NURSERY DISEASES

1 INTRODUCTION

Any deviation from the normal, healthy condition of a plant that threatens its usefulness or health is in its broadest sense a disease. Diseases can be caused in the nursery by algae, fungi, bacteria, viruses, viroids, mycoplasma, malnutrition, environmental conditions, animals, insects, mites, nematodes and inherited genetic weaknesses.

This chapter deals only with algae, bacteria, fungi and nematodes. Virus and virus-like diseases are mostly eliminated by shoot-tip grafting. The other factors such as insects, mites and malnutritional disorders are covered elsewhere in these guidelines.

Disease control in the nursery can include one or more of the following strategies:

- excluding, removing or restricting the source of infection;
- avoiding conditions that promote infection;
- preventing entrance by treating susceptible parts of the host; and
- using resistant varieties.

2 ALGAL DISEASE

This is not a common problem in citrus nurseries. It is caused by *Cephaleuros virescens* which is not a true parasite as it manufactures its own food supply. However, it can cover the leaf surface resulting in reduced photosynthesis and eventual defoliation. The disease occurs only in the warmer, more humid areas.

2.1 Symptoms

The algae appears on the leaves or twigs as a yellowish-green or grey felt-like superficial growth.

2.2 Control

Algae can be controlled by routine copper sprays used for fungal disease control.

3 BACTERIAL DISEASES

3.1 Citrus canker

Southern Africa is fortunate in not having any types of citrus canker caused by *Xanthomonas campestris*. This dreaded bacterial disease was eradicated in South Africa in 1927. However, nurserymen are warned not to import any plant material into South Africa without going through the official quarantine channels. The detection of citrus canker in a nursery will most definitely lead to the destruction of the trees in the nursery, and the trees supplied to growers from it.

3.2 *Pseudomonas* leaf spot

Pseudomonas syringae is a common inhabitant of citrus leaves. Under prolonged wetting at low temperatures, it can cause water-soaked lesions on the leaves of very succulent shoots, especially on rough lemon seedlings.

3.2.1 Control

Copper fungicides will control the disease.

4 FUNGAL DISEASES

4.1 Damping-off

Damping-off is a disease experienced in seedbeds when the germinating seedling is attacked by a pathogen before it reaches the surface or at the surface of the growing medium. This is common when excessive soil moisture is accompanied by high temperatures.

Phytophthora, Pythium and *Rhizoctonia* are the principal pathogens which cause damping-off in citrus nurseries.

4.1.1 Symptoms

After germination, seedlings can be attacked before they reach the surface of the germinating medium; this results in a sparse stand. Disturbing the surface of the germination medium will reveal rotting of the seed or seedling hypocotyl. If seedlings are attacked after emergence, toppling will occur as a result of girdling of the stems.

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4.1.2 Control

Ensure that germination media is free of pathogens. This can be achieved either by methyl bromide fumigation at the prescribed dosage (1 kg/10 m^2) or by pasteurisation using steam. Irrigation water should also be flocculated, filtered and chlorinated to ensure that it is free from pathogens. Avoid over-watering, poor drainage and inadequate ventilation.
The following products can be used just prior to or after seed planting:

Fungicide	Application rate per litre of water	Application instructions
Bordeaux	3 g	Apply as a drench at 2 litre/m^2
Kaptan	4 g	Apply prior to sowing as a drench at 2 litre/m^2
Copper oxychloride	2,5 g	Apply as a drench at 1,5 litre/m^2
Copper hydroxide	2,5 g	Apply as a drench at 1,5 litre/m^2
Xanbac D	2 ml	Apply as a pre- and post-emergence drench at 7-10 day intervals
Previcur N+ Benlate or Topsin	2,5 ml + 0,5 g or 1 g	Apply directly after sowing as a drench at 3 litre/m^2
Terraclor	1,25 g	Work into seedbed at 1 litre/m^2 (will only control *Rhizoctonia*)

4.2 Albinism

This is a sporadic problem in South Africa where nurseries use their own seed sources.

Albinism can be caused by either *Alternaria* or *Aspergillus*.

4.2.1 Symptoms

The seedlings do not turn green on emergence from the surface of the germination medium. They remain a pale yellow colour for some time, after which a certain percentage recover and produce normal plants. Those in which chlorophyll synthesis does not take place, die.

4.2.2 Control

Seed treatment with Thiulin (1,5 g/kg seed) or a hot water seed treatment at 52°C for 10 minutes, will prevent albinism from developing.

4.3 Diseases of the root system and trunk

Phytophthora, which causes feeder root rot and collar rot in citrus is the most important pathogen in the nursery. The species *P. nicotianae* var. *parasitica* and *P. citrophthora* are chiefly responsible for killing citrus trees in nurseries in southern Africa.

Other fungi which can also be associated with these diseases in the nursery are *Pythium*, *Fusarium*, *Sclerotinia* and *Thielaviopsis*. Recent studies show that there are huge differences in pathogenicity between the different *Pythium* spp.. Some may be as pathogenic as *Phytophthora*.

4.3.1 Symptoms

Injury and destruction of the small fibrous feeder roots results in fewer rootlets in comparison to uninfected root systems. On feeder roots that have not completely rotted, sloughing of the bark is sometimes evident. Decaying cortex easily slides off the stele when a slight pinching pressure is applied with the fingers.
In severe cases, gummosis of the crown or trunk may be visible. Gummosis is characterised by a profuse exudation of dark, amber-coloured gum on the bark surface.

Both feeder root rot and collar rot affect the foliage. The leaves turn pale yellow and develop yellow veins.

4.3.2 Control

The most effective way to control *Phytophthora*, is by excluding it from the nursery. This can only be done if pathogen-free irrigation water and growing media are used. To ensure that the irrigation water is kept pathogen free, it should be checked regularly using a

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Phytophthora/Pythium spore trap. (Consult the part on the Diagnostic Centre also in this chapter.) For further information regarding the acquisition of petri-dishes with selective media, contact the Diagnostic Centre, P O Box 28, Nelspruit 1200 (telephone (013) 759 8000) or at cridc@cri.co.za.

Any new sources of irrigation water should be tested prior to use in the nursery. Thereafter, the water source should be tested monthly to check on the efficacy of filtration and chemical treatments being used.

A stable potting medium with an air-filled porosity of approximately 20% should be used. Care should also be taken to avoid over-irrigation. Suffocation from over-watering increases the quantity of root exudate that leaks from the root which in turn increases the number of zoospores which are chemostatically attracted to the root. (Consult the part on *Phytophthora* in Chapter 7.)

Trees should be produced on raised structures to ensure that run-off water from infected trees cannot come into contact with adjacent trees.

Since visual symptoms do not develop rapidly enough, it is essential to conduct routine diagnostic tests by sampling trees every two to three months to ensure that the nursery remains free from pathogens.

Trees can also be kept on a preventive programme using foliar applications of Phosphonate fungicides (1 ℓ/100 ℓ water) or Aliette WP applied at a rate of 2,5 g/litre every six weeks. Soil-applied fungicides are not recommended in nurseries for preventive treatments as their repeated use is conducive to the development of resistance by soil-borne pathogens.

If used too frequently, Aliette can slow the growth of citrus trees. Therefore, it is preferable to grow trees in a pathogen-free environment.

Suppressing *Phytophthora* in the nursery with chemical treatments may also camouflage the problem. Once these trees leave the nursery they are seldom kept on a fungicide programme. Symptoms of *Phytophthora* can develop, casting a poor reflection on the nursery.

If *Phytophthora* or *Pythium* are detected in a nursery following monitoring by diagnostic tests, the following action should be taken:

- Reduce the irrigation. Only irrigate when trees show signs of wilting during the mornings.

- Spray Aliette WP at a rate of 2,5 g/litre or Phosphonate fungicides (1 ℓ/100 ℓ water) immediately and follow up with two more applications at six weekly intervals.

- Apply Kaptan as is described under damping-off disease. Kaptan can only be used if the potting mix consists of sand, bark or a mixture of the two. If soil is used, Kaptan will bind to the clay particles rendering the treatment ineffective.

4.4 Diseases of the twigs

Twig die-back is in most cases a result of pathogens entering the twigs through wounds caused by pruning, hail or any other mechanical damage as well as through cracks formed as a result of cold damage and malnutritional disorders such as copper deficiency.

It is extremely difficult to determine whether a fungus isolated from a lesion is in actual fact the primary cause of the lesion or whether it is secondary. The fungi most commonly involved are *Alternaria*, *Colletotrichum* or *Diplodia*. *Sclerotinia, Fusarium* and *Botrytis* can also be pathogenic.

4.4.1 Symptoms

Twigs can become wilted from the tip downward or can die off at any distance from the tip resulting in ring-barking of the twig. The whole twig eventually dies.

4.4.2 Control

As it is often difficult to establish the primary cause of twig die-back, it is recommended that a mixture of 0,5 g Benlate and 0,8 ml Score/Folicur per litre water be sprayed if twig die-back occurs. The dead wood including 40 mm of healthy tissue should be removed before application of the fungicide.

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4.5 Diseases of the leaves

Leaf infection is the result of direct infection of fungi through stomata, lenticels, wounds caused by insects, hail, or mechanically, or host-specific toxins secreted by fungal spores which kill host tissue ahead of the invading hyphae. If leaves are left unprotected, photosynthesis is impaired and defoliation can occur which will have a direct effect on the growth of the tree.

4.6 *Alternaria* brown spot

This is a common problem on the young flush of certain mandarin cultivars in nurseries. A host-specific toxin is produced by the spores in the presence of free water on the leaf which kills the host tissue.

The casual organism is *Alternaria alternata*. Consult the part on *Alternaria* brown spot in Chapter 6 for further information.

4.6.1 Symptoms

Leaf symptoms vary from large, necrotic, blighted areas to small, circular spots. Leaf infection is characterized by the extension of necrosis into the veins. Defoliation then occurs. Stems are also infected resulting in die-back.

4.6.2 Control

Three sprays of 2 g copper oxychloride per litre water applied at five-weekly intervals will be sufficient to control the disease. If overhead irrigation is used, more spray treatments will be necessary.

4.7 *Alternaria* leaf spot on rough lemon

Although this pathogen is morphologically similar to the fungus which causes brown spot in fruit, it also produces a toxin that is host specific to *Citrus* spp. The disease can be a major problem when propagating rough lemon seedlings for rootstocks.

The casual organism is *Alternaria alternata*. Consult the chapter on *Alternaria* brown spot in Chapter 6 for further information.

4.7.1 Symptoms

Lesions on leaves vary from large, necrotic, blighted areas to small, circular spots. The necrotic areas are usually surrounded by an extensive chlorotic halo. Lesions tend to extend out along veins. Stem infection and the defoliation that commonly follows infection of the leaf blade cause die-back of the shoot apices. Severe attacks lead to the development of trees with short internodes and excessive branching which are then difficult to bud.

4.7.2 Control

Protect new growth flushes with sprays of copper fungicides applied at 2 g per litre water.

4.8 Sooty mould

Sooty mould is a black, superficial fungal growth on the surface of leaves. The fungus grows on honeydew deposited by heavy infestations of honeydew-producing insects. These insects include aphids, soft scales, mealybugs and whiteflies. Although sooty mould does not penetrate host tissue, it may interfere with photosynthesis.

The causal organism is *Capnodium citri*.

4.8.1 Symptoms

The fungal growth is usually heavier on the upper surface of the leaf.

4.8.2 Control

Honeydew-producing insects should be controlled before significant amounts of honeydew are produced. Consult the IPM recommendations for the control of these insects. Copper oxychloride should be applied at a rate of 2 g per litre water once the insects have been dealt with. Oil sprays of 0.5% or higher will also control this fungus.

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