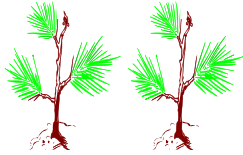




*Dr. Sharon M. Douglas  
Department of Plant Pathology and Ecology  
The Connecticut Agricultural Experiment Station  
123 Huntington Street, P. O. Box 1106  
New Haven, CT 06504*

*Phone: (203) 974-8601  
Fax: (203) 974-8502  
Email: Sharon.Douglas@po.state.ct.us*



## **DISEASES OF CHRISTMAS TREE SEEDLING AND TRANSPLANT BEDS**



Growing and maintaining a plantation of healthy Christmas trees starts with healthy seedlings and transplants. Whether you are starting with seeds, seedlings, or transplants, there are a number of issues that should be considered and addressed prior to or at planting time that will help to avoid or minimize problems from developing right from the start. This fact sheet is divided into two parts: Part 1 covers general factors for consideration prior to planting and Part 2 covers common disease problems at various stages in production (seed beds, seedling and transplant beds, and field-planted transplants).

### **Part 1. General Factors for Consideration Prior to Planting**

#### **1. Site Selection for Seedling and Transplant Beds-**

When selecting a location for seedling and transplant beds, it is important to consider the following factors and characteristics of the site:

- Sunny location away from frost pockets and protected from sweeping winds.
- Well-drained soil, preferably a loam or sandy loam, with moderate fertility and pH 5.5-6.2.
- Source of water for irrigation readily available.
- Fumigation- Compounds for fumigation are limited in availability and are generally extremely toxic. Therefore, it is often suggested that they be used only in areas with a history of soil problems. Soil fumigation is best done in late summer or early autumn when the soil temperature is relatively high and soil moisture is usually within a moderate range. Among the compounds registered in Connecticut is metam sodium (Vapam).

#### **2. Seed Selection-**

It is important to use seed of good quality from a known source. Fungal contamination is more common in dirty seed lots and poor quality seed often has reduced germination percentages and produces weak seedlings that are more vulnerable to disease.

### 3. Planting Stock and Transplants-

Several different types of stock are now available for planting. When selecting transplants, characteristics of the planting site should be considered in order to determine the type of stock that you select. Among the factors for consideration are: 1) amount of competition from other vegetation (e.g., grasses, shrubs), 2) soil type, season of planting, and 3) population of wildlife (e.g., such as deer, risk of browsing). For example:

- When competition from vegetation is expected- larger stock might out-perform smaller stock.
- When extreme site conditions are encountered (e.g., shallow soils or rocky sites)- container stock might be easier to plant because of the smaller root plug; they can also be easier to establish.

#### **Bare Root Stock**

This is the most common seedling type available to most landowners. Bare root seedlings are grown outdoors in nursery beds and shipped without soil on their roots. Once removed from the beds, they must be kept cool and moist to keep the roots alive. Typically, bare root seedlings are two to three years old and their height can range from 6 inches to 2 feet, depending on the species and age. Some nurseries also have transplant seedlings available. Bare root seedling stock is lifted from high-density seedbeds and then replanted in new beds at a lower density. This results in a seedling that will generally have a more fibrous root, larger stem diameter, and a better shoot-to root ratio. Transplant stock is generally a little more expensive to produce and may cost a slightly more, but this stock type is more robust and may be more suited to some planting sites.

#### Advantages and disadvantages:

- Greater availability both in the variety of species and in the number of nurseries selling this type of stock;
- Has a larger root system that provides greater rooting depth;
- Less susceptibility to frost heaving;
- Since it is larger than container stock, it is better suited to planting sites with higher levels of competition;
- Due to their larger size, they are more difficult to plant when compared to container stock; root placement is critical;
- Once the seedlings are lifted from the nursery bed, they are perishable – they must be kept cool and moist until planting;
- Bare root stock is generally more expensive than container stock.

#### **Container Stock**

Once used mostly by the forest industry, container stock is now available at some nurseries. There are many different types. Typically, container stock is grown for eight to nine months in a controlled environment (greenhouse) and is overwintered outside before being shipped to the planting site the following spring. The seedling roots form a plug with a soil-less growing medium. Depending on the species and container size, they can typically range from 3-6 inches in height and the root plug measures 2 inches in diameter by 4 inches in length.

#### Advantages and disadvantages:

- Generally less expensive to purchase than bare root stock;

- Easier to plant than bare root stock because of the small root plug; generally results in better planting quality;
- Easier to plant in areas of shallow or very stony soils (small root plug);
- Extends the planting season;
- Can be easily grown in different container sizes to meet the characteristics of the planting site;
- Limited species availability and not readily available at most nurseries;
- Generally requires good preparation of the planting site and follow-up, in order to reduce competition;
- Smaller size (top and root) makes it a poor match for planting sites with heavy competition.

### **Characteristics of Quality Seedlings**

Seedlings and transplants should be purchased from reputable nurseries in order to avoid introducing disease problems into the plantation. Although this helps to minimize problems, there is no guarantee of quality, so each shipment of seedlings or transplants should be carefully inspected as follows:

- Open the package as soon as it arrives to check if the seedlings have been properly handled and packed so that the roots are still moist. If the roots are shriveled and dried out, survival may be low once they are planted.
- Foliage should be green and fresh and under NO conditions should there be any visible mold or fungal growth. If there is gray mold on the needles (probably *Botrytis cinerea*), it is probable that the seedlings have been in storage too long or were not properly packed or handled during transport. Botrytis can kill and injure foliage and stems so it can substantially reduce the number of seedlings that survive once planted.
- Seedlings should have a good height-to-diameter ratio. This is the ratio of the shoot height to the stem diameter (height ÷ diameter). A seedling with a high ratio (i.e., >120) is less sturdy than a seedling with a lower ratio (i.e., <80).
- Buds should be large and well developed, not shriveled or dried out.
- Good stem diameter (or caliper). This is perhaps one of the best indicators of seedling quality. It is an attribute that has been linked to higher survival and increased growth. Larger caliper seedlings generally offer the following advantages – better lateral branching and bud development, are more resistant to heat, have more roots and are resistant to bending by wind.
- The root systems should also be carefully examined. There should be a good straight taproot with an abundance of fibrous or “feeder” roots. A taproot with minimal feeder roots or one that is crooked, twisted, or J-shaped are signs of poor quality stock, which will probably result in a transplant that is slow-growing, generally weak, and prone to disease.
- Gently scrape the surface of some of the finer roots with your fingernail to check on their health. If the root is healthy, the woody portion should be white. If it appears brown, tan, or gray, it can indicate that the roots have been infected with a root rot organism at some point in their growth. This can influence survival once the seedlings are planted. However, it can serve as an important way to introduce

- unwanted root rot pathogens into a seedling or transplant bed and eventually, a plantation.
- Maintain good records on each seedling lot and planting. This will allow you to trace the source of a problem should one develop.

***Remember - do not select seedlings based solely on one characteristic. It is important to look for seedlings that have a balance of all these attributes.***

## **Part 2. Common Diseases of Seedling and Transplant Beds and Field Transplants**

### **1. DISEASE PROBLEMS OF SEED BEDS**

Conifer seedlings are tender and very susceptible to damping-off, a common fungal disease. Seedlings are also extremely sensitive to water and temperature extremes.

#### **A. Damping-Off (Pre- and Post-Emergence):**

This is a common disease that affects seeds and young seedlings of many plants, including conifers. It can be divided into two stages based on the stage of the seedling when it is attacked.

**i. Causal Agents:** *Rhizoctonia, Pythium, Phytophthora, Fusarium*

**ii. Symptoms:**

**Pre-Emergence-** (before seedlings emerge)

- difficult to diagnose since the affected seeds aren't visible; best recognized as skips in the planting bed where no seedlings have emerged; if you dig into the soil, you will often find that the seed has been attacked and rotted;

**Post-Emergence-** (after seedlings emerge)

- newly emerged seedlings topple over and collapse; there is often a brown discoloration or constriction at the soil line; another form of this stage of damping-off is "cotyledon blight" that occurs when the seed coat clings to the newly expanding needles and the fungi present on the seed coat infect the seedling;

**iii. Management: (Table 1)**

1. Start with quality seed since fungal contamination is more common in dirty seed lots. Additionally, poor quality seed often has reduced germination percentages and produces weak seedlings which are more vulnerable to disease.
2. Follow cultural practices that maximize germination and growth of the seedlings. The faster the seeds germinate and emerge from the soil, the lower the risk of damping-off. It is also helpful to avoid oversowing and overcrowding of the seedling bed. Attention to soil pH and providing frequent but light waterings and adequate light help to reduce disease development.
3. Fungicides are generally not suggested since they usually provide poor control and can damage tender seedlings. Among the compounds registered in

Connecticut are: *Pythium* and *Phytophthora*- thiophanate-methyl plus etridiazole (Banrot), mefenoxam (Subdue MAXX), and etridiazole (Terrazole, Truban). *Rhizoctonia* and *Fusarium*- thiophanate-methyl plus etridiazole (Banrot), thiophanate-methyl (AllBan, Cleary's 3336), PCNB (Terraclor, Defend).

**B. Drought-** Seedlings are quite vulnerable to drying so it is important to maintain adequate soil moisture, especially in the early stages of development.

**C. Excess Water-** Seedlings are sensitive to waterlogged soil so it is important to avoid overwatering.

**D. Heat-** It is helpful to provide adequate shade and mulch to keep the surface soil temperature from getting too high since physical contact with high temperatures can kill tender roots and desiccate the stems of young seedlings.

**E. Fertilizer Burn-** Although developing seedlings need fertilizer, it is important to avoid over-fertilizing since this can injure and burn young seedlings.

**Table 1.** Environmental conditions and cultural practices affecting damping-off in container conifer nurseries.

Environmental condition or cultural practice	Impact on Disease Development	
	Promote Disease	Discourage Disease
Seed quality	Dirty or contaminated; slow, weak seedlings	Clean and sterile; vigorous seedlings
Growing medium	Contaminated Fine-textured Overly-compacted	Pest-free Mixture of particle sizes Good porosity
pH	High (>6.5)	Acid (4.5-6.0)
Growing density	Oversowing	One seedling per cavity
Nutrition	High nitrogen	Well-balanced fertilization especially phosphorus, potassium, and calcium
Irrigation	Frequent, heavy applications	Frequent, light applications
Growing environment	High humidity Low light Extreme temperatures	Moderate humidity Adequate light Ideal temperatures

## **2. DISEASE PROBLEMS OF SEEDLING AND TRANSPLANT BEDS**

The most common diseases of seedlings and transplants are root rots and Botrytis blight but seedlings are also affected by drought, excess water, heat, and fertilizer burn as outlined in the previous section on seed beds.

### **A. Root Diseases**

Seedlings and transplants affected by root rots may show a variety of aboveground symptoms. One of the first indications of root disease is a general loss of vigor, followed by needle-tip dieback, needle curling, chlorosis, and wilting. Even a low level of root involvement can severely reduce seedling growth by injuring the root tips and therefore interfering with water and nutrient uptake. Healthy roots have many white root tips whereas diseased roots exhibit varying degrees of water-soaking and discoloration, often appearing brown or black.

#### **Fusarium Root Rot**

**i. Causal Agent:** *Fusarium* spp.

**ii. Symptoms:** This disease can occur on spruces, true firs, and pines but is most severe on Douglas-fir. Symptoms appear as scattered chlorotic or curled needles. There is also tip dieback, wilting, and stunting. Roots lack fine root development and show extensive cortical decay so the epidermis can be easily stripped or pulled away from the core tissues. Yellow to orange fruiting bodies and spore masses can sometimes be seen on the stem of an infected seedling.

#### **Pythium and Phytophthora Root Rots**

**i. Causal Agents:** *Pythium* spp. and *Phytophthora* spp.

**ii. Symptoms:** All conifer seedlings are susceptible. The primary symptom is wilt followed by chlorosis and stunting. With *Pythium*, the roots appear black and water-soaked and are often hollow and collapsed. Since the fungus attacks the root tips, the root system has very few lateral roots. With *Phytophthora*, infected roots develop a distinctive reddish-brown discoloration of the cambial regions.

#### **Rhizoctonia Root Rot**

**i. Causal Agent:** *Rhizoctonia* spp.

**ii. Symptoms:** All conifer seedlings are susceptible. The primary aboveground symptom is a general decline and eventual wilting and death of the seedling. Infected roots are discolored and darkened and there is a noticeable lack of feeder roots.

#### **Management of Root Rots:**

1. Root diseases are more easily prevented than controlled!! Attention to site selection for the transplant bed and proper planting are critical. It is also important to carefully inspect stock before planting. If a problem develops, it might be helpful to check irrigation water as a potential source of the fungus.

2. Fungicides- These compounds are preventative and not curative so they are primarily used to limit the spread rather than cure the disease. Among the compounds registered in Connecticut are: *Pythium* and *Phytophthora*- thiophanate-methyl plus etridiazole (Banrot), mefenoxam (Subdue MAXX), and etridiazole (Terrazole, Truban). *Rhizoctonia* and *Fusarium*- thiophanate-methyl plus etridiazole (Banrot), thiophanate-methyl (Allban, Cleary's 3336), PCNB (Terraclor, Defend).

### **B. Foliage Diseases**

The most damaging foliage disease of seedlings and transplants is Botrytis blight. This disease can occur on all conifers.

**Botrytis Blight or Gray Mold**

**i. Causal Agent:** *Botrytis cinerea*

**ii. Symptoms:** Botrytis blight is identified by the gray, cottony growth of the fungus on the surface of affected needles and shoots. The fungus usually moves from the needles to the shoots and into the stems. As the disease progresses, infected shoots become water-soaked and brown lesions develop. If the fungus spreads to the main stem, it can canker and eventually girdle and kill the shoot. The fungus is an aggressive saprophyte so infections often begin on shaded, senescent needles and plant debris at the base of a seedling.

**iii. Management:**

1. Follow good cultural practices to keep the seedlings as healthy as possible. Weak and frost-damaged tissues are particularly susceptible to infection.
2. Avoid overcrowding to allow for good air circulation.
3. Avoid overhead irrigation or water early in the day so the foliage has a chance to dry.
4. Practice good sanitation. Remove all plant debris as soon as it develops.
5. Fungicide sprays- Among the compounds registered for use in Connecticut are: mancozeb (Protect, Dithane), chlorothalonil (Daconil, Bravo), and thiophanate-methyl (Cleary's 3336, AllBan).

**3. DISEASE PROBLEMS OF TRANSPLANTS IN THE FIELD**

Assuming a proper site has been selected and good planting practices are used, newly transplanted stock is most vulnerable to root injury from drought stress, especially in dry years. However, once out-planted in the plantation, transplants are also vulnerable to many of the diseases found on mature trees (e.g., Rhabdocline needlecast, Diplodia blight). These diseases are not covered in this fact sheet but information is available in the fact sheet entitled *Disease Problems in Connecticut Christmas Tree Plantations*.

- A. Drought-** As a direct result of the transplant process, newly transplanted stock is very susceptible to drought stress. Therefore it is important to provide water for those transplants in years when natural rainfall is limited.
- B. Winter Injury or Frost-** Newly planted trees are susceptible to quirky winter conditions and spring frosts. Damage might not be visible until the following spring or summer.
- C. Excess water-** Waterlogged soils limit growth of new roots and inhibit the ability of existing roots to absorb water. These conditions represent a challenge for newly planted seedlings.

September 2007 (revised)