NURSERY DISEASE PROBLEMS - CONTAINERIZED NURSURIES

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The same organisms that cause disease of conifer seedlings grown in the traditional way in ground beds cause disease in containerized seedlings. However, there are differences in importance. As an example, Macrophomina phaseolina, a soilborne fungus, is not apt to be a problem in containerized seedlings since one of the requirements for pathogenicity is low soil moisture coupled with high temperatures.

For convenience and for practical purposes diseases of seedlings ,,in be divided into those that attack aboveground parts (foliage and stem) and those that attack belowground parts (roots). Above ground diseases of containerized seedlings might be the same as chose grown in ground beds in the open since airborne pathogens
e not restricted by overhead structures such as roofs of plastic or glass. In an ideal containerized greenhouse the humidity is controlled and theoretically condensation of moisture can be prevented and thereby the known airborne pathogens of conifers can be prevented from infecting. This degree of humidity control has been achieved through heating, venting and air circulation in greenhouses where chrysanthemums and roses are grown. These types of greenhouses are expensive and require considerable energy for operation. Most of the containerized nurseries that I have seen have not had the environmental controls necessary to prevent by
airborne pathogens.

Location of containerized nurseries in areas where host-specific airborne pathogens do not occur seems to be a reasonable requirement for disease control. One host-specific airborne pathogen that should be considered is rust (gall, fusiform, and others).

Location might also be considered in the case of non-host specific pathogens such as the ubiquitous Botrytis cinerea. From experience it is known that B. cinerea is most troublesome in the coastal areas of California. This of course is related to high atmospheric moisture. Filtration of air to exclude spores has been suggested but it is not in general use and may not be practical.

Some decree of environmental control, that is humidity control, can be achieved in simple structures (greenhouses) by providing for good air movement *through* orientation of the structure, moving air by fans, plant spacing, watering practices (water when normal condensation might occur such as early in the morning so that the foliage is wet the shortest length of time).

Fungicides can be very helpful in controlling grey mold cased by Botrytis cinerea. Where tolerance is not a factor benomyl [2] is the outstanding fungicide. However, where the fungus has developed tolerance to benomyl, it is reported that the disease can become more intense with continued use of the fungicide. Chlorothalonil[3] is effective against B. cinerea and several other pathogens of conifers. Mancozeb [4] is also effective in the same way. Dicloran[5] was the outstanding fungicide in a trial to control grey mold of redwood seedlings but it is not registered for use on conifers. I believe that it is desirable to alternate fungicides. There are two reasons for this. First, levels toxic to the plant are less likely to build up and, second, there is much less opportunity for selection of tolerant fungi. A number of growers are successfully controlling grey mold by application through the overhead watering system. The fungicide is usually applied at the end of the irrigation cycle.

The most important belowground or soilborne pathogens are Pythium spp., Rhizoctonia solani, and Fusarium oxysporum f. pini. Both Pythium and Rhizoctonia are present in practically all agricultural soils. Fusarium oxysporum f. pini, while perhaps not as widely distributed, has been implicated in death of containerized seedlings (Sequoia gigantea in California). All three can be eliminated from soil by heat or chemical fumigation. Recontamination by Pythium and somewhat less by Rhizoctonia is common, if not the rule. Peat can be and often is infested with Pythium and Rhizoctonia. For this reason, nurseries experiencing problems should consider treating the growing mixture.

All plant pathogens are killed in moist soil held at 60 C (140 F) for 30 minutes. High treatment temperatures are not desirable because many beneficial organisms which survive the 60 C treatment are killed. Ordinary steam treatment of soil rarely heats the soil much over 93 C (200 F). This is because air is entrapped in the soil. By intentionally combining air with steam lower treatment temperatures can be achieved. This can be accomplished in large transit-type cement mixers adapted for mixing soil. Steam is simply injected into the mixer until the desired temperature is reached.

[2] Benomyl = methyl l-(butylcarbamoyl)-2-benzimidazole carbamate; sold as Benlate®, Tersann 1991.

[3] Chiorothalonil = tetrachloroisophthatonitrile; sold as Daconil 2787® Bravo®

4 Mancozeb = a coordination product of zinc ion and manganese ethylenebis-dithiocarbamate; sold as Dithane M-45®, Manzate 2000,

[5] Fore®.
Dicloran = 2,6-dichloro-Il-nitroaniline; sold as Botrann.

Specially designed blowers and valuing devices are available for treatment of soil in open containers or carts with plenums In the bottom for uniform distribution of the steam (Lindig®).

The most useful fumigant for treatment of soil mixtures is methyl bromide because it is fast acting, diffuses rapidly throughout the soil mass and dissipates when confinement is terminated. It must be confined and this is usually accomplished using polyethylene sheets. It should be pointed out that polyethylene sheeting is not impermeable to methyl bromide gas and losses through the film are significant, especially in the thinner sheets. Four mil (0.004 inch) thickness is probably best for pile treatment. When the gas is injected into field soils, a 2 mil cover seems to be sufficient. The amount required under a 2 mil thickness cover is greater than that required when a 4 mil cover is used.

Metham-sodium, also known as SMDC (sodium N-methyldithiocarbamate) sold in the U.S. as Vapam®, is another fumigant sometimes used. It is a liquid that can be injected or mixed with water and drenched into the soil. It can also be used in "cement" mixers and in some other ways. Dazomet, also called DMTT (tetrahydro3,5-dimethyl-2H, 1,3,5-thiadiazine-2-thione), is generally sold as a powder (Mylone®) but is also available as a liquid concentrate. It is similar to metham-sodium in that in moist soil both breakdown to form MIT (methyl isothiocyanate), the volatile toxicant. Diffusion of MIT is not as rapid as methyl bromide and the treatment time is longer. For best results, a gas-proof cover of polyethylene should be used when treating nursery soils.

MIT is also available dissolved in chlorinated C hydrocarbons (Vorlex®=20% MIT, 80 % chlorinated C hydrocarbons). It must be injected into soil and is not particularly adaptable to bulk treatment of soil.

Chloropicrin (trichloronitromethane) is now generally used in combaination with methyl bromide; it also must be injected as MIT because of slow diffusion. While methyl bromide-chloropicrin combinations have proven to be most effective for treatment of ground beds in conifer nurseries, the mixture is not suitable for bulk treatment of soil.

Methan sodium, dazomet, MIT, and chloropicrin all require about two weeds for treatment and aeration.

I mentioned that recontamination is the rule and treated soil is more readily recolonized than non-treated soil. It is very important that treated soil be protected from contamination.

Sanitation is the name of the game. But in spite of sanitation, some Pythium may "get in". Certain soil fungicides have been very helpful in preventing recontamination of soil and in controlling Pythium and Rhizoctonia.

Ethazol, 5-ethyoxy-3-trichloromethyl-1,2,4-thiadiazole, is sold as Terrazole®, Truban® and in combination with thiophanatemethyl

as Banrot®. It is used as a soil drench or mixed with the soil prior to planting. As a soil drench it is applied at the rate of 4 to 10 oz. (30%)/1000 sq. ft.; 5 oz. (30%)/1000 sq. ft. is probably adequate. Usually the product, which is either an emulsifiable concentrate or a wettable powder, is applied in 100 gallons water/400 sq. ft. These rates do not damage foliage and with many ornamental crops the chemical is metered into the water with irrigation.

Diazoben or fenaminosulf, p (dimethylamino) benzenediazo sodium sulfonate, sold as Dexon® is rather specific in controlling Pythiaceous fungi. Ethazol is also primarily active against water molds. Diazoben can be mixed with the soil as ethazol, but it is usually applied as a drench at 100 ppm. It is light sensitive and decolorized rapidly with loss of activity. It is best applied at night. Recently some Canadian plant pathologist reported that Dexon® damaged conifer seedlings. The most effective fungicide for control of Rhizoctonia solani is PCNB. However, it must be applied and mixed into the top inch or so of soil to be most effective. It probably will not be used in this way in containerized nurseries. It likely does some good applied as a drench to stop a rapidly moving epidemic. Benomyl at high rates will slow down Rhizoctonia and chlorothalonil will also slow it down.

Benomyl has been useful in controlling Fusarium oxysporum on other crops such as gladiolus (corm dip) and carnations. It probably will help in the control of Fusarium oxysporum f. pins. Captan will also help control Fusarium.

Seed treatment with thiram or captan should not be overlooked. It is possible that some pathogens might be introduced on the seed.