BMP 2. Dispose of Unhealthy Plants in Designated Locations (*Table 1, BMPs for Nurseries and Disposing of unhealthy plants, page 14 , OSU Extension Service, EM9330, 2022*)

Unhealthy plants will be disposed of at designated locations. See BMP 22.

Disposal area outside of fenced perimeter for greenhouse.

4.2 Plants Brought in from Off-Site

Plants brought into nursery from off-site locations pose a special risk of pathogen introduction.

4.2.1. BMP 3. Do Not Acquire Nursery Stock Propagated at Other Nurseries Unless Other Nursery Has Certifiable Clean Production System and Plants are Quarantined for Minimum of 2 to 3 Months. Plant Returns Are Treated with Same Risk as Off-Site Production. (*Risks of moving plants into the nursery from off-site, page 15, OSU Extension Service, EM9330, 2022 and Section 2.13, Swiecki and Bernhardt, 2016*).

Assume nursery stock from others is infested and do not bring such material into clean production areas of the nursery (greenhouse). Stock from another nursery may be clean if it was produced entirely under a well-documented and certifiable clean production system that is substantially the same as these BMPs. If such material is accepted, maintain it in quarantine for observation and repeated testing for Phytophthora. Quarantine period of at least 8 weeks recommended in OSU EM9330 and at least 3-4 months recommended in Section 2.13, Swiecki and Bernhardt, 2016. Also monitor for other pests such as fungus gnats, which spread Phytophthora, during quarantine period.

4.2.2. BMP 4. Start with Cutting Material from Plants Free from Infection or External Contamination by Phytophthora Species as well as other Possible Pathogens (*Section 2, Swiecki and Bernhardt, 2016*)

Number of Cuttings In Single Day

Plan to only make as many cuttings as can be processed that same day.

Plant Material Location

Collect in natural locations with low probability of Phytophthora and from healthy plants.

Weather

Avoid collecting cuttings during wet or muddy conditions to minimize potential for contaminating cuttings or spreading contaminated soil.

Avoid Introducing Phytophthora into Collection Areas

Make sure equipment, vehicle, and footwear are clean. Clean and sanitize footwear and tools between locations. See BMP 35.

Height

Collect cuttings as high above the ground as possible, preferably at least 3 feet above the soil surface.

Equipment

- Pruning shears/trimmers
- Gloves
- Disinfectant (sanitize cutting tools frequently)
- Containers for transportation to propagation site (bags or trays)
- Rubber boots

Sanitize Collection Equipment and Containers

See BMP 35.

Pre-Plant Dip (https://www.canr.msu.edu/resources/greenhouse-insecticides)

Prior to planting dip unrooted cuttings in reduced risk pesticide such as ZeroTol 2.0 at 1:100 dilution.

4.2.3. BMP 5. Collect Seeds, Clean, Treat (if necessary) and Store Seeds to Keep Free from Infection or External Contamination by Phytophthora Species as well as other Possible Pathogens, or Acquire Seeds Only from Approved UNPP Producers (*Section 2, Swiecki and Bernhardt, 2016*)

Either: a) follow procedures outlined in Section 2, Swiecki and Bernhardt, for seed collection and processing, or b) seeds shall be acquired through UNPP or UNPP approved producers.

5.0 CONTAINERS AND POTTING MATERIAL

5.1 Containers

5.1.1. BMP 6. Use Only New or Properly Sanitized Containers (*Table 1, BMPs for Nurseries, OSU Extension Service, EM9330, 2022*)

Use only new or cleaned and sanitized containers, flats, racks, and trays in the nursery (Section 3, Swiecki and Bernhardt, 2016).

5.1.2. BMP 7. Do Not Accept Used Containers from Other Nurseries Unless Other Nursery Can be Identified and Has Certifiable Clean Production System (*Risks of moving plants into the nursery from off-site, page 15, OSU Extension Service, EM9330, 2022*)

Do not accept used containers from other nurseries unless nurseries have certifiable clean production system that is substantially the same as these BMPs. Never accept other nurseries' plants or empty containers left over from multi-nursery restoration projects. This transmits disease among restoration nurseries.

5.1.3. BMP 8. Do Not Store Used Containers in Clean Areas of Nursery and Do not Let Accumulate, Prior to Sanitizing (*Section 3, Swiecki and Bernhardt, 2016*).

Assume that used containers, flats, racks, and trays are contaminated. Don't store dirty containers in or near clean areas of the nursery and don't let them accumulate. Clean or dispose of them promptly. Keep used containers, etc., in bins or an enclosed area outside of the clean nursery area where the contamination can be contained and cleaned up.

Used plug containers stored outside in tub prior to cleaning.

5.1.4. BMP 9. Sanitize Used Containers with Method Listed in Table 2, BMPs for Nurseries, OSU Extension Service, EM9330, 2022

The cost of purchasing new pots is expensive and recycling pots at the nursery can be cost-effective and good for the environment. However, purchasing used pots from other nurseries creates risk (see BMP 7) and may not be cost-effective when combined purchase and labor costs are considered. OSU Extension Service, EM9330, page 15, "Sanitation approaches for containers, tools, potting media and soil", provides a detailed description of options available for cleaning and disinfection of used containers including: 1) washing and disinfection, 2) steaming, and 3) solarization. Labor requirements, effectiveness, and environmental impacts of each option must be considered. See OSU Extensions Service, EMP 9330, Table 2 for the approved list of sanitation methods and Tables 3 and 4 for safety, cost and environmental considerations of each sanitation method.

<u>Washing and Disinfection</u>

Sanitation treatments that rely on chemical sanitizers will be more effective if old potting media and plant material are cleaned off before sanitizing. The container cleaning area should not be in the clean area of the nursery (*Section 3, Swiecki and Bernhardt, 2016*). Use a two-step process for chemical disinfection of recycled containers:

1. <u>Handwash</u>. Handwash with dish soap.

Dishwashing soap, concrete mixing tub, and gloves for washing containers. Wash rags and sponges not shown. High-pressure water hose can be used to remove media prior to washing with soap.

2. Disinfect Containers.

Bleach

Disinfect for minimum contact time of 15 minutes (let sit, submerged), in diluted bleach solution of 1 part bleach per 10 parts water (Chemical Disinfectants, OSU Extension Service, EM9330, 2022). Diluted bleach solution equates to 12 oz of bleach per gallon of water. Sanitize the containers in an area outside of clean production area (outside of greenhouse) that drains away from nursery.

Bleach, glass jar for measuring, 1 gallon bucket, heavy duty gloves, and 27-gallon tote for disinfecting containers.

Hydrogen Perioxide (with stabilizer)

Hydrogen peroxide (H2O2) breaks down into water and oxygen, so the end products are non-toxic. ZeroTol is a product manufactured by BioSafe systems as a general-purpose algaecide, bactericide, and fungicide for nursery production. ZeroTol is specifically noted in OSU Extension Service, EM9330, 2022, under chemical disinfectants, as having greater stability than (due to use of peroxyacetic acid as stablizer, an organic peroxide which breaks down into vinegar and water) and lower unit cost than food-grade hydrogen peroxide. The higher the percentage peroxyacetic acid the longer the time before the hydrogen peroxide breaks down. See manufacturer's labels for recommended dilution concentrations and safety procedures. The diluted mix is sprayed (or applied with sponge) on surface until wet (runoff) and then left wet for 10 minutes.

Solarization

Solarization is a sanitation treatment method listed in Table 2, OSU Extension Service, EM9330, 2022. Snippet of Figure 37 from EM9330 follows. Since heat treatment also kills pathogens in media, the used containers do not have to be cleaned prior to solarization. Moist heat of 140 degrees for 30 minutes has been found to kill Phytophthora (page 19, Figure 32, EM9330). However, outdoor solarization may result in uneven heating and incomplete kill of pathogens and vertically stacking of containers may result in incomplete kill ("Putting the sun to work, Solarization can be effective to kill pests, pathogens and weeds," Jennifer Parke and Fumiaki Funahashi, OSU and USDA). Note that Figure 37, EM9330 shows pots placed horizontally for more consistent heating of containers. Record temperature and humidity if solarization is used.

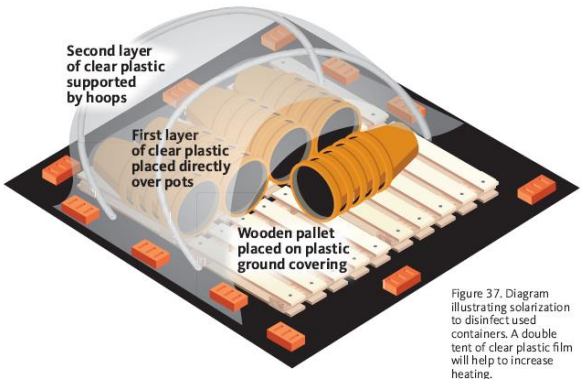


Figure 37. Diagram illustrating solarization to disinfect used containers. A double tent of clear plastic film will help to increase heating.

Steam

Steaming is the most cost-effective choice for a larger nursery, even with higher initial costs for equipment. Labor costs for treating posts with steam are far less than washing and disinfection (page 15, OSU Extension Service, EM9330). However, initial capital costs are significant for the structure to store containers during steaming. Following link is for nursey using tarp for cover: Steam cleaning nursery containers, https://www.youtube.com/watch?v=u8K7nxInYTU.

5.1.5. BMP 10. Store Clean Containers Off the Ground in Clean Racks or Bins *(Table 1, BMPs for Nurseries, OSU Extension Service, EM9330, 2022).*

Store clean containers off the ground in clean racks Do not allow your clean containers (new or sanitized) to become contaminated (Section 3, Swiecki and Bernhardt, 2016):

- Store containers off the ground on clean racks or shelves out of reach of splashing water or in covered bins.
- Never place clean containers on the ground, in water, or on other potentially contaminated surfaces.

Containers stored off the ground/floor in clean racks or shelve.

5.2 Germination and Potting Material for Container Stock Must be Certified Pathogen Free

Germination and potting media must be pathogen-free. All potting media must be heat treated (Table 1, BMPs for Nurseries, OSU Extension Service, EM9330, 2022) unless components are certifiably pathogen free and have been handled and stored in a manner that precludes contamination. However, unless potting media is very highly contaminated, it is difficult to effectively test large volumes of media to reliably determine whether it is free of Phytophthora (Section 3, Swiecki and Bernhardt, 2016).

Using pathogen-free potting media is an essential starting point for producing nursery container stock that is free of soil-borne plant diseases. Diseased plant material that is outplanted can introduce pathogens from the container into the new planting site. ("Using heat to eradicate soil-borne plant pathogens from nursery potting media, (soil sterilization),"2021, Phytosphere Research).

Seed starting and potting media is soilless and sterile, which is safer for nursery container production than soil mixes. Bark fiber, peat moss, or coconut husk fiber are substituted for soil in potting mix and combined with perlite or pumice for drainage, and other heat-treated or sterile components.

5.2.1 BMP 11. Germination and Potting Media Shall Either Use Soilless, Heat-Treated Components and Certifiably Pathogen Free or Be Approved by UNPP *(Table 1, BMPs for Nurseries, OSU Extension Service, EM9330, 2022 and Section 4, Swiecki and Bernhardt, 2016)*

To comply with BMP, planting media shall either: 1) utilize commercially purchased, soilless, heat-treated components that are pathogen-free, and shipped, transported and stored in plastic bags, or 2) be approved by UNPP and certifiably pathogen-free, with controlled storage, shipping, and transport to producer to prevent contamination.

Commercial potting mixes, certified pathogen free, are locally available and can be a cost-effective option for small producers to comply with BMPs, especially for containers with small volumes such as plugs.

5.2.2 BMP 12. Store Germination and Potting Media in Manner to Prevent Contamination (*Table 1, BMPs for Nurseries, OSU Extension Service, EM9330, 2022 and Section 4, Swiecki and Bernhardt, 2016)*

Store planting media in clean, covered bins. Stored heat-treated potting media should not come in contact with the ground or be exposed to water splash or runoff.

5.2.3 BMP 13. Handle Planting Media in a Manner to Prevent Contamination. Ensure that Tools and Equipment for Mixing and Loading Planting Media are Clean *(Table 1, BMPs for Nurseries, OSU Extension Service, EM9330, 2022 and Section 4, Swiecki and Bernhardt, 2016)*

Handle heat-treated potting media in a manner to prevent contamination. Do not contaminate heat-treated potting soil by using non-sanitized tools, hands, gloves, or by walking on it.

Planting media prepared and plant containers filled on potting table that utilizes flood table elevated above floor to contain media and prevent contamination during handling.

6.0 WATER AND IRRIGATION (Table 1, BMPs for Nurseries, OSU Extension Service, EM9330, 2022)

6.1. Drainage

6.1.1 BMP 14. Construct Good Drainage for Nursery Site to Direct Runoff Away from Production Area and to Prevent Standing Water *(Table 1, BMPs for Nurseries, OSU Extension Service, EM9330, 2022)*

The nursery site should be designed and constructed for drainage. Assess the areas adjacent to the nursery to determine whether they could serve as sources of contamination via flowing water, mud flows, blowing soil or debris, or splash from roads or vegetation. Install drainage, fencing, and barriers where appropriate to mitigate contamination from off-site sources (Section 6.2, Swiecki and Bernhardt, 2016)

Site graded to drain away from production site.

Drainage ditches and culverts can be used to direct drainage.

Greenhouse floor can be sloped at 1 percent grade to drain.

6.2. Water Source

6.1.2 BMP 15. Confirm All Water Comes from Pathogen-Free Water Source. Surface Water Sources Will Be Treated at Nursery Production Site or Tested to Verify Pathogen Free *(Table 1, BMPs for Nurseries, OSU Extension Service, EM9330, 2022 and Section 5, Swiecki and Bernhardt, 2016)*

Phytophthora is a fungus-like organism called water mold, that can infect a wide variety of nursery plant species, and it spreads in irrigation water (2018, Dr. Redekar and Dr. Parke, OSU Department of Crop and Soil Science).

Confirm that all irrigation water comes from a pathogen-free water source, such as municipal water or a well. Assume that water from surface water sources (rivers, ponds) is contaminated and needs treatment (Table 1, BMPs for Nurseries, OSU Extension Service, EM9330, 2022). Do not use untreated irrigation runoff or water from surface streams or ponds. Water from these sources can be contaminated and can spread that contamination through the nursery. Surface water can be disinfected by heat, ozone, chlorine, UV, ultrafiltration, or other methods proven to eliminate Phytophthora. These treatment systems must be monitored to ensure that treatment is effective (Section 5, Swiecki and Bernhardt, 2016).

Water sources can be tested for phytophthora (2018, Dr. Redekar and Dr. Parke, OSU Department of Crop and Soil Science). Information on water testing and treatment for phytophthora is available at https://diggermagazine.com/testing-the-waters/

Water source with spring box and overflow pipe; not under direct influence of surface water source.

6.3 Irrigation Systems

6.3.1 BMP 16. Employ Irrigation Systems That Minimize Splash Between Containers *(Table 1, BMPs for Nurseries, OSU Extension Service, EM9330, 2022)*

Use low water pressure and small droplet sizes to minimize splash between containers (Section 6.5.1, Swiecki and Bernhardt). When feasible, some alternates to overhead irrigation include:

1. Bottom-up watering, either manual or with automated, pumped flood and drain systems
2. Manual overhead watering
3. Drip irrigation

Bench design, elevated tables, and spacing of containers can help to minimize water splashing between containers.

Automated bottom-up watering, pumped flood and drain

Manual bottom-up watering

Utilizing flood trays to prevent splash from manual watering. Any excess water drains through sump in flood tray to container below.

Handheld waters, spray bottles, and hose mister and wand attachments for manual overhead

6.3.2 BMP 17. Verify Irrigation Systems Deliver Right Amount of Water *(Table 1, BMPs for Nurseries, OSU Extension Service, EM9330, 2022)*

Avoid excessive irrigation or stressing plants with inadequate water. Consider water loss from evapotranspiration, inputs from rainfall, size of plants and containers, and other factors when scheduling irrigations (Section 6.5.1, Swiecki and Bernhardt). Moisture can be monitored by:

1. Visual observation of moisture at top of media. Fingers must be sanitized if used to check moisture by feel.
2. Moisture meter
3. Plant health

Methods to help ensure consistent delivery of the right amount of water include:

1. Timing and recording the duration of irrigation
2. Use a limited number of container sizes, for example seedling propagation plug trays, 1 pint, 1 quart, and 1 gallon
3. Use the smallest size container feasible for the current vegetive growth stage of plant
4. Group plants of same species and same container size for watering

6.3.2 BMP 18. Keep Hoses and Wands Off the Ground *(Table 1, BMPs for Nurseries, OSU Extension Service, EM9330, 2022)*

Keep irrigation wands, nozzles, and hose ends at least 3 feet off the ground on clean, sanitized hooks or racks. The same standard applies to any portion of a hose that may come in contact with or will be held over plants or benches during use (Section 4, Swiecki and Bernhardt, 2016).

Floors in greenhouses constructed with concrete, gravel, or “gravel sandwich” provide a barrier between soil and plants. Although the hose is technically not on the ground due to the barrier provided by “gravel sandwich”, the end of hoses, irrigation wands, and nozzles should be kept from contacting the floor.

7.0 WORKFLOW AND LAYOUT (Table 1, BMPs for Nurseries, OSU Extension Service, EM9330, 2022)

7.0.1 BMP 19. Maintain Separation Between Clean Grow Areas and Potentially Contaminated Areas *(Table 1, BMPs for Nurseries, OSU Extension Service, EM9330, 2022)*

Maximize separation between clean and potentially contaminated areas. Don't situate contaminated areas (e.g., trash bins, dirty pot piles) where runoff, splash, or wind can move contaminated soil, water, or debris into clean areas. Separation between clean and contaminated areas should be at least (10 ft). Solid barriers that prevent movement of contamination may be used where this minimum separation distance cannot be achieved or where other circumstances warrant (Section 6.2.3, Swiecki and Bernhardt, 2016).

Example where staging area is identified to store containers prior to cleaning.

7.0.2 BMP 20. Install Barriers and Control Access of People, Animals, Pathogens, Pests, and Weeds by Restricting Movement from Contaminated Areas into Clean Production Zone *(Table 1, BMPs for Nurseries, OSU Extension Service, EM9330, 2022)*

Use barriers and controlled access to restrict movement from contaminated to clean and require sanitation at entry points into clean areas (Section 6.2.4, Swiecki and Bernhardt, 2016). Access controls and barriers might include designated driveways for vehicle access, gates, fencing, fencing, insect netting, and mowing.

7.0.3 BMP 21. Design Workflow to Move from Clean Areas to Dirty Areas *(Table 1, BMPs for Nurseries, OSU Extension Service, EM9330, 2022)*

Organizing the nursery layout to separate clean and contaminated areas and activities will help reduce opportunities for spreading contamination into clean areas (Section 6, Swiecki and Bernhardt, 2016). Consider placement of doors and vehicle/cart access to facilitate workflow to moving from clean to dirty areas.

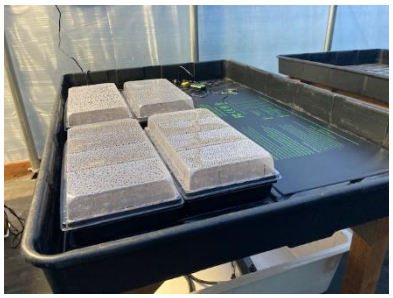
7.0.4 BMP 22. Separate Plant Cull Pile from Clean Production Area *(Table 1, BMPs for Nurseries, OSU Extension Service, EM9330, 2022)*

Any potentially diseased plants should be placed in plastic bags and disposed of at landfill. Cull plants and used media will be disposed of at designated location on property.

8.0 PROPAGATION AND GROWING AREA (Table 1, BMPs for Nurseries, OSU Extension Service, EM9330)

8.0.1 BMP 23. Propagation Area Kept Scrupulously Clean *(Table 1, BMPs for Nurseries, OSU Extension Service, EM9330, 2022)*

Make it easy for workers to follow clean production practices. (Section 6.2.11, Swiecki and Bernhardt, 2016). Used flood tables can help contain media to make cleanup easier. Shop vacs can be used for quick cleanup.



Seed germination, heat pads and humidity domes

Modular sand boxes for cutting propagation

Wetlands species, seedling propagation

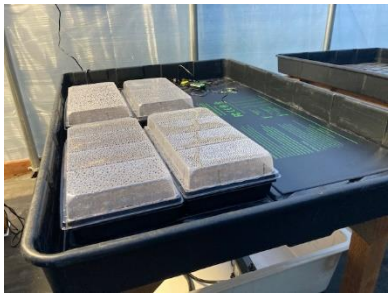
Oak seedlings propagated from acorns

Potting tables

Shop vac

8.0.2 BMP 24. Growing Area Kept Separate from Propagation Area *(Table 1, BMPs for Nurseries, OSU Extension Service, EM9330, 2022)*

Organize the flow of work in the nursery so that contamination from old plants, containers, and soil won't be spread to clean materials and areas (Section 6.2.7, Swiecki and Bernhardt, 2016). Separate grow tables minimum of 3 to 6 feet horizontally from propagation tables.

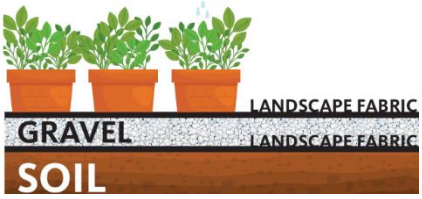


8.0.3 BMP 25. Plants are Kept Off the Ground on Benches at Least 2 to 3 ft High *(Table 1, BMPs for Nurseries, OSU Extension Service, EM9330, 2022)*

The ground surface, even if it is covered with gravel or landscape fabric, is nearly impossible to maintain as a clean surface. The common practice of placing containers on or near the ground is generally not compatible with clean production (Section 6, Swiecki and Bernhardt, 2016). Table legs for benches should designed so plants are kept off the floor a minimum of 2 to 3 feet off the ground.

8.0.4 BMP 26. For Container Stock, Ground Surface in Production Area Covered by Gravel, Landscape Fabric Over Gravel, or Gravel Sandwich to Create Barrier Between Soil and Plants. Landscape Fabric Over Soil Alone is Not Adequate *(Table 1, BMPs for Nurseries, OSU Extension Service, EM9330, 2022)*

Snippet follows of "gravel sandwich" created by placing landscape fabric above and below a layer of gravel, 6-inches deep, to create a barrier between soil and plants (Figure 27, OSU Extension Service, EM9330, 2022).



8.0.5 BMP 27. Routinely Clean up Leafy Debris *(Table 1, BMPs for Nurseries, OSU Extension Service, EM9330, 2022)*

8.0.6 BMP 28. Disinfect Bench Surfaces Between Crops. Bench Tops Shall Not Be Constructed from Pallets or Other Surfaces That Can Catch and Hold Water or Debris. Wood Frames and Support legs Will Either Be Pressure Treated or Sanitized with Hot Steam. (*Table 1, BMPs for Nurseries, OSU Extension Service, EM9330, 2022 and Section 6, Swiecki and Bernhardt, 2016)*

Bench tops should be made of expanded wire mesh or other open, nonporous materials that do not allow water to move between pots and can be effectively sanitized. *Plywood, wood pallets, or similar solid surfaces that allow water to pool or run laterally are not acceptable. Do not use benches that have wide horizontal surfaces that can catch and hold water or debris* (Section 6, Swiecki and Bernhardt, 2016). Non-porous bench tops, such as wire mesh or flood tables, will be disinfected with a method listed in "*Table 2. Summary of Sanitation Methods and Suggested Uses, OSU Extension Service, EM9330*". Wood is a porous material and not easily disinfected. Therefore, wood frames and support legs will be either: a) pressure treated with preservative to inhibit pathogens and pests or b) sanitized with hot steam at 180 to 200 deg F. Wood support legs should not be in direct contact with the floor or ground.

4 ft x 5 ft modular table design. Interior joists spaced 16" on center. Pressure treated wood for frame inhibits algae/fungus growth and insects. Tabletop covering shown is 6-gage, 5 ft x 8 ft horse panel mesh, cut to length. Tiles placed on floor under support legs provide moisture barrier and are used for leveling.

8.0.7 BMP 29. Prevent Containers from Tipping Over *(Table 1, BMPs for Nurseries, OSU Extension Service, EM9330, 2022)*

Flood trays provide adequate support to prevent plants in 1-gallon containers from tipping over. For containers are set directly on wire mesh tops, a secondary wood frame will be constructed (with no wire mesh) and set on top of tables. This method is used by Douglas County Master Gardeners to support large plants from tipping over in outside weather conditions.

8.0.8 BMP 30. Organize Nursery with Space Between Blocks on Benches and Between Benches *(Table 1, BMPs for Nurseries, OSU Extension Service, EM9330, 2022)*

Modular benches work well for organizing the nursery. Plants are generally grouped in a single block based on plant species and container size. The horizontal spacing between benches is minimum of 2.5 ft when access is required between benches and minimum of 2 ft otherwise.

8.0.9 BMP 31. Monitor Populations of Fungus Gnats and Shore Flies Using Yellow Sticky Traps *(Table 1, BMPs for Nurseries, OSU Extension Service, EM9330)*

Fungus gnats and shore flies can spread Phytophthora and must be monitored and managed for both inside greenhouse and outdoor production of plants.

Table 1, BMPs for Nurseries, OSU Extension Service, EM9330, identifies management of fungus gnats and shore flies as a BMP. Monitoring is a critical part of management. Identifying populations early allows for early treatment. Continuing to monitor during and after treatment allows assessment of the effectiveness of treatment.

<u>Monitor</u>

Monitor for adult fungus gnats and shore flies with yellow sticky traps (10 traps per 1,000 square feet). Yellow color works for both species and is easier to inspect than blue sticky traps. To monitor fungus gnat larvae in growth media, place potato disks on the media surface. Check for larvae after three to four days. If there are larvae in a container, they will come to the surface to feed on the potato tissue.

Yellow sticky traps. Used for monitoring, not control.

See video "Caught in the Trap, Identifying Fungus Gnats & Shore Flies", Colorado State University https://www.youtube.com/watch?v=mA6sB4S9hpU

8.0.9 BMP 32. Manage Populations of Fungus Gnats and Shore Flies *(Table 1, BMPs for Nurseries, OSU Extension Service, EM9330)*

Not overwatering and using pasteurized media without organic matter will help to discourage fungus gnats and shore flies. However, after fungus gnats or shore flies become established in nursery, additional measures must be taken to eradicate. Although published documentation focuses on media surface, fungus gnats can also lay eggs through drain holes in bottom of containers, which may complicate control/treatment.

Fungus gnat adults live from about one to two weeks after larvae develop and complete one life cycle in about 18-30 days. It can take 2 months to control fungus gnats. Resources:

- Fungus Gnats Management Guide, University of California, https://ipm.ucanr.edu/PMG/PESTNOTES/pn7448.html
- Fungus Gnats and Shore Flies in Greenhouses, University of Wisconsin, https://hort.extension.wisc.edu/articles/fungus-gnats-and-shore-flies/

Most of the fungus gnat's life is spent as a larva and pupa in organic matter or soil, so the most effective control methods target these immature stages rather than attempting to directly control the mobile, short-lived adults. Physical and cultural management tactics—primarily the reductions of excess moisture and organic debris—are key to reducing fungus gnat problems. Commercially available and naturally occurring biological control agents can also control this pest. Biological treatment/control of larvae with products that contain BTI (natural bacteria) or predatory mites are most common. Hydrogen peroxide drench is used for persistent population but will also eliminate biological controls. Insecticides are considered an important control option in some commercial plant production. Chemical treatment with pyrethrins or a pyrethroid insecticide may provide temporary, fast-acting control for adults (Fungus Gnats Management Guide, University of California).

<u>Operations Management</u>

- Quarantine plants acquired from another producer, for minimum of 2 to 4 weeks.
- Use heat-treated planting media.
- Do not overwater plants.
- Keep nursery clean and avoid algae growth.
- For flood/drain watering systems, clean and disinfect trays monthly, add algaecide/fungicide weekly to reservoirs to slow algae growth, replace water every two weeks in reservoirs, and clean tubes and pumps every three months ("Ebb And Flow Hydroponics: A Complete Guide For Beginners," https://www.mygreenterra.com/ebb-and-flow-hydroponics/)

<u>Biological Treatment and/or Preventative</u>

- *Bacillus thuringiensis subspecies israelensis (BTI): Larvae (Fungus Gnats).* Manufactured products include Gnatrol and Mosquito Bits. Uses natural bacteria (BTI). Follow instructions. For Mosquito Bits, use 4 tablespoons per gallon of water. Soak pellets overnight in water – use nylon or cheese cloth to contain pellets (corn husk shells contain bacteria in pellets and will mold if spread on media) and dispose of pellets after soaking. Use this mix to surface water weekly plants weekly.
- *Nemotodes (predatory mites). Treatment of Larvae (Fungus Gnats).* Stratiolaelaps predatory mites are one available product. Come in a vermiculate carrier that is sprinkled on raised beds or container pots. The mites eat anything that pupates out of the soil. They can survive on other food sources and can overwinter.

- *Neem Oil Products (Natural Botanical Insecticides) – Fungus Gnat Larvae*. Drench can be made from neem cake (smells). Azaguard is a BioSafe product derived from neem oil.

Physical Barrier: Fungus Gnats or Shore Flies

- *Mesh #25 (or Smaller) Insect Netting.* Adults (Fungus Gnats and Shore Flies). Greenhouse or install netting over hoops for outside plants.
- *Block access to laying eggs in media.* Adults (Fungus Gnats). Add layer to the top surface of media of vermiculite, fine pumice or perlite, sand, or diatomaceous earth. Based on internet testimonial, this option provides inconsistent results.

Insecticide Treatment

See links for University of California and Wisconsin sources for details, pros and cons, and restrictions.

- *Adults.* Pyrethrins or Pyrethroid (bifenthrin, permethrin). Can be purchased for use in sprayer or as fogger. Greenhouse foggers are available in 2 oz cans that cover up to 3,000 square feet. Treatment is repeated per label.

Larvae (Fungus Gnats). Sevin is a manufactured product that uses Cyromanzine and is available from internet or garden stores. Dust is spread on the media surface per label or mixed at 1/2 teaspoon per quart and applied as drench. Bonide Systematic Granules is a manufactured product that uses Imidacloprid and is mixed with media.

9.0 PHYTOSANITARY PRACTICES (Table 1, BMPs for Nurseries, OSU Extension Service, EM9330)

9.0.1 BMP 33. Sanitize Footwear Prior to Entering Clean Areas at Nursery with Treatment Listed Method Listed in Table 2, BMPs for Nurseries, OSU Extension Service, EM9330, 2022, or Provide Clean Footwear or Footwear Covers

Provide mandatory sanitizing foot baths at entrance to cleaning area (Table 1, BMPs for Nurseries, OSU Extension Service, EM9330). Provide disinfectant footbaths or other decontamination supplies (brushes and disinfectant sprayers) for sanitizing footwear at all entrances to clean areas. Footwear, including grooves in soles, should be free of visible soil and debris before entering clean areas. Workers may alternatively use dedicated clean, sanitized shoes or boots that are stored and used only in the clean area. Sanitize these at least daily (Section 6, Swiecki and Bernhardt, 2016)

Bin outside greenhouse to stored dedicated footwear for workers, shoe covers, and cleaning/disinfectant supplies for sanitizing footwear.

Option 1. Wear Disposable Footwear Covers

Option 2. Wash to Remove Soil (if Soil is Present) and Treat with Disinfectant After Soil is Removed

After soil is removed, either spray with either Lysol or chlorine disinfectant mix, or use wipes (new wipe for each shoe/boot) to clean sole of footwear. Wait 2 or 3 minutes after disinfectant is applied before entering clean area. Lysol is a quaternary ammonium compound (QAC). Lysol is less corrosive and less sensitive to temperature than chlorine disinfectant.

9.0.2 BMP 34. Wear Clean Waterproof Gloves *(Table 1, BMPs for Nurseries, OSU Extension Service, EM9330)*

Have staff wear clean waterproof gloves. Items (including workers' gloves or hands) that have been in contact with the ground or other potentially contaminated surfaces or materials must be sanitized before being placed in contact with clean plant materials, pots, soil, or benches (Section 6, Swiecki and Bernhardt, 2016).

9.0.3 BMP 35. Nursery Procedures and Systems to Sanitize Shall be Listed on Table 2, OSU Extension Service, EM9330. Planting Media Shall Be from UNPP approved source. Wood Shall Either be Pressure Treated or Steam Cleaned. Methods That Require High Temperature Shall Monitor Temperature and Duration with UNPP Approved Sensors.

9.0.4 BMP 36. Dedicate Tools and Watering Equipment to Specific Areas in Greenhouse *(Table 1, BMPs for Nurseries, OSU Extension Service, EM9330)*

Assign tools and equipment for exclusive use in the clean production area. Heat-treated potting media should also have dedicated clean tools. Provide clean storage areas where tools can be stored off the ground and away from splashing water. Tools and equipment should be stored clean and sanitized before use (Section 6, Swiecki and Bernhardt, 2016).

10.0 TRAINING AND AWARENESS

For all workers, keep track of training that was conducted (when, by whom, topics). Make sure nursery workers have read these BMPs and other related materials and have enough training to follow them. Keep copies of BMPs and related references available for quick reference in the nursery. Where appropriate, post relevant procedures in work areas where they will be used (Section 7, Swiecki and Bernhardt, 2016).

10.0.1. BMP 37. Nursery Staff Complete Training on Phytophthora Ramorum and Clean Production of Nursery Stock *(Section 7.8, Swiecki and Bernhardt, 2016)*

Nursery staff will complete training "PHYTOPHTHORA ONLINE COURSE: TRAINING FOR NURSERY GROWERS": https://horticulture.oregonstate.edu/nursery/nursery/phytophthora-online-course-training-nursery-growers

10.0.2 BMP 38. Nursery Staff Have Access to Information on Symptoms and Test Procedures for Unhealthy Plants (*BMPs for Nurseries, Table 5 and Table 6, OSU Extension Service, EM9330*).

Nursery staff should refer to OSU Extension Service, EM9330, sections, "*Recognizing Phytophthora symptoms*" and "*What happens when you find plants with potential disease symptoms?*"; and tables, *Table 5. Phytophthora system checklist for restoration plants*; and *Table 6. Diagnostic testing resources.* These sections and tables provide information and photos on test procedures for unhealthy plants. Digital copy of EM9300 is available at: https://extension.oregonstate.edu/sites/default/files/documents/em9330.pdf

10.0.3. BMP 39. Nursery Staff Read Nursery BMP Manual. Reference Copy is Kept in Nursery *(Section 7.8, Swiecki and Bernhardt, 2016)*

Copy of Nursery BMP manual is kept in greenhouse for reference. Appendix C. Form: Record of Training and Posting of BMP Manual, is signed by staff to acknowledge training, reading BMP manual, and having links to internet access for related references.

11.0 DELIVERY OF PLANTS OFF SITE FOR SALE OR TRANSPLANT

11.01 BMP 40. Follow phytosanitary procedures to maintain clean stock until it has been transferred to the customer *(Section 8, Swiecki and Bernhardt, 2016)*

Follow phytosanitary procedures to maintain clean stock until it has been transferred to the customer. Cleanliness of nursery stock is producer responsibility until the plants have been delivered to the customer. Plant stock should not be exposed to contamination during handling, transport, or delivery. In most situations, stock that has been removed from the nursery for delivery or sale should not be returned to the nursery. Follow the BMPs explained in this manual to prevent contamination of plants as they are moved back and forth in vehicles or carts for delivery. Place plants only on clean sanitized surfaces for transport. Do not move plants in unsanitized carts or wheelbarrows. Be sure to sanitize handles. Clean paper or plastic sheeting can be used to provide a clean surface as long as these materials are intact. Only plants that have been handled under phytosanitary conditions and maintained in clean vehicles can be considered for return to the nursery. Such material should be kept separate from other plants and not mixed back into clean production blocks. Plants delivered to clients or sites should not be returned to the nursery since plants have been out of nursery control.

12.0 AUDIT OF BMPS

Adopted BMPs will be audited by an independent party approved by UNPP. Audit form is attached as Appendix A.

APPENDIX A.
AUDIT OF BMPS FOR PRODUCTION OF CLEAN NURSERY CONTAINER STOCK

BMP	Description	Verified
PLANT HEALTH		
Healthy Production Stock		
BMP 1	Routinely Monitor and Record Plant Health Throughout All Production Phases	
BMP 2	Dispose of Unhealthy Plants in Designated Location	
Clean Planting Materials		
BMP 3	Do Not Acquire Nursery Stock Propagated at Other Nurseries Unless Other Nursery Has Certifiable Clean Production System and Plants are Quarantined for Minimum of 3 Months	
BMP 4	Start with Cutting Material from Plants Free from Infection or External Contamination by Phytophthora Species as well as other Possible Pathogens	
BMP 5	Acquire Seeds Only from Approved UNPP Producers	
CONTAINERS AND POTTING MATERIAL		
Clean Containers		
BMP 6	Use Only New or Properly Sanitized Containers	
BMP 7	Do Not Accept Used Containers from Other Nurseries Unless Other Nursery Can be Identified and Has Certifiable Clean Production System	
BMP 8	Do Not Store Used Containers in Clean Areas of Nursery and Do not Let Accumulate, Prior to Sanitizing	
BMP 9	Treatment Method for Cleaning and Disinfection of Used Containers Shall Be Listed in Table 2, BMPs for Nurseries, OSU Extension Service, EM9330, 2022	
BMP 10	Store Clean Containers Off the Ground in Clean Racks or Bins	
Clean Potting Media		
BMP 11	Germination and Potting Media Shall Either Use Soilless, Heat-Treated Components and Certifiably Pathogen Free or Be Approved by UNPP	
BMP 12	Store Planting Media in Manner to Prevent Contamination	
BMP 13	Handle Planting Media in a Manner to Prevent Contamination	
WATER AND IRRIGATION		
Drainage		
BMP 14	Construct Good Drainage for Nursery Site to Direct Runoff Away from Production Area and to Prevent Standing Water	
Water Source		
BMP 15	Confirm All Water Comes from Pathogen-Free Water Source. Surface Water Sources Will Be Treated at Nursery Production Site or Tested to Verify Pathogen Free.	
Irrigation Systems		
BMP 16	Employ Irrigation Systems That Minimize Splash Between Containers	
BMP 17	Verify Irrigation Systems Deliver Right Amount of Water	
BMP 18	Keep Hoses and Wands Off the Ground	
WORKFLOW AND LAYOUT		
BMP 19	Maintain Separation Between Clean Grow Areas and Potentially Contaminated Areas	
BMP 20	Install Barriers and Control Access of People, Animals, Pathogens, Pests, and Weeds by Restricting Movement from Contaminated Areas into Clean Production Zone	
BMP 21	Design Workflow to Move from Clean Areas to Dirty Areas	
BMP 22	Separate Plant Cull Pile from Clean Production Area	

APPENDIX A. AUDIT OF BMPS FOR PRODUCTION OF CLEAN NATIVE NURSERY STOCK (continued)

BMP	Description	Verified
PROPAGATION AND GROWING AREA		
BMP 23	Propagation Area Kept Scrupulously Clean	
BMP 24	Growing Area Kept Separate from Propagation Area	
BMP 25	Plants are Kept Off the Ground on Benches at Least 2 to 3 ft High	
BMP 26	For Container Stock, Ground Surface in Production Area Covered by Gravel, Landscape Fabric Over Gravel, or Gravel Sandwich to Create Barrier Between Soil and Plants. Landscape Fabric Over Soil Alone is Not Adequate.	
BMP 27	Routinely Clean up Leafy Debris	
BMP 28	Disinfect Bench Surfaces Between Crops. Bench Tops Shall Not Be Constructed from Pallets or Other Surfaces That Can Catch and Hold Water or Debris. Wood Frames and Support legs Will Either Be Pressure Treated or Sanitized with Hot Steam.	
BMP 29	Prevent Containers from Tipping Over	
BMP 30	Organize Nursery with Space Between Blocks on Benches and Between Benches	
BMP 31	Monitor Populations of Fungus Gnats and Shore Flies with Yellow Sticky Traps	
BMP 32	Manage Populations of Fungus Gnats and Shore Flies	
PHYTOSANITARY PRACTICES		
BMP 33	Sanitize Footwear Prior to Entering Clean Areas at Nursery with Treatment Listed Method Listed in Table 2, BMPs for Nurseries, OSU Extension Service, EM9330, or Provide Clean Footwear or Footwear Covers	
BMP 34	Wear Clean Waterproof Gloves	
BMP 35	Nursery Procedures and Systems to Sanitize Shall be Listed on Table 2, OSU Extension Service, EM9330. Planting Media Shall Be from UNPP approved source. Wood Shall Either be Pressure Treated or Steam Cleaned. Methods That Require High Temperature Shall Monitor Temperature and Duration with UNPP Approved Sensors.	
BMP 36	Dedicate Tools and Watering Equipment to Specific Areas in Greenhouse	
TRAINING AND AWARENESS		
BMP 37	All Nursery Staff Complete Training on Phytophthora Ramorum and Clean Production of Nursery Plants	
BMP 38	Nursery Staff Have Access to Information on Symptoms and Test Procedures for Unhealthy Plants	
BMP 39	All Nursery Read Nursery BMP Manual and Reference Copy is Kept in Nursery	
DELIVERY OF PLANTS OFF SITE FOR SALE OR TRANSPLANT		
BMP 40	Follow phytosanitary procedures to maintain clean stock until it has been transferred to the customer	

APPENDIX B.
Monitoring Plant Production and Health
Scientific Name:
Block ID# ____

Tracking Information

Description	Notes
Project Name	
Scientific Name	
Common Name	
Final Container Size	
Client, Name and Address	
Number Containers Delivered	
Delivery Location, Address	
Delivery Date	
Plant Health at Delivery	
Plants Returned to Nursery: Yes or No	
If Plants Returned to Nursery, Number of Plants	

APPENDIX B.
Monitoring Plant Production and Health (continued)
Block ID# ____

Plant Health Monitoring

Description	Notes
BACKGROUND	
Project Name	
Scientific Name	
Common Name	
Delivery Anticipated	
Production Season	
Production Duration	
SEEDLING STARTS: PHASE I	
Propagation Method: seed or cutting?	
Start of Germination or Cutting: Date	
Container Size for Germination or Cutting Propagation	
Date: First True Leaf (Seed) or Root Development (Cutting)	
Days Total: Duration of Phase I	
Root Health if Potted Up, healthy or not healthy	
EARLY VEGETATIVE DEVELOPMENT: PHASE II	
Container Size for Early Vegetative Development	
# of Containers	
Outcome of Phase II: Potted up or Delivered to Client?	
Date: Potting Up or Delivery to Client	
Days Total: Duration of Phase I and Phase II	
Root Health if Potted Up, healthy or not healthy	
CONTINUED VEGETATIVE DEVELOPMENT: PHASE III	
Phase III initiated, Yes or No	
Container Size for Final Vegetative Development	
# of Containers	
Date: Delivered to Client	
Plant Health at Delivery	
Days Total: Duration of Phase I, Phase II, and Phase III	
MONITOR DAILY. COMPLETE FOLLOWING IF PLANT(S) IN BLOCK OBSERVED WITH UNHEALTHY SYMPTOMS	
Reference: Check List for Plant Health (See OSU EM9330, Table 5 for Photos and Descriptions) **If plants have unhealthy symptoms, complete following information.**	
# of Containers with unhealthy symptoms	
Distribution in Block: Uniform or Non-Uniform	
Stem, Branch or Foliar Symptoms - Wilting, yes or no - Foliar Blight, yes or no - Shoot dieback, yes or no	
Root Systems - Absence of fine roots, yes or no - Discolored or decayed roots, yes or no - Blackened root collar, yes or no	
Action Taken	

APPENDIX C.
Record of Training and Posting of BMP Manual

Training and Awareness: Self Certification

Description	Notes	Date
Staff Name		
Completed online training: **"**PHYTOPHTHORA ONLINE COURSE: TRAINING FOR NURSERY GROWERS": https://horticulture.oregonstate.edu/nursery/nursery/phytophthora-online-course-training-nursery-growers	Signature	
Reviewed and Have Access to Copy: **"**Manual of Adopted Best Management Practices For Production of Clean Nursery Container Stock of Native Plants for Restoration Projects, Ben More Mountain Nursery, July 2024"	Signature	
Reviewed: "Preventing Phytophtora Infestations in Restoration Nurseries, A Key to Protecting Wildland Plant Communities," OSU Extension Service, EM 9330, January 2022. https://extension.oregonstate.edu/sites/default/files/documents/em9330.pdf	Signature	
Reviewed: "Best Management Practices (BMPs) for Producing Clean Nursery Stock," 3/5/2016 and 2021 updates, Tedmund J. Swiecki and Elizabeth A. Bernhardt, Phytosphere Research. Support provided by the Santa Clara Valley Water District, the California Native Plant Society, and Phytosphere Research. http://phytosphere.com/BMPsnursery/index.htm	Signature	