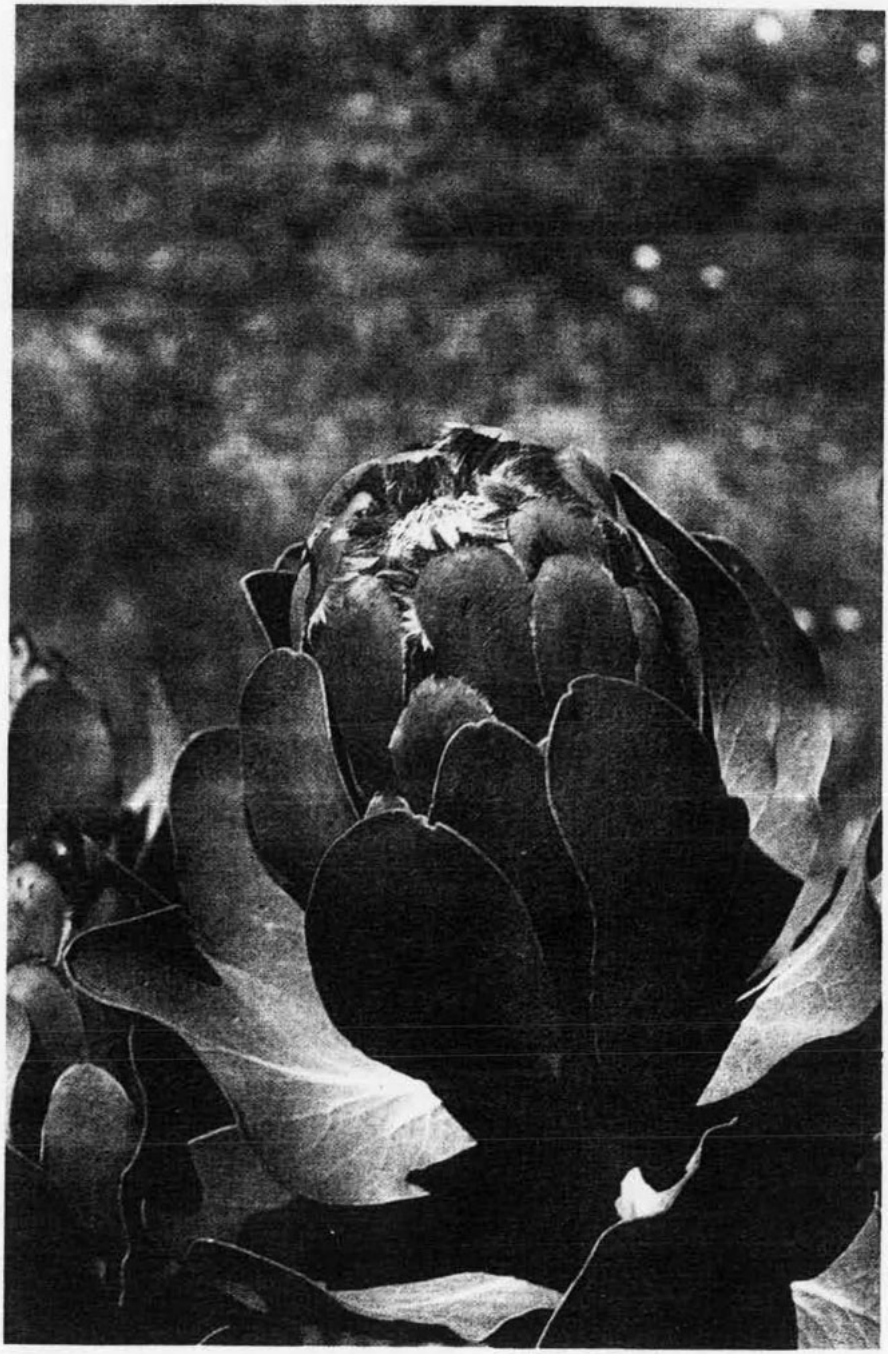
PROTEA DISEASES

HANDBOOK OF DISEASES OF CUT-FLOWER PROTEAS



HANDBOOK OF
DISEASES OF CUT-FLOWER PROTEAS

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IDENTIFYING DISEASE PROBLEMS

It is essential to be able to recognize the diseases of proteas if they are to be controlled. This handbook has been designed to allow growers to recognize the common diseases of proteas grown for the production of cut flowers. Only then can the control options which have been set out be effectively implemented and integrated into the overall disease management strategy.

DETECTION

The key to successful disease control is early detection. Many diseases can easily be brought under control in the early stages when only a few plants are affected. Some diseases can quickly become epidemic if not treated immediately. Plantings should therefore be inspected frequently for the first symptoms of diseases.

DIAGNOSIS

Growers should make themselves familiar with the common diseases that occur in their area. By studying the figures and descriptions in this handbook one should also be able to recognize many diseases. The handbook is organised so that all the diseases that affect a certain part of the protea plant are grouped together. The leaf spot *(Chapter 5)* and the shoot and flower *(Chapter 3)* diseases are generally the easiest to diagnose because all the symptons are readily observable. Root diseases *(Chapter 2)* are the most difficult to diagnose. It is usually necessary to dig up an affected plant and to examine the roots to be able to determine the cause of the problem.

SUBMITTING SAMPLES

If the disease can not be identified using these methods, a sample should be submitted to a local plant pathologist for diagnosis. It is always best to ascertain how and when the samples should be submitted before doing so. In general, a range of the symptons present should be included in your sample. Root or soil samples should be placed in plastic bags to prevent desiccation. Samples of above ground parts should be placed in paper bags or wrapped loosely in paper. All samples should be kept cool. A written synopsis of the problem including a description of the symptoms, the kinds of proteas affected, the extent of the planting that is diseased, when the symptons were first observed, and any other factors that might be relevant should be submitted with the sample. Don't forget to include your name, address and telephone number.

ROOT DISEASES

Root diseases are the most difficult type of disease to diagnose. All the symptoms that can be observed without digging up the plants are indirect consequences. The most common above ground symptoms of root diseases are poor growth, chlorosis, wilting or death of plants. However, the key to distinguishing amongst the three most important root diseases of proteas are the underground symptoms.

Root diseases are also the most difficult kind of disease to control, because most field treatments must be mediated through the soil. Progress in controlling these diseases is difficult to monitor. Furthermore, once a root pathogen is present it is very difficult, if not impossible, to eliminate the pathogen from the soil completely. Prevention, especially through the use of disease free planting material, is an important means of control.

PHYTOPHTHORA ROOT ROT

Occurrence.

Phytophthora root rot is the most important root disease of cut-flower proteas. The disease is caused by the fungus, *Phytophthora cinnamomi.* All the commercially grown genera of Proteaceae are attacked, but the disease is an especially serious problem on *Banksia, Leucospermum* and *Leucadendron.* For these types, plants of any age can be killed within a short period of time, but most losses occur during the first two years after establishment in the field. For the less susceptible types, such as most *Protea* spp., root rot primarily results in poor growth and decreased yield, but young plants may be killed. There is a reasonable amount of variation in susceptibility within most genera. Phytophthora root rot occurs in all the major protea growing regions but is a particularly serious problem in regions such as South Africa and Western Australia where the pathogen is widespread in native vegetation.

Symptoms.

The most characteristic symptom of Phytophthora root rot on the more susceptible types is the rapid death of whole plants **(Fig. 2.1)** due to wilting (the so-called "sudden death syndrome"). Less susceptible types literally starve to death due to inadequate uptake of nutrients and usually become chlorotic and grow poorly. These plants may also wilt during periods of water stress **(Fig. 2.2).** The overall structure of root systems which have been diseased for some time is generally poor and plants often fall over in windy or wet conditions. The extent of rotting on roots which are still present varies with conditions, but the exteriors of such roots are brown to black in colour. Under some con-

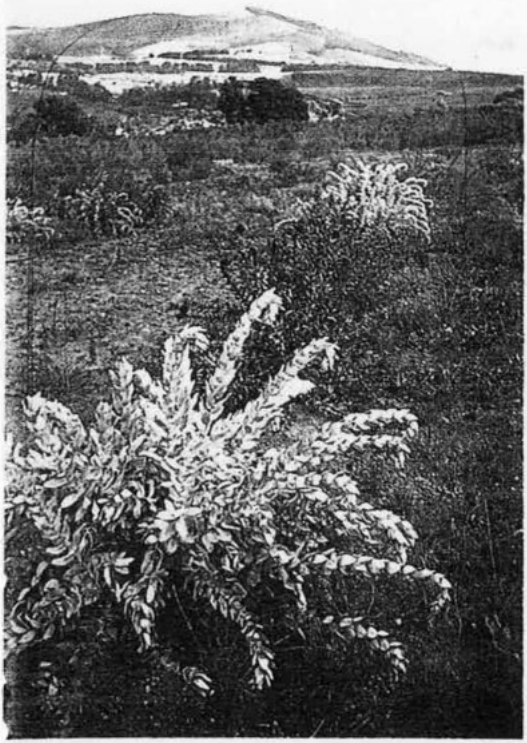


Fig. 2.1

Fig. 2.2

ditions, root rot extends above ground and forms dark, sunken stem lesions **(Fig. 2.3).**

Disease cycle.

The fungus, *Phytophthora cinnamomi,* is a pathogen of more than a thousand different kinds of plants and therefore often occurs in protea

Fig. 2.3

growing regions on other crops or native plants. Irrigation water taken downstream from other diseased crops or native vegetation could thus serve as a significant source of inoculum for protea plantings. The fungus has a special resistant spore which allows it to survive in a resting state in the soil for long periods. Ground on which other diseased plants have been growing may stay contaminated for several years after these plants have been removed. Phytophthora root rot is also a common problem in many nurseries, and infected nursery plants can bring the fungus into protea fields.

Infection of roots is usually initiated by motile zoospores which are produced when soil moisture is very high and soil temperatures are between 15-25°C. These spores can swim through or be carried by soil water to the roots of healthy plants in a field. The fungus can also be spread on contaminated field implements and with contaminated plant debris. Poor drainage and waterlogging conditions favour infection and disease spread, while water stress accentuates the final effects of root rot by bringing about rapid death.

Control.

The importance of avoiding bringing the pathogen into plantings can not be overemphasized. Disease-free nursery material should be planted out onto sites free of the pathogen and pathogen-free water should be used to irrigate plantings. This is especially difficult in Australia and South Africa where *Phytophthora cinnamomi* is abundant in native vegetation, and land cleared of native vegetation may be infested. Irrigation water taken downstream from diseased crops or native vegetation can also be infested and must be decontaminated before use.

Plantings should be inspected regularly for dead or dying plants. These plants should be removed, placed in some container such as a plastic refuse bag to prevent contamination of other parts of the planting, taken from the planting, and burned. Individual planting sites can be disinfected with dazomet or metham-sodium.

Several systemic fungicides are available, including furalaxyl (an analogue of metalaxyl that is not phytotoxic to proteas) and phosetyl-AL. Very promising results have recently been obtained with foliar applications of phosphorous acid. Fungicides should be applied when the fungus is in its attacking phase. In winter rainfall regions, this is likely to be from mid spring to mid summer and again in autumn after the first rains. Treatments should cover mid spring through the entire summer in summer rainfall regions.

Most *Protea* and *Telopea* spp. are fairly resistant when grown under conditions suitable for good growth. In South Africa, *Protea* spp. such as

P. cynaroides, P. repens and *P. neriifolia* are planted back onto land where pincushions have died out due to Phytophthora root rot. Programmes to detect species and lines within the highly susceptible *Banksia* and *Leucospermum* genera have been carried out in Australia and South Africa, respectively. Resistance is apparently limited to disease tolerance in these genera, but further research is underway to select for tolerant lines and potential rootstocks.

Cultural practices are important in minimizing Phytophthora root rot. Poorly draining or low lying sites should be avoided. Plants can be grown on ridges to give better drainage. Irrigation should be managed to avoid overwatering or underwatering. Living, non-competitive ground covers can be used to promote an active soil microflora and limit spread of the fungus.

OTHER ROOT DISEASES

Nematode Root Disease.

Diseases, caused by nematodes, especially the root knot nematode, *Maloidogyne incognita,* are an important problem in Hawaii and parts of Australia. Diseased plants grow very poorly, become chlorotic and wilt **(Fig. 2.4)** or eventually die. Roots infected with the root knot nematode develop small, swollen knobs or "knots". Infested soil, infested irrigation water, infected planting material and infected weeds or other nearby plants are the major sources of disease for protea plantings. The non-fungicidal aspects of the control programme set out for Phytophthora root rot will be helpful in controlling nematode diseases. Methyl bromide fumigation can be used as a pre-plant treatment. Phenamiphos has been successfully used in Hawaii to control root knot disease.

Fig. 2.4

Armillaria root rot.

Armillaria root rot is economically important in parts of Australia where proteas are grown on land cleared of diseased woody plants, especially *Eucalyptus* spp. The fungi which cause the disease, *Armillaria* spp., spread from plant to plant by root contact and make characteristic white fungal mats on roots and contiguous stems **(Fig. 2.5).** Armillaria root rot kills plants **(Fig. 2.6),** is extremely difficult to control, and usually forces abandonment of infested land.

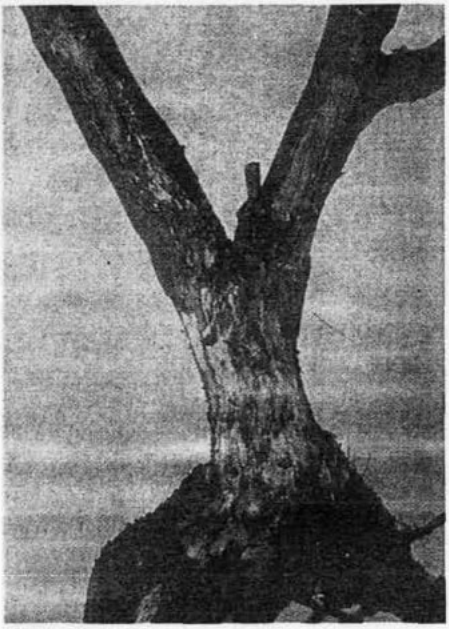


Fig. 2.5

Fig. 2.6

DISEASES OF SHOOTS AND FLOWERS

Diseases of this type affect the current season's growth or the actual flower crop and therefore can result in an immediate loss to the grower. Furthermore, these diseases often develop quickly under the right environmental conditions. It is therefore essential that the grower be able to recognize these diseases when they first appear in plantings so that control measures can be undertaken immediately.

Shoot and flower diseases can usually be brought under control using fungicides if the varieties are not very susceptible. If resistant varieties are available, these should be used in areas where a disease appears year after year.

COLLETOTRICHUM DIE-BACK

Occurrence.

Colletotrichum tip die-back is the most important disease of *Protea* spp. cultivated for cut flowers. It attacks all the commercially important *Protea* spp. A list of recorded hosts includes *P. neriifolia, P. repens, P. magnifica, P. cynaroides, P. compacta, P. eximia, P. grandiceps, P. punctata, P. obtusifolia, P. longiflora, P. susannae, P. coronata, P. stokoei, P. lepidocarpodendron, P. mundii, P. lacticolor, P. laurifolia, P. nana, P. scolymocephala, P. pudens* and *P. longifolia,* and also *Serruria florida.* The disease occurs in all the major protea growing regions around the world, but is most serious in summer rainfall regions.

Symptoms.

The most common symptom is the die-back of young shoot tips **(Fig. 3.1).** The affected tissues rapidly become dark and a definite boundary can be seen between diseased and healthy tissues. The shoot tips may bend to form a shape resembling a shepherd's crook **(Fig. 3.2).** Sometimes lesions extend down into the older tissues and eventually whole branches can be killed by the resulting stem cankers **(Fig. 3.3).** Other symptoms include necrotic leaf spots (anthracnose) or necrotic leaf tips

Fig. 3.1

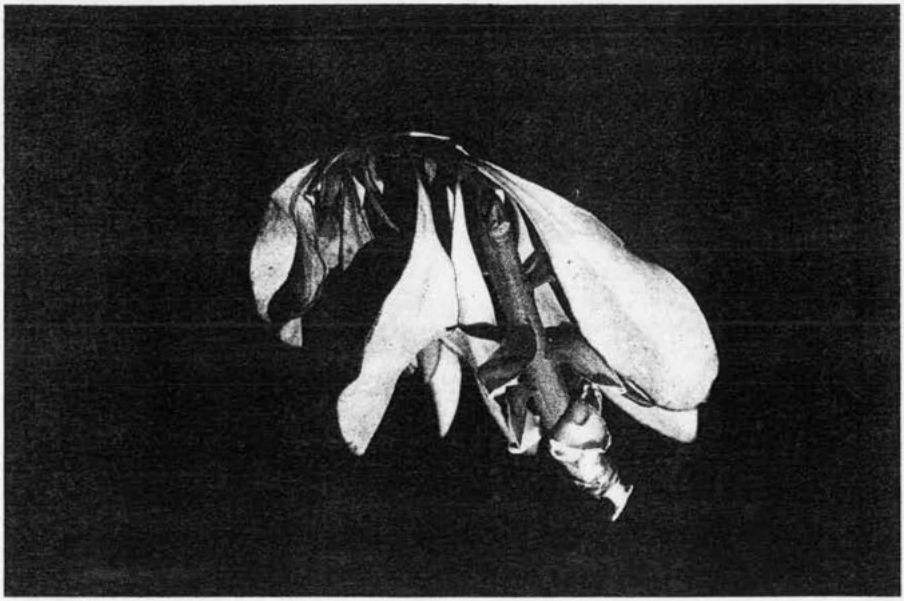


Fig. 3.2

(Fig. 3.4 and **Fig. 3.5).** Under moist conditions in the field or in storage, powdery orange fungal structures (acervuli) often develop on diseased tissues.

Fig. 3.3

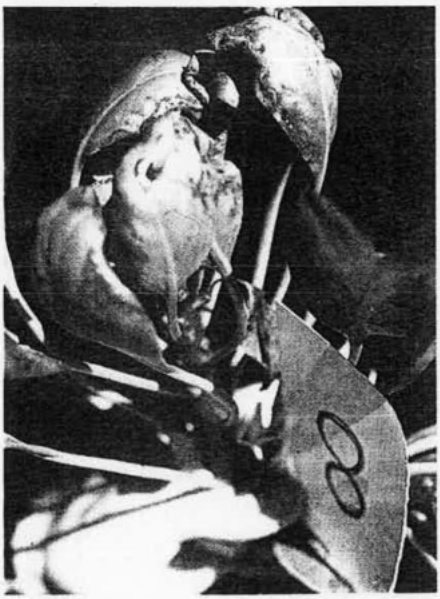


Fig. 3.4

Fig. 3.5

Disease cycle.

The fungal pathogen *(Colletotrichum gloeosporioides)* is seed-borne on protea seed. It frequently causes damping off and die-back of nursery plants. Plants infected in the nursery can bring fungal inoculum into the field. Fungal spores are dispersed from lesions on diseased plants by the splashing action of rain or irrigation water. Infection is favoured by moist, moderately warm conditions. However, the subsequent development of the stem canker phase involving other secondary fungi is favoured by drought stress to the plants.

Control.

It is essential that seed be treated before sowing (see Appendix B). Cuttings for rooting should only be taken from disease-free mother plants. Cuttings should be examined carefully for disease symptoms and any dubious material should be discarded. Sprays of procloraz plus a benzimidazole fungicide applied 2-3 weekly during shoot flushing and wet weather will protect the shoots against infection. This treatment can be applied once a month under other conditions. Plantings should be inspected regularly for disease. Dead or dying shoots should be removed by sanitation pruning (see Appendix A). Overhead irrigation should be avoided so that periods of moisture on foliage are minimized. Sufficient water should be given to plants with severe Colletotrichum die-back so that extensive stem cankers do not develop. Resistant lines or cultivars have not yet been identified.

ORECHSLERA BLIGHT

Occurrence.

Drechslera blight is the most important disease of pincushions (*Leucospermum* spp.) cultivated for cut flower production. All the commercially

important species are susceptible to some extent, but many of the popular cultivars derived from *L. cordifolium* are especially susceptible. Some *Leucadendron* and *Mimetes* spp. are also susceptible to Drechslera blight. The disease occurs in all the major protea growing regions of the world and is caused by different *Drechslera* spp. in different regions.

The disease can quickly become epidemic under favourable conditions and significant crop losses can occur. The fungus attacks primarily the current season shoots, especially during growth flushes. Potential flower bearing shoots and developing flowerheads are damaged and rendered unmarketable or are killed. Shoot stem lesions often become infected with decay fungi which cause whole branches to die back. Badly blighted young plants can be killed.

Symptoms.
The most common symptoms are the rapid death of young shoot tips **(Fig. 3.6)** and the characteristic leaf lesions **(Fig. 3.7).** Affected leaf tissues quickly turn yellow, tan and finally brown. Shoot tips do not collapse and leaves remain aligned with the stem as before infection. Superficial, red lesions often develop on stems from the places where infected leaves are attached **(Fig. 3.8).** Symptoms on flowers depend on the stage of development of the flowerheads at the time of infection and range from partial disfigurement to death **(Fig. 3.9).**

Fig. 3.6

Fig. 3.7

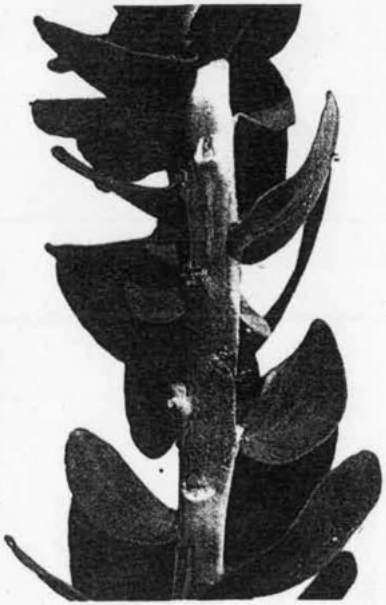


Fig. 3.8

Fig. 3.9

Disease cycle.

The Drechslera blight pathogens can be spread into the nursery on seed or cuttings. Infected nursery plants can carry the disease into the field. The fungi may also spread from certain grasses and native hosts. Infection is favoured by a combination of moderate temperatures (20-25°C) and adequate leaf wetness periods. Any factor which extends the period of leaf wetness after or in addition to rain or dew, such as overhead irrigation, shading, crowding, or weed growth around the base of plants, therefore favours disease.

Control.

It is essential that seed be treated before sowing (see Appendix B). Cuttings for rooting should be taken from disease-free mother plants. The cuttings should be carefully examined and discarded if any disease symptoms are found. Sprays of either iprodione or chlorothalonil plus a benzimidazole fungicide applied 2-3 weekly during wet weather, shoot flushing or flower formation will protect the shoots and flowers against infection. (One of these combinations should be alternated with procloraz plus the benzimidazole if Elsinoe disease is also a problem.) The pincushion cultivars, Luteum, Scarlet Ribbon, Vlam, Caroline, Sunrise and Goldie, were found to be highly resistant to blight caused by *Drechslera dematioidea* in evaluations conducted in South Africa.

Plantings should be inspected regularly for disease and sanitation pruning should be carried out (see Appendix A). Areas which favour moisture

retention on foliage such as those in the shadows of mountains, in mist retaining areas or areas next to windbreaks should be avoided. Overhead irrigation should also be avoided. Practices which allow adequate movement of air around and through plants such as weed control and pruning should be employed.

ELSINOE DISEASE

Occurrence.
Elsinoe disease occurs on *Leucospermum, Leucadendron, Mimetes* and *Serruria* spp. grown for cut flowers in southern Africa and parts of Australia. It also has a limited distribution in Hawaii. The disease is a very serious problem only in Victoria, Australia, where it must be considered a major disease. The taxonomy of the pathogen is poorly understood and it is not clear whether different *Elsinoe* spp. or strains occur in different regions. *Elsinoe* spp. have been recorded on wild *Banksia* spp. in Australia and on wild *Leucospermum* spp. in South Africa.

Symptoms.
The most characteristic symptom of Elsinoe disease is the presence of red, raised, scablike lesions which develop on current season stems **(Fig. 3.10)** and leaves. This symptom has given rise to the common name "scab" for this phase of the disease. Branches of heavily infested plants often grow abnormally and become twisted and distorted **(Fig. 3.11),** and pits are sometimes formed on stems **(Fig. 3.12).** In South Africa, insects feeding on Elsinoe lesions cause the surrounding tissues to proliferate and take on a corky appearance **(Fig. 3.13).** This symptom has caused the disease to be referred to locally as "corky bark".

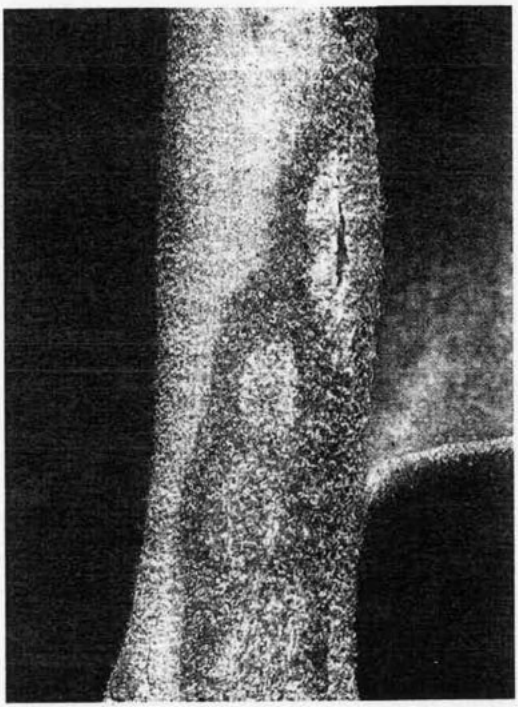


Fig. 3.10

Disease cycle.
The fungal pathogen can remain latent for some time after the infection of shoots without the development of visible symptoms. Infected nursery plants and cuttings

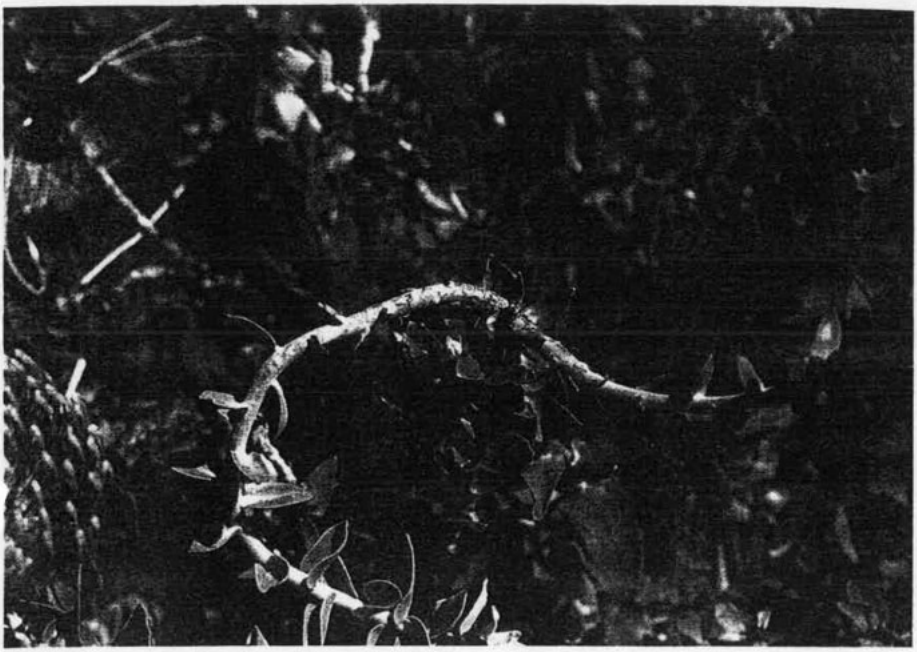


Fig. 3.11

Fig. 3.12

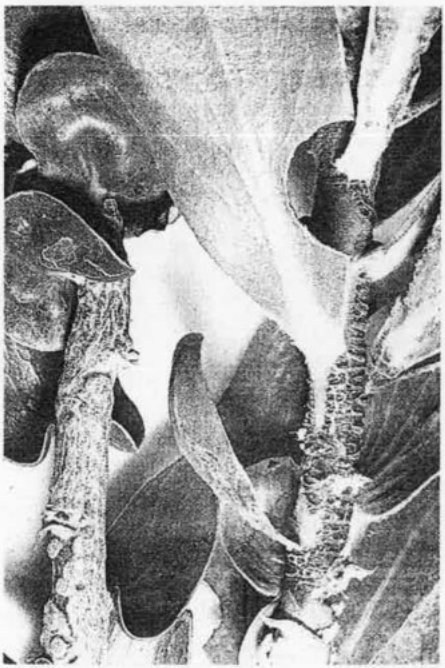


Fig. 3.13

from infected mother plants are the main means of long distance spread of this disease. It is also possible that native proteas may be serving as a source of inoculum for cultivated proteas. The fungus infects flushing shoots and the infection of shoots is favoured by moist conditions and moderate temperatures. The disease spreads relatively slowly in the field, usually by splash or wind from diseased to adjacent healthy plants.

Control.
It is not possible to visually detect latent infections. Cuttings for rooting should therefore only be taken from mother plants which have never shown any symptoms of Elsinoe disease. Although the disease spreads slowly it is difficult to bring under control. Flushing shoots should be protected with prochloraz. Visibly diseased shoots should be removed by sanitation pruning (see Appendix A). Once the disease becomes established in a planting it can only be eliminated by a conscientious programme of sanitation pruning in combination with regular fungicide applications. Resistant species or lines have not been identified.

BOTRYTIS BLIGHT

Occurrence.
Botrytis blight is an unpredictable disease which attacks the flowerheads and very young shoot tips of *Banksia, Leucospermum, Leucadendron, Protea* and *Serruria* spp. Flower blight sometimes develops after packing if infection has already taken place in the field. The disease is known to occur on proteas grown in Australia, Hawaii, New Zealand and South Africa. Botrytis blight is caused by the fungus, *Botrytis cinerea.*

Symptoms.
Flowers initially become blemished or discoloured at the sites of infection **(Fig. 3.14).** If disease favouring conditions prevail, the affected tissues collapse and die. If disease development is arrested by a change in conditions, the flowers continue to develop but are disfigured **(Fig.3.15).** Infected shoot tips collapse, darken and die **(Fig. 3.16** and **Fig. 3.17).** The soft collapse of shoot tips and their attached leaves distinguishes this disease from shoot tip blight caused by Drechslera blight and Colletotrichum tip die-back. The fungus is commonly referred to as the "grey mould" because it produces abundant masses of tannish grey spores on the affected tissues under moist conditions. These spore masses are visible without magnification.

Disease cycle.
Botrytis cinerea also attacks a wide range of other crops. The abundant spores it produces are readily dispersed by wind and rain. The disease is favoured by wet and cool to moderate conditions and can develop relatively quickly.

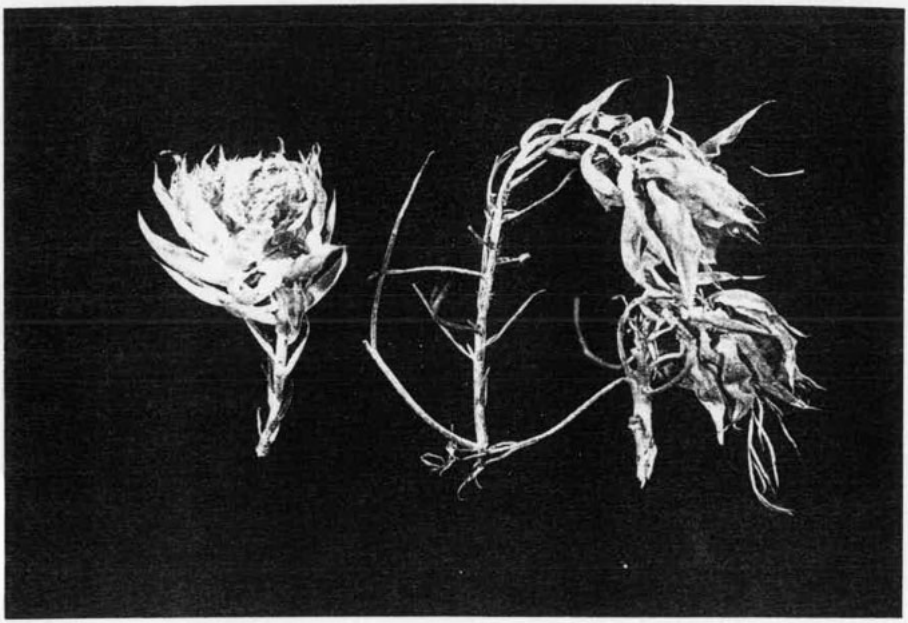


Fig. 3.14

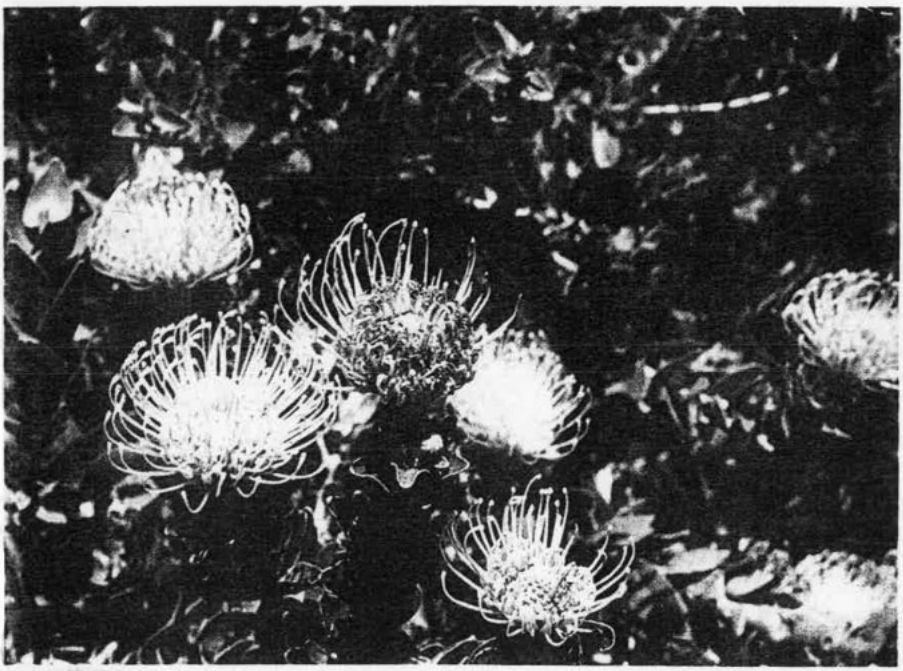


Fig. 3.15

Fig. 3.16

Fig. 3.17

Control.
Protective sprays of iprodione should be applied 2-3 weekly to flowers or young shoots during moist, cool to moderate weather. Diseased plant parts should be removed by sanitation pruning (see Appendix A).

WITCHES' BROOM DISEASE

Occurrence.
Another important shoot and flower disease, witches' broom, only occurs in South Africa. The cause of the disease has not been identified but is believed to be a mycoplasm transmitted by the mite, *Aceria proteae.* This mite only attacks proteas and only occurs in South Africa.

Symptoms.
Characteristic "witches' broom" proliferations develop from apparently normal vegetative or floral buds **(Fig. 3.18).**

Fig. 3.18

Control.
Spread from plant to plant can be prevented by controlling the mite. On large plants the disease can sometimes be eradicated by pruning away any branch on which a proliferation occurs. Plants of less than two years should be removed entirely. All such diseased plants or plant parts should be destroyed by burning.

CHAPTER FOUR

DISEASES OF WOODY STEMS

The importance of diseases of woody stems is often underestimated because symptom development is slow and losses may be spread out over several years. Sometimes growers do not realize that branch deaths are caused by infectious pathogens which can be controlled.

Elimination of unnecessary wounding, protective treatment of wounds and sanitation pruning are the main means of controlling diseases of woody stems.

STEM CANKERS

Occurrence.
Cankers of woody stems caused by fungi such as *Botryosphaeria, Botryodiplodia, Phomopsis,* and *Phoma* spp. are a common problem in most protea growing regions on all kinds of proteas.

Symptoms.
Stem cankers are usually sunken and darker in colour than the surrounding tissues **(Fig. 4.1).** If the bark is scraped away the underlying woody tissues are discoloured **(Fig. 4.2).** Internal discolouration sometimes occurs for some distance beyond the outer canker. Disease development is usually slow but eventually branches and even whole plants can be killed, particularly if the canker is on the main stem **(Fig. 4.3).**

Disease cycle.
The canker fungi enter through wounds made by pruning, flower harvesting, insects, field machinery, wind breakage, as well as leaf scars and lesions of other stem diseases. These fungi spread naturally from plant to plant under wet conditions by splash and wind but can also be spread by contaminated pruning and harvesting tools.

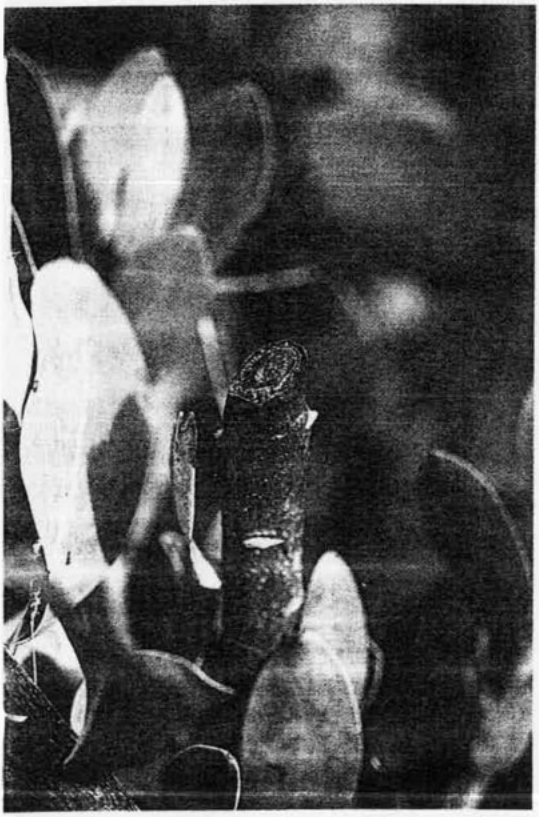


Fig. 4.1

Control.
All unnecessary wounding and damaging of stems should be prevented, including that made by insects and other diseases. Pruning and harvesting wounds should be protected with a fungicidal spray or wound sealant. Sanitation pruning (see Appendix A) should be carried out regularly to remove cankered branches and to eliminate sources of the canker fungi.

SILVER LEAF

Occurrence.
Silver leaf is a destructive disease which is apparently

Fig. 4.2

Fig. 4.3

Fig. 4.4

imited to protea production in parts of New Zealand. *Leucadendron* spp. are most seriously affected there. The disease is caused by the stem attacking fungus, *Chondrostereum purpureum*.

Symptoms.
The leaves of affected branches take on a silvery cast. These branches and eventually the whole plant are killed **(Fig. 4.4).** The fungus forms a characteristic purplish fruiting structure on the dead branches **(Fig. 4.5).**

Disease cycle.
The fungal pathogen, *Chondrostereum purpureum,* attacks a wide range of woody plants. It has apparently spread from poplars used as windbreaks for protea plantings in New Zealand. The pathogen can also be spread from plant to plant by infested pruning and harvesting tools.

Control.
Trees which are hosts of the pathogen should not be used as windbreaks. Diseased branches and stems, which serve as an additional source of the pathogen, should be eliminated from plantings by sanitation pruning (see Appendix A). Pruning and harvesting tools should be disinfested when moving from plant to plant. Wounds should be protected with a fungicidal spray or wound sealant.

Fig. 4.5

LEAF SPOT DISEASES

Although leaf spot diseases are generally less destructive than other kinds of diseases, they are certainly economically significant when they occur on the flower bearing shoots. Leaf spots render the flower crop unmarketable for either aesthetic or phytosanitary reasons.

Control of the leaf spots caused by fungi is generally brought about by a regular spray programme implemented to control other protea diseases, but sometimes additional applications are necessary. A special treatment is needed for bacterial leaf spot.

BATCHELOROMYCES LEAF SPOT

Batcheloromyces leaf spot is only a problem of commercial importance on *Protea cynaroides,* but occurs in most of the places where this species is grown. The disease is not destructive, but makes the blooms unmarketable due to the presence of yellow to red to purple, irregular spots on leaves **(Fig. 5.1** and **Fig. 5.2).** The fungal pathogen, *Batcheloromyces proteae,* is specific to *Protea* spp. and its appearance in areas where seeds have been the sole propagative source suggests that the fungus is seed-borne. Seed treatment is therefore advised (see Appendix B). Even when spray programmes with general fungicides have been carried out regularly, field control has been poor. The disease cycle is not known. Resistant material has been observed in South Africa but has not been selected for use in resistant cultivars.

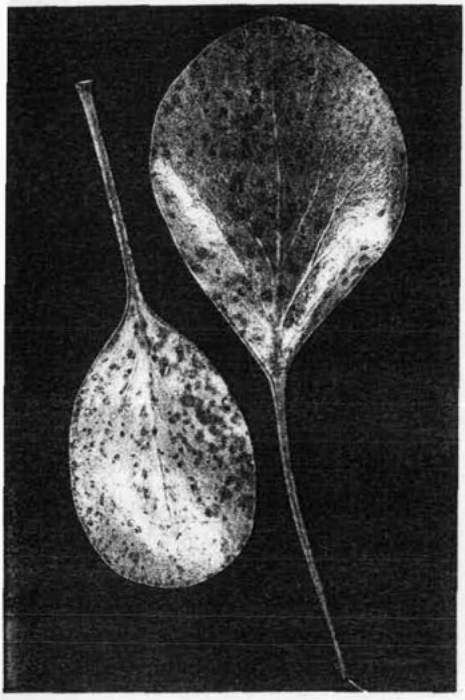


Fig. 5.1

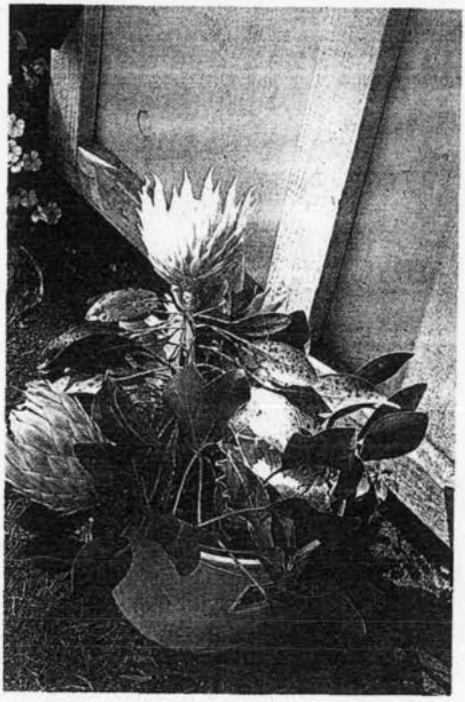


Fig. 5.2

BACTERIAL LEAF SPOT

Bacterial leaf spot of *Protea cynaroides* is economically important only in parts of Australia. Characteristic red leaf spots with concentric rings or halos **(Fig. 5.3)** make this leaf spot easily identifiable in the field. Flowers with spotted foliage are not marketable. Copper sprays are used to protect foliage.

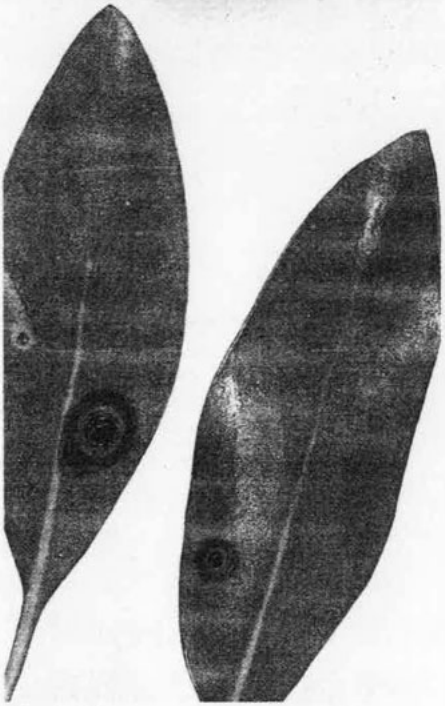


Fig. 5.3

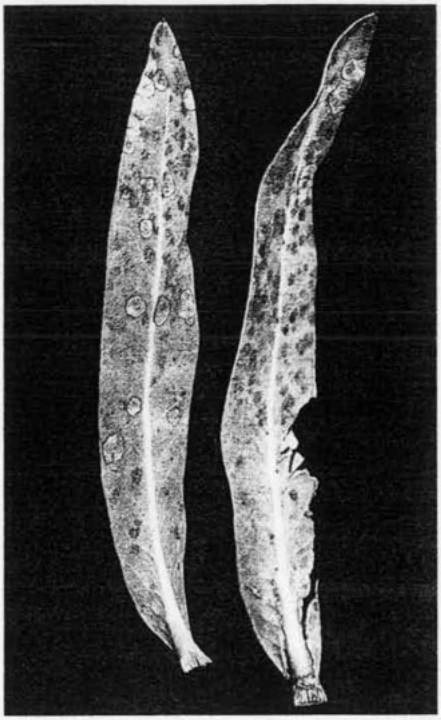


Fig. 5.4

COLEROA LEAF SPOT

Coleroa leaf spot occurs on the older foliage of *Protea* spp. in South Africa, Australia and New Zealand. This leaf spot disease is not considered to be economically significant because it is only able to attack young foliage when plants are growing poorly for other reasons. Fungal fruiting structures look like pepper grains in roughly circular groups on leaf surfaces **(Fig. 5.4.** N.B. The tan, sunken, circular spots in this figure are not Coleroa leaf spots). Regular spray programmes which include a benzimidazole fungicide are used to control Coleroa leaf spot.

ALTERNARIA LEAF SPOT

An Alternaria leaf spot that attacks flower bearing shoots of *Leucospermum* or *Leucadendron* spp. has been reported from New Zealand, Hawaii and Australia.

LEAF SPOT DISEASES KNOWN ONLY TO OCCUR IN SOUTH AFRICA

There are several important foliar diseases which are apparently limited to cut-flower proteas in South Africa. These diseases are particularly destructive and can result in loss of shoots that are heavily diseased. The fungi which cause these diseases are specific to proteas and cannot spread from other crops. The symptoms of these diseases are included here to assist with identification. In South Africa control is effected by regular spray programmes which include a benzimidazole fungicide. If these diseases appear elsewhere, every effort should be made to eradicate them.

LEPTOSPHAERIA LEAF SPOT

This leaf spot is caused by the fungus, *Leptosphaeria protearum,* and only occurs on *Protea* spp. Lesions are tan to brown, irregular and sunken with definite margins and circular groups of black fruiting structures **(Fig. 5.5).** Under favourable conditions the disease becomes more like a blight than a leaf spot disease. Young plants can be severely attacked **(Fig. 5.6)** and killed. Sometimes branches of mature plants are killed.

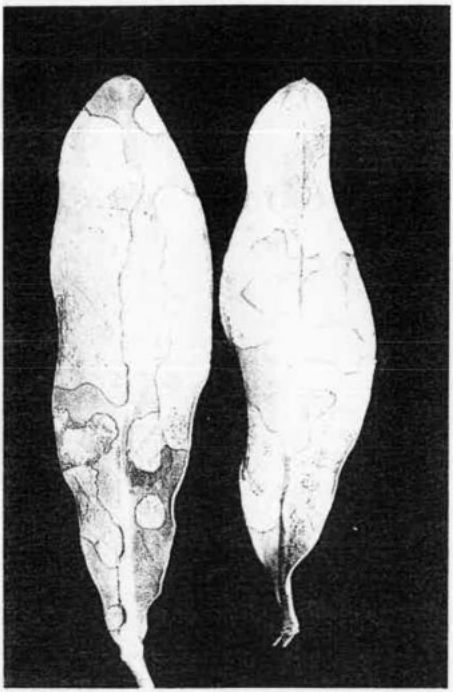


Fig. 5.5

Fig. 5.6

MYCOSPHAERELLA LEAF SPOT

This leaf spot is caused by the fungus, Mycospherella proteae, and only occurs on *Protea* spp. The dark red, raised blotches of this leaf spot disease are very distinctive and easy to recognize **(Fig. 5.7).** This disease is not as destructive to young plants **(Fig. 5.8)** as Leptosphaeria leaf spot.

STIGMINA LEAF SPOT

This leaf spot disease is caused by the fungus, *Stigmina protearum.* It attacks *Leucospermum* and *Leucadendron* spp. Dark blotches of fruiting structures appear on leaves **(Fig. 5.9).** The area around the blotches turns chlorotic and dies. Young shoot tips can be severely damaged **(Fig. 5.10).**

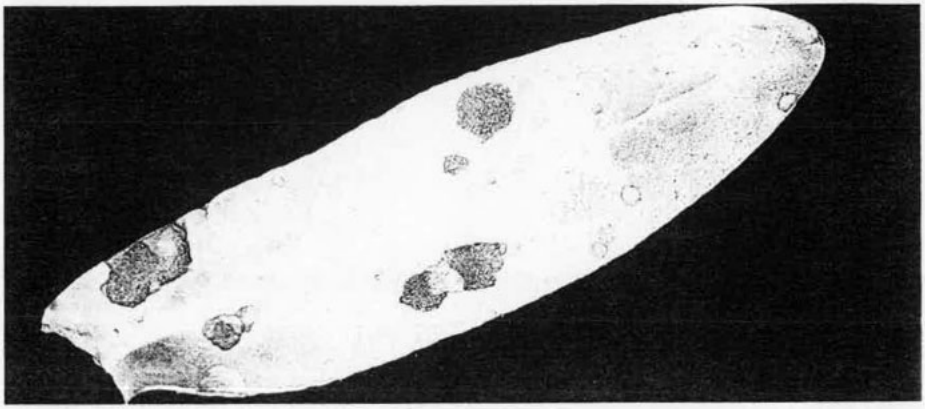


Fig. 5.7

Fig. 5.8

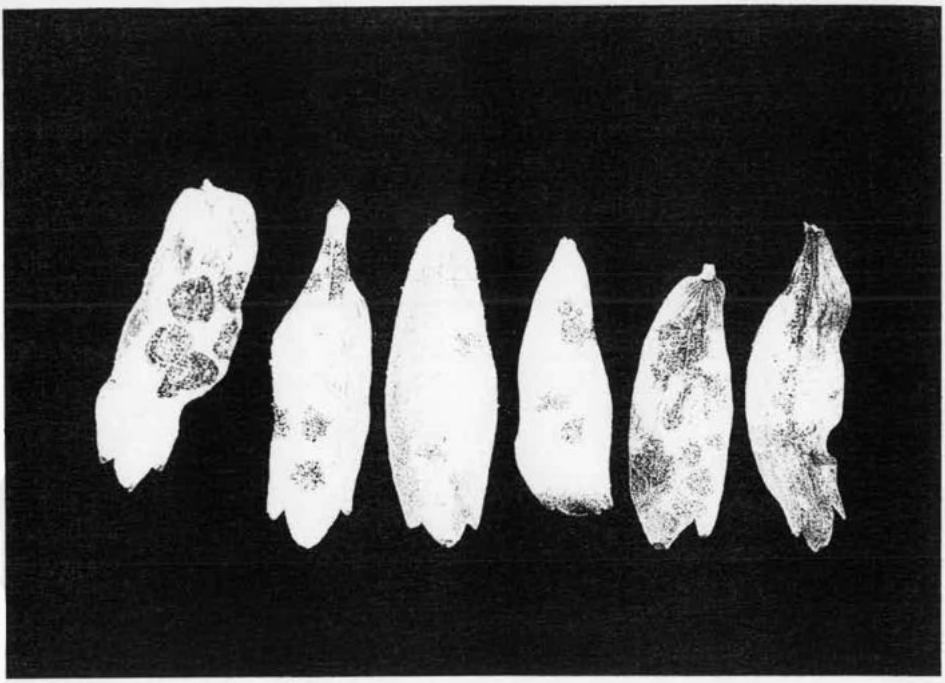


Fig. 5.9

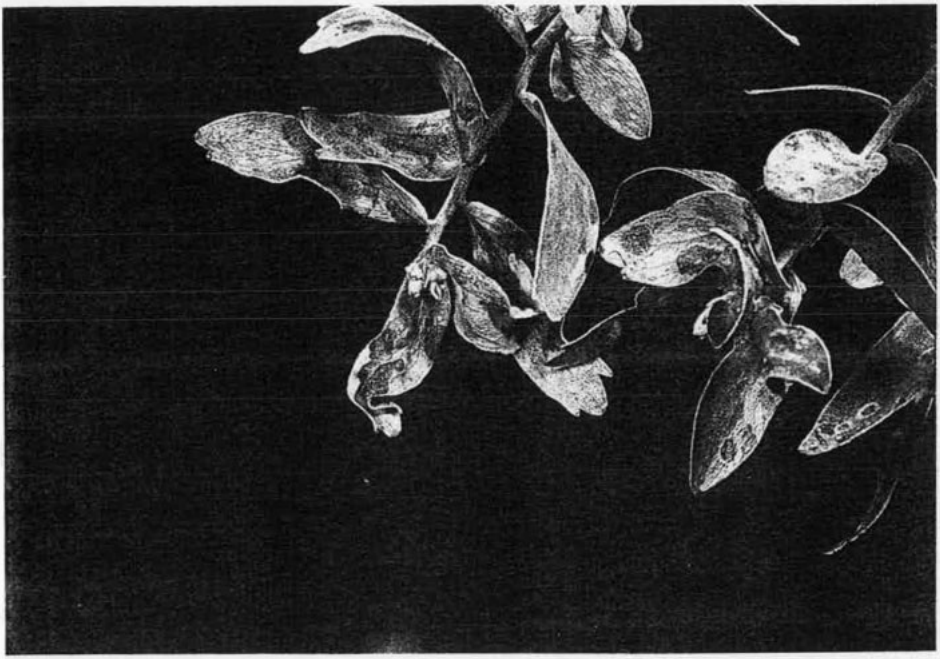


Fig. 10

FORMULATING A DISEASE MANAGEMENT PROGRAMME

Growers must not only know what important diseases occur on their proteas, but they also need to know what options for avoiding and controlling these diseases are available to them. It is particularly important to think beyond chemical control as a solution for disease problems. Most chemicals only prevent disease and do not get rid of disease once it is present. Chemical control is also very expensive and requires special care in application to avoid the detrimental effects of the chemical used. Fortunately, there are a wide range of methods to control plant diseases which can be brought into the disease management programme for a particular protea disease.

WAYS OF CONTROLLING DISEASES

There are five major methods of controlling protea diseases. These are:

1. use of plant *resistance* in varieties or rootstocks,
2. avoidance of the pathogens *(exclusion)*,
3. elimination of infested plant material *(eradication)*,
4. *protection* of plants using chemicals, and
5. *minimization* of disease by specific cultural practices.

Resistance

The ultimate method of controlling any plant disease is through resistance that is part of the plant's genetic make-up. Cut-flower proteas are still in the early stages of development as a horticultural crop. Breeding and selection for disease resistance has understandably received very little attention so far. Research on disease resistance so far has concentrated on establishing what kinds of proteas are susceptible to various diseases and on estimating how susceptible they are.

Methodical screening of many genetically different lines of cut-flower proteas for resistance to the most important diseases is urgently needed and is sure to be an important priority of the protea industry in the near future. A few pincushion cultivars resistant to Drechslera blight have been identified in South Africa. A breeding programme designed to obtain pincushion lines that are resistant or tolerant to Phytophthora root rot and that might be used as rootstocks or be bred into commercial varieties is also underway there. This kind of research takes a long time and resistant cultivars for even the most important diseases may not be available for some time. In the meantime, observant growers can identify material in their own plantings that is less disease prone and propagate this material.

Exclusion

The old saying, 'An ounce of prevention is worth a pound of cure' is especially appropriate in the control of protea diseases. Growers need to be aware of all the ways that pathogens can enter protea plantings and to avoid as many of these as possible.

Excluding diseases starts at the international level and is especially important for regions where proteas and their pathogens are not native. International movement of cuttings and rooted plants is strictly controlled by quarantine regulations, but seed movement is less restricted. Certain very important protea pathogens are seed-borne and have already been introduced into protea growing regions on untreated seed. Seed treatment is important even for seed being moved from one part of a country to another.

Using disease-free nursery material to establish new plantings is a most important way to exclude diseases from these plantings. This is especially important for root diseases which are so difficult to control once they have become established. Root pathogens such as nematodes and *Phytophthora cinnamomi* can also be brought into protea fields in contaminated irrigation water. Where this is a problem, water should be decontaminated before use or another source of water free of these pathogens should be used.

Another important source of pathogens causing protea diseases are other plants which are also attacked by these pathogens. This is especially important for generalist pathogens with a wide host range, such as *Phytophthora cinnamomi* or *Colletotrichum gloeosporioides*. In as much as is possible, the other hosts of pathogens of proteas ought to be avoided in the vicinity of protea plantings. Land cleared of other hosts of root diseases such as Phytophthora or Armillaria root rot may be infested with the fungi causing these diseases and should be avoided.

Eradication

There are two main ways of eliminating infested plant material from protea plantings. The first of these, sanitation pruning, is dealt with in detail in Appendix A. The second method is to remove whole plants that are diseased or dead. This is often necessary for plants that die of root diseases or systemic diseases such as witches' broom disease. It is most important that the plants are burnt after thery are carefully removed from the planting. If the plants are suspected of dying of a nematode root disease or Phytophthora root rot, the planting site should be disinfected with vapam or dazomet before replanting.

Protection

The use of chemical sprays to protect plants from becoming infected is an important means of preventing disease. It is essential that disease control chemicals be applied exactly according to the methods set out by manufacturers for each different brand and formulation of these chemicals. That is why only the generic names of chemicals are given in this handbook. Some chemicals are not registered for use in certain countries. Growers should contact a local plant pathologist to find out which brands and formulations are registered in their country and should follow the recommended application methods and dosages.

Most of the chemicals given in this handbook are chemicals which the author has personally found to be effective in controlling diseases in the field. Other equally effective products may be available which have not been mentioned. Proteas appear to be more sensitive to chemical treat-

ɛnts than most ornamentals. Therefore, if there is any uncertainty, it is st to test out a new treatment on a few plants and observe the effects fore applying it to all the plants.

nimization

ɛ methods used to grow proteas often have a marked influence on cer- ɲ diseases. Overhead irrigation usually favours leaf spot and blight dis- ses and should therefore be avoided. Controlling weeds around the se of plants allows better air movement and minimizes the moist condi- ns which favour infection. Using non-competitive ground covers helps nimize the spread of Phytophthora root rot in a planting. The kinds of teas most susceptible to Phytophthora root rot should only be planted well draining sites or on ridges.

EVELOPING AN OVERALL DISEASE ANAGEMENT STRATEGY

ɛ prerequisites for developing an effective disease management ategy are to be able to recognize the most important protea diseases d to know how to control these diseases. A management strategy can n be formulated on the principle of 'first things first'. Using this princi- , the management strategy must first deal with the most important dis- ses. The three most important diseases of the protea industry rldwide – Colletotrichum die-back, Drechslera blight and Phytoph- ra root rot – have been discussed in detail and control programmes for m have been set out in previous chapters. In certain regions it may be cessary to include a fourth disease, e.g. Elsinoe disease in Victoria, trytis blight in Hawaii or silver leaf disease in New Zealand.

ɛ advantage of formulating an overall management strategy based on major diseases is that, in doing so, most other disease problems will ɔ be successfully managed. Only minor modifications, such as the ɔrporation of an additional fungicide into the spray programme, may necessary. Furthermore, many of the management procedures for the jor diseases are similar and should be applied to all proteas. For exam- , seed treatment, sanitation and use of healthy nursery material are ɲeral measures against most diseases.

s obvious that there can be no one management programme that ets the needs of all growers. The management of cut-flower protea eases will always be a challenge that is unique to the specific produc- ɲ situation. However, the knowledge and options are available to meet s challenge.

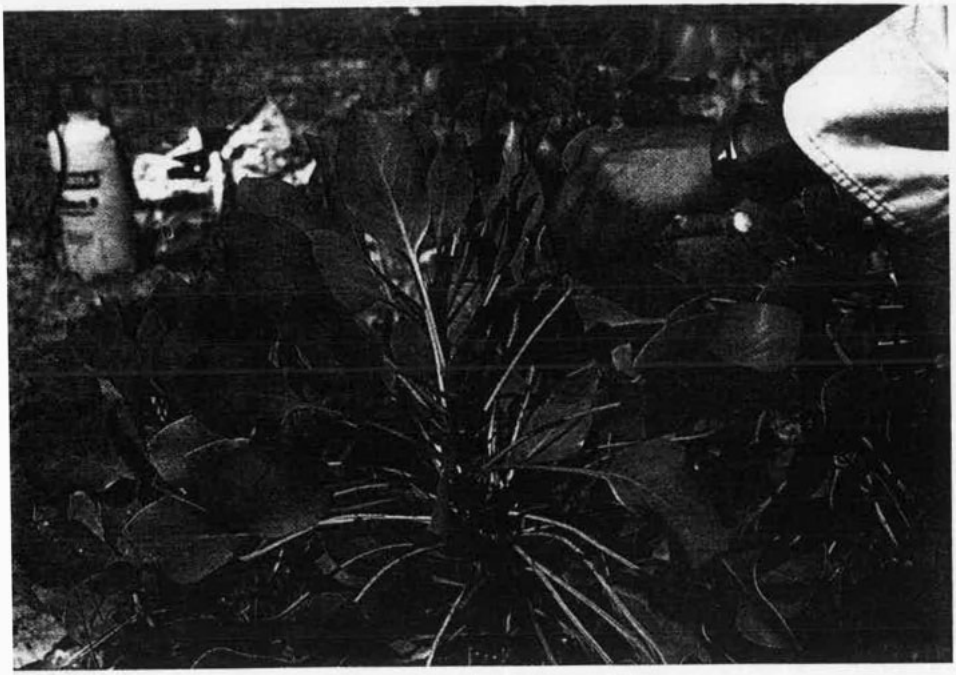
APPENDIX A:

SANITATION PRUNING

Sanitation pruning is a most effective means of eliminating sources of disease or insects from plantings when it is carried out on a regular basis. Dead or diseased plant parts should be removed with pruning shears at a point well below the diseased tissue *(Fig. A.1).* The cut should be clean with no tears. Pruning shears can spread pathogens and should be disinfected with dilute sodium hypochlorite or formalin when moving from plant to plant. All the pruned away material should be collected, removed from the planting, and burned. The sanitation pruning should be done just prior to (and on the same day as) one of the routine fungicide spray applications *(Fig. A.2)*, so that the wounds made by the pruning are protected from infection by other fungi. Benzimidazole fungicides have been shown to be very effective for this purpose. Alternatively, the pruning wounds can be covered with a fungicidal wound sealant *(Fig A.3)* if only a few wounds have been made.

Fig. A.1

Fig. A.2



A.3

APPENDIX B:

SEED TREATMENT

Protea seed obtained from a reliable seed distributor may have already been treated with a general fungicide such as thiram. *Leucospermum* seed which is treated with acid or hydrogen peroxide to promote germination does not need to be treated further. In all other cases, a thiram dusting alone or following warm water treatment can be used.

Warm water treatment followed by dusting with thiram has been shown to be especially effective for seeds of cut-flower *Protea* spp. However, certain heat-sensitive seeds, such as those of *Leucadendron platyspermum,* should not be treated with the warm water treatment. If in doubt about the heat sensitivity of a kind of seed, test out a small amount of seed before applying the treatment to all the seed. Seeds should be held submerged in warm water at 50°C (122F) for thirty minutes and then immediately cooled to room temperature with running water. Remove the seeds from the water and spread them out to dry off until they are just damp. Then dust with thiram by shaking the seed and a small amount of thiram powder (about 1/50 of the seed volume) around in a container. Use just enough of the thiram powder so that all the seeds have a thin, continuous coating. Seeds treated with warm water should be sown within 24 hours because dormancy is broken by the treatment.