PATHOGENS IN PLANT PROPAGATION

OLGA M. GOSS[1]
Department of Agriculture, Perth, Western Australia

Before going deeply into this subject it is essential that you realise a fundamental truth in relation to plant disease. For a plant disease to develop, whether it be during propagation or following planting out, three things are essential. There must be:

(a) a susceptible plant
(b) the disease-causing organism, and
(c) a favourable environment for the pathogen.

Unless all three are present at the same time disease will *not* develop.

(a) **The susceptible plant.** All plants are not susceptible to the same diseases. Even within the same broad group of plants, *some are resistant while other are susceptible.* With the resistant plants they can be susceptible at the very early stages of growth, but with susceptible plants they are more liable to attack by disease causing organisms only at certain growth stages, e.g. just after emergence as tender seedlings.

(b) **The disease organisms (pathogens).** These may be bacteria, fungi, nematodes or viruses. Some organisms, e.g. *Botrytis*, are almost ubiquitous in their distribution, whilst others are sporadic.

(c) **The favourable environment.** This is a major factor because pathogens can only cause disease when temperature, moisture and other conditions are favourable. These conditions vary with the different pathogens. In the nursery situation, of course, the environment is ideal for many of the pathogens, but it can still be manipulated to some extent to reduce the ravages of disease. By understanding this basic principle a person can often make it work for his benefit.

The adverse role of plant pathogens in propagation can be considered from four main aspects:

(a) The plant material being used for propagation.
(b) The propagation medium being used.
(c) The water used for misting and irrigation.
(d) The environment in which the plants are grown.

You have all heard the old adage, "Prevention is better than cure." Nowhere is this more true than in the field of plant pathology. It is far better to adopt measures which will prevent a disease developing than to try to control it once it has become

[1] Senior Plant Pathologist

established. The latter is seldom really successful, hence the ideal is to grow a healthy plant in a clean mix and environment when diseases can often be completely avoided and only minimal spraying is necessary. Diseases simply cannot be afforded.

(a) **Plant material being used.** This may be either seed or vegetative material used for cuttings.

Seeds. Seeds can carry a number of disease organisms either externally as spores on the seed coat or internally in the seed. Ideally, sowing of disease-free seed is the best way to start growing plants. However, there is no way of guaranteeing that any and every seed line is free of disease-causing organisms. Therefore appropriate seed treatments should be carried out as a routine measure, especially for particular seed types known to be a disease risk. Such treatments include hot water, air-steam and fungicidal steeps or dusts. Hot water and air-steam treatments are particularly important for internally borne diseases such as the bacterial diseases — black rot of crucifers and bacterial canker of tomatoes, and for some fungal diseases like the downy mildews and damping off. In fact many nurserymen have told me they have been unable to efficiently grow some plants prior to using air-steam seed treatments. Since using this treatment few, if any, problems have occurred. The temperature and time of exposure to this temperature varies with different types of seed, but it is usually around 50°C for about half an hour. The maximum temperature seed will tolerate is about 53°C; above this the seed is likely to be killed.

Fungicides of value for seed treatment include the benzimidazoles, thiram and captan. The best treatment to use will vary with the seed and the disease to be controlled and it is largely a matter of experience. After treatment, seed should be put into a clean container, labelled and kept separate from untreated seed, if it is not being planted immediately.

Vegetative material for cuttings. Cuttings should only be taken from healthy plants, preferably growing in containers, and kept protected from possible disease by regular spraying for disease and pest control and replaced on a regular basis to ensure that soil-borne problems do not develop. Mother plants growing in containers are preferred as it is impossible to maintain "open ground" grown plants in a completely clean condition. When cuttings are taken, secateurs, knives etc. should be regularly dipped in a disinfectant, such as 2% formalin, to ensure that diseases are not introduced to cuttings or plants. Particularly if open ground mother plants are used, cuttings are best taken at least 30 cm above the soil to avoid the risk of pathogen contamination from the soil. Cuttings can be dipped in fungicides or disinfectant solution, such as hypochlorite.

In some cases heat treatments can be given, e.g. air-steam can be used on mature wood or canes of *Dieffenbachia*, *Aglaeonema*, *Philodendron* and *Syngonium*, dormant tubers and bulbs, and on *Fittonia*. In the last case the leaves are killed but the stem remains viable. It could be well worth experimenting with some of the disease prone types. Cuttings should be kept clean at all times after collection and, particularly, after treatment, e.g. they should only be placed on benches which have been thoroughly cleaned down and disinfected (e.g. with formalin or hypochlorite) and in an area where contaminated material is not present.

(b) **The propagation medium.** At this stage it is essential that one start with a pathogen-free medium which is free draining but still capable of holding moisture. It is wise, therefore, to prepare mixes using only pathogen and pest-free components to prevent re-contamination. Most of you will be well aware of the types of mixes which are suitable for cuttings, but are you sure that they are really clean? For example, peat may have been in contact with surface soil; the bags may have been placed on contaminated soil; sawdust may have been put in dirty bags or picked up from soil, and so on. Nematodes have been regularly recovered from peat. Hence, although relatively slight, there is a risk that mixes of this type may not be sterile and it is, therefore, advisable that they be sterilised at least in the propagation stage. Suitable methods include air-steam, full steam, microwave treatment, solar heat or a chemical method such as methyl bromide.

The air-steam method is favoured because it does not kill all organisms and so create a biological vacuum, but only kills the pathogens. Hence, if by misadventure subsequent contamination does occur, a pathogen will not develop as rapidly as it does when complete sterilisation is carried out, since this treatment also kills antagonistic organisms. In addition, there is no risk of toxicity build-up in the soil which can occur with full sterilisation. Once the soil mix has been treated, ensure that it does not become recontamined by keeping it covered and in a clean area until used. The containers (either pots or trays) used for propagation need to be clean — preferably new — but if being re-used they should be thoroughly washed and disinfected. Suitable methods of disinfection include air-steaming, methyl bromide fumigation, hypochlorite dipping and, in some cases, formalin and copper naphthenate swabbing or dipping.

(c) **The water used for misting and irrigation.** As a general rule water taken from the mains or from deep bores will be free of pathogens. However, water which has been in contact with surface soil such as in dams, rivers, creeks etc. can be contami-

nated with pathogens such as *Pythium* spp., *Phytophthora* spp. and nematodes. The water can be freed of these pathogens by several methods, including chlorination, filtration and UV sterilisation.

The filtration method appears to be the safest and most reliable. Remember to ensure that hose nozzles etc. are not left in contact with soil; they can pick up and transmit contamination. Misting does not encourage disease build-up and spread of fungal disease, probably because the leaves are subject to continued wetting, washing off spores before they can germinate and penetrate. However, it is important that cuttings are free of disease when misting is used because it will encourage development of disease already present. Obviously it is also essential that water used for misting be clean, both biologically and chemically.

(d) **The environment in which plants are grown.** This, of course, includes the actual glasshouse or frame being used as well as the temperature and humidity at which it is kept. The walls, roof, benches and floors of these houses must be cleaned down regularly, sprayed, swabbed or fumigated with disinfectant which will kill spores lodging in crevices as well as on the surface. Copper naphthenate, hypochlorite and formalin are suitable for benches and floors.

If the house is well ventilated and plants are adequately spaced, disease can be avoided or appreciably reduced because leaf surfaces do not remain wet for very long so reducing the chance of infection if spores do land on them.

DISEASES WHICH ARE OF MAJOR IMPORTANCE IN PROPAGATION AND SUBSEQUENT GROWING OF PLANTS

(1) *Bacterial diseases*, like black rot of crucifers and bacterial canker of tomatoes.

These are seed-borne and can be controlled by heat treatment, as mentioned earlier.

(2) *Pythium* and *Phytophthora*

These are important in causing damping off, root rots, collar rots, cutting rot and in some plants, *Phytophthora* can cause leaf and stem blights, e.g. in *Philodendron* and *Dieffenbachia*. Care in treatment of mixes, water and propagation material used is vitally important in controlling these diseases. If subsequent contamination occurs, fungicidal drenches will reduce losses.

Suitable chemicals are Terrazole, Le-San DX or one of the newer chemicals shortly to be made available such as Ridomil, Fungarid, LS 74-783 (Alliette) and Previcur.

(3) *Rhizoctonia* spp.

Although this fungus is important in causing disease in its own right, it is also often associated with *Pythium* in causing damping off. It is active all the year round but develops best in warm moist conditions. It has a very wide host range and can attack all types of plant tissue. Adequate spacing of plants, increase in ventilation and reduction in watering will assist in control.

Suitable chemical drenches include quintozene (PCNB, Folosan, Terrachlor, Brassicol, Lanes Purasoil), benzimidazoles (Benlate, Topsin) and when available iprodione (Rovral).

(4) *Botrytis* spp. (Grey mould)

This develops rapidly where dead or damaged leaves or other tissue are left in pots and, particularly, if plants are closely spaced so reducing aeration. It is usually worse in the cooler periods of the year. This fungus can only attack through dead or dying tissues, but can develop rapidly once infection has occurred, causing a wet softish rot. Control can be achieved by improving spacing of the plants, improving ventilation and removal of dead tissue.

Suitable spray chemicals are the benzimidazoles, captan, dichloran (Allisan), and when available iprodione (Rovral).

(5) *Peronospora* and other downy mildews

These are mainly of importance to the seedling growers — particularly in the crucifers (cabbage, cauliflower, stocks etc.), onions and lettuce. The disease causes yellowing of the leaves often associated with a bluish haze caused by the sporing of the fungus. These diseases are very difficult to control unless preventive sprays are applied and plants kept as dry and warm as possible. Seed treatment is important.

Suitable sprays are dithiocarbamates like zineb and maneb, mezineb (Antracol), captafol (Difolatan) and when available the newer chemicals, Fongarid, Ridomil, LS 74-783 and Previcur.

(6) *Oidium* and other powderly mildews

These fungi do not need free moisture on the leaves to cause infection. Shading is very conducive to disease development. The fungus spores prolifically on the leaf surface, producing a dense white powdery layer.

Control can be helped by good aeration and spacing to avoid shading, and spraying with benzimidazoles, sulphur compounds, dinocap (Karathane), pyrazophos (Afugan), oxythioquinox (Morestan), binapacryl (Morocide) or one of the newer chemicals soon to be availabe, namely Bayleton, bupirimate (Nimrod).

(7) Leaf spots caused by various fungi such as *Alternaria* and *Cercospora*

These fungi develop leaf spots and sometimes stem rots. The colour and form of the spotting varies with the particular fungus.

Control is usually by the application of fungicides such as the dithiocarbamates (zineb and maneb), captan, captafol, mezineb, benzimidazoles and chlorothalonil (Daconil and Bravo). Where the benzimidazole fungicides are used, it is unwise to use these chemicals solely because fungi can develop resistance to them. They should be used either mixed with or alternated with another suitable unrelated fungicide.

(8) *Aphelenchoides* spp. (Leaf nematodes, e.g. in ferns)

Blackish patches develop between the leaf veins. Control can be achieved with insecticides such as Metasystox.

(9) Tobacco Mosaic Virus on tomatoes

This disease is seedborne. Seed should be treated with 1% trisodium orthophosphate for 15 minutes and then with 0.5% sodium hypochlorite for 30 minutes.

It is quite possible that in the future much of the sterilisation of potting mixes now carried out may be unnecessary. A considerable amount of work is being carried out on antagonists to various pathogens; some look quite promising. Certain mixes containing types of organic material, like composted bark for example, have been shown to develop antagonism to some fungi, e.g. *Phytophthora cinnamomi* and *Fusarium*. The reasons for this are not yet properly evaluated.

In Western Australia many nurserymen are incorporating jarrah (*Eucalyptus marginata*) sawdust in their potting mixes. Again, we have noted that there appears to be a reduction in disease development. This is only circumstantial evidence. Unfortunately, it has not been possible to conduct experimental work to evaluate this as yet, but it will make an interesting project for the future.

These forms of possible biological control show promise of future success. The main difficulty is that it is unlikely that antagonists effective on all types of pathogens will be found — usually they are effective on one only.

NOTE – Fungicides mentioned in this paper should only be used if registered for the purpose in your state or country. I have included fungicides which have shown promise experimentally and will probably be registered.