Abstract: -- Several insect, weed, and disease pests are discussed that have been observed affecting container-grown longleaf pine (*Pinus palustris* Mill.) seedlings. The available tools to minimize the effects of these pests are limited to a few select insecticides, herbicides, and fungicides. Extreme care should be taken to ensure that the chemical chosen is used within the recommended guidelines and used with proper equipment. Accurate identification of the pest is important to ensure that the correct remedy is chosen. When growing longleaf pine seedlings in containers, pest prevention is cheaper than crisis intervention. Care should be taken to use the best available clean seed and potting media, to clean containers between crops, and to prevent stress by using the right amount of irrigation water. A list of pesticides is given to aid the grower in selecting the proper tool for pest problems.

INTRODUCTION AND CAUTIONS

If you have experience growing longleaf pine (*Pinus palustris* Mill.) seedlings in containers you may find it difficult to believe that containerization is supposed to reduce pest problems. Actually, it just changes the set of pest problems, compared to bareroot nurseries, and increases their importance by increasing the per-unit crop value. In integrated pest management (IPM), pesticides should be applied only at or above the economic threshold (ET). That is, at the point where the value of damage is just greater than the cost of the pest control. With container seedlings costing four times as much as bareroot seedlings, the ET is reduced to a fourth.

Pest control covers protecting your crop from three categories of pests: fungi, insects, and weeds. The tools for this are, not surprisingly, fungicides, insecticides, and herbicides. Each of these "tools" (pesticide categories) come, with a different set of cautions associated with the consequences of making an application mistake. The wrong fungicide will not stop the disease. Careless or incorrect application of an insecticide is dangerous to the applicator and to the environment. The wrong rate or careless application of any herbicide can severely damage longleaf seedlings.

The diseases and insects presented here are those the authors have found associated with container-grown longleaf pine seedlings (Table 1, 2). The herbicides shown are a shortened list of ones used in the bareroot nursery industry (Table 3). We suspect the level of pesticide experience differs widely among producers of container-grown longleaf pine seedlings. Remember that workers and pesticide handlers must be trained under WPS every 5 years. Agriculture is not complying well with Worker Protection Safety (WPS) regulations (<50% compliance), and a push for greater enforcement seems to be in the works. If caught in noncompliance you may receive a substantial fine. Contact your local county extension office for assistance in getting yourself or your workers the necessary training. Everyone must be properly trained and licensed by their State before obtaining or using most, if not all, of the products mentioned.

DISEASES

*Fusarium* spp.

One of the more troublesome fungal organisms in container nurseries is the genus *Fusarium*. At least four species of the genus are generally considered opportunistic pathogens. They take advantage of stressed or weakened seedlings. The most common of these fungi are *Fusarium oxysporum*, *F. solani*, *F. piliferatum*, and *F. subglutinans*. Their affects on longleaf production appear to the nursery manager as (1) poor germination, (2) damping-off, (3) root rot, (4) late-season root and crown rot, and even (5) seedling mortality after outplanting. While these fungi can be spread by wind and rain, the
most common entry point into the nursery is with seed. Improperly collected and processed cones and cones from seed orchards may have a greater incidence of these fungi. Typically, mortality from these fungi are scattered or random throughout the nursery, but the percentage of seedlings infected often varies by seedlot. When environmental conditions favor spread, serious infestations may spread between container cells. The State of North Carolina now has a special local needs (24-C) registration for a Benlate® seed treatment that has improved germination and cavity fill in preliminary tests. Additional 24-C registrations are desirable in States that produce many container-grown longleaf seedlings. Seedlots suspected of extensive contamination can be treated with surface disinfectants such as hydrogen peroxide (H₂O₂), which has improved performance in some tests. Fungicide evaluations, for potential registration, to improve longleaf seed germination are in progress.

**Rhizoctonia solani**

Probably the second most destructive fungus among container-grown longleaf is *Rhizoctonia solani.* This fungus is particularly serious on longleaf because of the seedlings stature. *Rhizoctonia* may be in planting media, and when this gets on the buds of longleaf seedlings, which are just above ground level, the fungus can infect both bud and needle tissue. After infection, the fungus causes a rapid death of the bud and needles and is capable of spreading rapidly through the container sets. Symptoms first appear as a water-soaked lesion that quickly turns yellow, then brown, and then darken as the bud and needles decay. The tightly packed nature of longleaf seedlings in containers and irrigation systems common in nurseries favor the growth and spread of this fungus. Circular areas of brown, dead, and dying seedlings are a good indication of *Rhizoctonia* infection. Seedlings symptomatic of this disease should be place away from the general population to reduce spread. This fungus can remain in soil particles left in containers from year to year in resistant structures called sclerotia. Sanitation is important to minimize carry-over. Other container crops have benefited by the disinfection of containers. This disease is also a problem in bareroot nurseries, and recent tests in South Carolina indicate that Chipco 26019® was effective at reducing disease incidence among bareroot seedlings.

**Pythium spp. and Phytophthora spp.**

Two other fungi that may be responsible for mortality in longleaf are *Pythium* and *Phytophthora.* These, too, are opportunistic pathogens that take advantage of stressed seedlings, especially seedlings that are over-watered. These fungi are considered water molds, as they move through the soil/water using a whip-like tail. Mortality by *Pythium* and *Phytophthora* appears as either damping-off or root rot early in the growing season and typically is scattered among the sets. As the seedling matures and becomes lignified, these pathogens are not a problem. Many, perhaps most, growers of container longleaf alternate some schedule of treatments with Subdue®, Cleary’s®, and/or Aliete® to prevent damage by these water molds. Whether this works or if problems would be rare anyway is hard to tell. We have noticed that some plant diagnostic clinics find one or both of these organisms in every sample they receive. That doesn't necessarily indicate they were the problem.

### Other Diseases

Two other diseases that can infect longleaf pine at the nursery but will only be noticed after outplanting are brown spot needle blight and pine needle rust.

**Needle rust—Brown spot**

**Needle rust**—Pine needle rust is caused by fungi in the genus *Coleosporium.* This disease may cause inconspicuous spots on the foliage at the nursery in the fall that may appear similar to brown spot. The next spring, after outplanting, small, yellow-white blisters form on the needles. These blisters are full of white to yellow aeciospores that do not infect pine, but rather infect other rust hosts, which are several common “weed” species such as goldenrod and morning-glory. Although fungicidal control would seldom be justified, Bayleton® would work. Even with spectacular needle infections, pine seedlings will normally survive without any problems. If seedling appearance is important to the customer, then locating the nursery away from the alternate host, or elimination via mowing or herbicides, is the best method to control this disease.

**Brown spot**—Brown spot needle blight is the last of the common diseases that may occur in the production of longleaf pine. This disease, caused by the fungus *Mycosphaerella dearnessii,* occurs throughout the Southeastern United States. Other pine species seldom get brown spot needle blight, and the disease is economically important only to longleaf pine. The fungus is spread via wind and rain splash of spores, and infection occurs throughout the year. The disease first appears as small gray spots on the foliage of longleaf, which become yellow, then brown, as the infection progresses. Each infection site has three distinct zones: green, yellow, and brown; multiple infections.
eventually coalesce on the needle giving it a mottled appearance. Infected seedlings rarely die, but severely infected trees will not commence height growth and may be defoliated and lose vigor to such a point that other agents kill it after outplanting. If experience shows that fungicidal control is regularly needed, Bravo® or Maneb® will prevent infection when prophylactically applied. This disease was once considered a major problem to reestablishment of longleaf pine in some regions of the South. The production of more vigorous seedlings and site treatments that shorten the "grass stage" of longleaf seedling development have greatly reduced the impact of this disease outside the nursery. Prevention and sanitation is the best method to control this disease.

**WEEDS**

Northern producers report that weeds are not a problem in their containers. It takes little investigation to determine that the South is different. However, the "science" of weed control in container production for southern pines is still in its very early stages, and there is nothing like the fairly standard protocol that exists for bareroot nurseries. Hand weeding is an option in small operations and some fairly large productions are still "crisis oriented" with respect to weeding or herbicide application. This will have to change where many seedlings are produced, and small productions should benefit economically if preventative measures were employed. Small weeds are controlled by much lower rates of herbicides than are larger weeds.

The information presented here was obtained from a telephone survey and may be a starting point for a weed control program appropriate for some nurseries (Table 3). There is a very short list of herbicides that should have selective activity, and the use of any of these should be initiated with great caution. One thing that makes a control program difficult to formulate is that both the weeds and possibly the activity of pre-emergent herbicides will differ with peat from different sources. The only "weed" species mentioned by several nurserymen was willow, and that is probably just a function of wind-blown seeds. Some nurserymen believe that weed seed come in some of the media they purchase.

Of many sick and dead seedlings observed by the authors, in many cases, herbicide damage is the cause of the problem, even though disease is usually the first culprit suspected. This paper is not to be considered to provide an endorsement of safety or efficacy of any pesticide discussed or listed. The tables are provided to help reduce the number of herbicides you might otherwise have to look through if you have limited experience in this area. **Always** when using a herbicide for the first time apply to a test plot of no more than you are prepared to lose. Reactions can change from year to year. Soil or planting media affect the way plants respond to herbicides. Any kind of stress will change the response of plants. You **must** have an appropriate label on site to use a pesticide and you really should read it and follow directions.
Table 1. Chemicals registered for use in controlling diseases in longleaf.

<table>
<thead>
<tr>
<th>Agent</th>
<th>LD50</th>
<th>Used</th>
<th>Fungus</th>
<th>Rate (lbs/acre)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bayleton</td>
<td>363</td>
<td>Foliar</td>
<td>Rusts</td>
<td>0.25 - 0.5</td>
</tr>
<tr>
<td>Triadimefon</td>
<td></td>
<td>systemic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Captan</td>
<td>9,000</td>
<td>Seed</td>
<td>damping-off</td>
<td>0.5 - 5.0 ai</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Foliar</td>
<td>Botrytis</td>
<td>0.06 - 0.6/100 1lbs seed</td>
</tr>
<tr>
<td>Thiram Gustafson-42S</td>
<td>780</td>
<td>Seed</td>
<td>damping-off</td>
<td>2 gal + 10 oz latex / 100 lbs seed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Foliar</td>
<td>birds, rats</td>
<td></td>
</tr>
<tr>
<td>PCNB</td>
<td>12,000</td>
<td>soil &amp; seed</td>
<td>Rhizoctonia</td>
<td>5-200 ai or</td>
</tr>
<tr>
<td>Terraclor</td>
<td></td>
<td></td>
<td></td>
<td>0.5 - 0.75/bu seed</td>
</tr>
<tr>
<td>Chlorothanil</td>
<td>10,000</td>
<td>foliar</td>
<td>anthracnose</td>
<td>0.75 - 1.5 ai</td>
</tr>
<tr>
<td>Bravo</td>
<td></td>
<td></td>
<td>Botrytis etc</td>
<td></td>
</tr>
<tr>
<td>Iprodiono Chipco-26019</td>
<td>3,500</td>
<td>contact</td>
<td>Botrytis Alternaria</td>
<td>0.25 - 1.0 ai</td>
</tr>
<tr>
<td></td>
<td></td>
<td>foliar</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fosetyl-AL</td>
<td>2,000</td>
<td>foliar</td>
<td>Phycomycetes</td>
<td>1.5 - 2.0 ai</td>
</tr>
<tr>
<td>Aliete</td>
<td></td>
<td>systemic</td>
<td>Rhizoctonia</td>
<td></td>
</tr>
<tr>
<td>Thiophanate</td>
<td>15,000</td>
<td>soil</td>
<td>Fusarium</td>
<td>0.12 ai</td>
</tr>
<tr>
<td>Cleary-3336-F</td>
<td></td>
<td>foliar</td>
<td>Botrytis etc</td>
<td></td>
</tr>
<tr>
<td>Thiophanate methyl + Terrazole = Banrot</td>
<td>1,070</td>
<td>soil</td>
<td>Phycomycetes</td>
<td>.38A</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Fusarium</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Rhizoctonia</td>
<td></td>
</tr>
<tr>
<td>Metalaxyl</td>
<td>669</td>
<td>soil</td>
<td>Phycomycetes</td>
<td>0.6 ai</td>
</tr>
<tr>
<td>Subdue</td>
<td></td>
<td>foliar</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

LD50’s and rates of application are given for comparative references between products and not as guides to safety or application and use rates. For application rates consult product label which must be on site at use.

Table 2. Chemicals registered for controlling insects in longleaf pine

<table>
<thead>
<tr>
<th>Agent</th>
<th>LD50*</th>
<th>Family</th>
<th>Used</th>
<th>Insects</th>
<th>rate /acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chloropyrifos</td>
<td>96</td>
<td>OP**</td>
<td>contact</td>
<td>corn borer</td>
<td>0.1 to 5 A lb</td>
</tr>
<tr>
<td>Dursban, Lorsban</td>
<td></td>
<td></td>
<td>stomach</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Esfenvalerate</td>
<td>325</td>
<td>pyrethroid</td>
<td>contact</td>
<td>lygus</td>
<td>0.1 - 1 lb ai</td>
</tr>
<tr>
<td>Assana</td>
<td></td>
<td></td>
<td>stomach</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Permethrin</td>
<td>430</td>
<td>pyrethroid</td>
<td>residual</td>
<td>lepidoptera</td>
<td>0.05 - 0.2 lb ai</td>
</tr>
<tr>
<td>Pounce</td>
<td></td>
<td></td>
<td>activity</td>
<td>weevils</td>
<td></td>
</tr>
<tr>
<td>Diazinon</td>
<td>300</td>
<td>OP</td>
<td>long</td>
<td>Many</td>
<td>0.25 - 2 A lbs</td>
</tr>
<tr>
<td>Spectracide</td>
<td></td>
<td></td>
<td>residual</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Malathion</td>
<td>1375</td>
<td>OP</td>
<td>Foliage</td>
<td>Many &amp; mites</td>
<td>0.5 - 3 A lbs</td>
</tr>
<tr>
<td>Bifenthrin</td>
<td>54</td>
<td>pyrethroid</td>
<td>contact</td>
<td>fire ants</td>
<td></td>
</tr>
<tr>
<td>Talstar</td>
<td></td>
<td></td>
<td>stomach</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Firebrand?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
*LD50’s and rates of application are given for comparative references between products and not as guides to safety or application and use rates. For application rates consult product label which must be on site at use.

**The EPA may soon ban all OP (organophosphates)
Table 3. Herbicides registered or probably registered for growing container longleaf

<table>
<thead>
<tr>
<th>Product</th>
<th>Crop Plant</th>
<th>Container</th>
<th>PPE</th>
<th>REI</th>
<th>Rate/acre*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goal</td>
<td>Conifers</td>
<td>Yes</td>
<td>1,3,4,5</td>
<td>24</td>
<td>Pre 1-2 pts Post 1-2 pts Pre 0.5-1 pt Post 0.4-1 pt Post 2.25-3.75 pts</td>
</tr>
<tr>
<td>Cobra²</td>
<td><em>P. palustris</em></td>
<td>Yes</td>
<td>1,2,3,4,5</td>
<td>12</td>
<td>Pre 0.5-1 pt Post 1-2 pts</td>
</tr>
<tr>
<td>Vantage</td>
<td><em>P. palustris</em> (bedding plants)</td>
<td></td>
<td>1,3,4</td>
<td>12</td>
<td>Post 2.25-3.75 pts</td>
</tr>
<tr>
<td>Fusilade**</td>
<td>Conifers (nursery beds)</td>
<td>1,2,4</td>
<td>12</td>
<td>Post 1-2 pts</td>
<td></td>
</tr>
</tbody>
</table>

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**Fusilade should probably be used without the recommended COC or NIS.

¹ PPE code = 1 shoes + socks, 2 long sleeve shirt, 3 coveralls, 4 gloves, 5 eye protection.

² In general, pine are more tolerant to Cobra than to Goal.

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Figure 1. The availability to plants of nutrient elements related to pH. The figure on the left is mineral soils. The figure on the right is organic potting mixes. From: Handreck, K.A.; Black, N.D. 1994. Growing Media for Ornamental Plants. Univ. of New South Wales Press. Randwick NSW Australia. p 86.
Figure 2. The relationship between seedling growth and seedling tissue nutrient levels follows a characteristic pattern. Point "A" represents the critical level. Beyond this point, increasing nutrient levels do not result in more growth, but lead to luxury consumption or even toxicity. 