

Alternaria diseases in production nurseries

Background

Numerous fungal pathogens cause leaf spots and defoliation of nursery plants but arguably the most prevalent and troublesome are those caused by *Alternaria* species. Leaf spots caused by *Alternaria* rarely kill plants but they can reduce their aesthetic quality and commercial value. Most *Alternaria* species are saprophytes that feed on dead organic matter; some only infect plant tissue weakened by stress, senescence or wounding; others are devastating primary pathogens, some of which produce potent plant toxins. *Alternaria* species produce a large number of spores on dead host tissue which are spread by wind or splashing water.

Some *Alternaria* diseases are seedborne with the fungus occurring on or within seed and this can result in rotting of seed or infection of radicles followed by death of seedlings. Symptoms produced by the suite of fungi causing leaf spots are often very similar; therefore an accurate diagnosis of the pathogen is required before successful disease management measures can be implemented.



Fig. 1. *Alternaria* leaf spot on *Vinca*.

Introduction

There are more than 40 species of *Alternaria* that can be found in most situations in the environment and are a natural part of the fungal flora almost everywhere. They are normal agents of decay and decomposition. Some species are plant pathogens that, collectively, cause a range of diseases with economic impact on a large variety of important agronomic host plants including, ornamentals, fruit, vegetable and other crops. *Alternaria* spp. are also well known as postharvest pathogens.

Some *Alternaria* spp. are of clinical significance as they are well known for the production of toxic secondary metabolites, some of which are powerful mycotoxins that have been implicated in the development of cancer in mammals. *A. alternata* in particular is gaining recognition as a human pathogen, particularly in immunocompromised patients. The terms alternariosis and *Alternaria* toxicosis are used for disorders in humans and animals caused by a fungus in this genus. In addition, *Alternaria* spores can cause allergies and asthma symptoms in people. The two major features of *Alternaria* species are the production of melanin, especially in the spores, and the production of toxins by primary pathogens for the colonisation of their host.

Alternaria – the pathogen

Alternaria spores can be air- or water-borne and are most often found in dead organic matter in soil. The multi-celled, club-shaped spores (Fig. 2) are produced singly or in long chains. Although usually seen as saprophytic contaminants, many are known plant pathogens attacking most parts of the plant both above and below ground.

Alternaria can be host specific or can attack a wide range of hosts. *Alternaria* can survive between crops as spores and mycelium in infected plant residues or within and on seeds. If the fungus is seed borne, it may attack seedlings, causing damping-off, stem lesions, or collar rot. The fungus grows and sporulates on plant residues during periods of rain, heavy dew, or under conditions of good soil moisture. Spores are wind blown or splashed onto plant surfaces where infection occurs. The spores must have free moisture to germinate and infect the plant tissue. Penetration of the host can be direct, through wounds or through stomata. Tissues that are stressed, weak, old or wounded are more susceptible to invasion than sound, vigorous tissues.

Detection and Diagnosis

As *Alternaria* leaf symptoms are often very similar to those caused by other fungal pathogens an observation of leaf lesions is not a conclusive diagnosis. Early and accurate identification of the fungal pathogen is usually required for disease control.

The traditional identification method is based on the morphological characters of the fungus. *Alternaria* spores have a distinctive appearance that makes them easy to recognise under a microscope. They are darkly pigmented, club shaped, and multi-celled with cross and longitudinal septa. They are formed in chains or branching chains at the apex of conidiophores.

The fungus is easy to isolate and grow in culture. Fungal colonies are usually black, grey or green. A PCR-based diagnostic test is available as a diagnostic tool particularly for pathogens of some species.



Fig. 2. *Alternaria* leaf spot on kangaroo paw (above) and typical spores of *Alternaria* species (below).

Symptoms

Alternaria infection can cause leaf spots or blotches, blighting and blackening of young shoots as well as stem and radicle lesions (Figs 1-5). Affected leaves develop brown to black spots or blotches which can vary considerably in size, colour and shape. These leaves may fall prematurely.

Some *Alternaria* species, particularly pathovars of *A. alternata*, depend on toxin production for colonization of their host. Some of these produce a toxin which translocates through the vascular system producing chlorosis along the veins from the leaf lesion, and causing death of adjacent leaf tissue. Others produce a toxin with a mild phytotoxic effect such as a yellow halo surrounding a necrotic spot (Figs 4-5).

Disease cycle and spread

Alternaria survives from crop to crop as mycelium or spores in infected plant material left on or in the ground, and on or within the seeds from infected plants. The elongated spores allow for better wind-dispersal, which increases the distances travelled. Healthy plants can pick up the spores from the ground or the air. Under favourable conditions, the spores quickly mature into fungal leaf spots that release more spores that can be carried to other plants by wind and/or splashing rain. This disease cycle will continue throughout the season for as long as favourable conditions persist and a suitable host is present. The most favourable conditions for *Alternaria* is rain or heavy dew occurring when temperatures are between 25-28°C.

The major sources of transport of these pathogens are by infected seeds with spores on the seed coat or as mycelium under the seed coat. The dissemination of spores occurs by wind, water, tools and animals. The fungus can survive in susceptible weeds or perennials between cropping cycles or seasons.

Host range

The *Alternaria* fungus has a very wide host range of fruits, vegetables and ornamentals including geranium, *Dahlia* hybrids, *Gerbera jamesonii* (African daisy), *Begonia* species, *Gardenia augusta*, *Cineraria*, *Verbena*, African violet, *Hibiscus*, and *Vinca*. Many other hosts can be affected, including those listed in Table 1. Other species of *Alternaria* may also affect many other ornamental plants not listed here.

Disease management

Adoption of appropriate nursery hygiene practices is the key to effective management of *Alternaria*. Control measures can be specific for particular crops, but there are some basic principles which generally apply for most hosts.



Fig. 3. *Alternaria panax* causing leaf spots on umbrella tree (above) and *Alternaria* stem blight on Frangipani (below).

Table 1. Hosts of commonly found *Alternaria* species. This table is not a complete listing, other hosts are likely to be affected by *Alternaria* spp. in certain situations.

<i>Alternaria</i> species	Hosts
<i>A. alternata</i>	Over 380 including apple, <i>Acacia</i> , <i>Antirrhinum</i> , <i>Asclepias</i> , <i>Calathea</i> , <i>Callistephus</i> , <i>Chrysanthemum</i> , citrus, clarkia, <i>Dahlia</i> , <i>Ficus</i> , <i>Hedera</i> , <i>Helianthus</i> , <i>Hibiscus</i> , litchi, <i>Oenothera</i> , passionfruit, pelargonium and petunia, tomato.
<i>A. brassicae</i> and <i>A. brassicicola</i>	Cruciferae; include broccoli, cabbage, cauliflower, horseradish, kohlrabi, mustard, radish, rape and turnip.
<i>A. chrysanthemi</i>	<i>Chrysanthemum</i> spp.
<i>A. cichorii</i>	<i>Cichorium endivia</i> (Endive); <i>Cichorium intybus</i> (Cichory) <i>Lactuca sativa</i> (Lettuce) all members of the tribe Lactuceae (Cichorieae) and Asteraceae
<i>A. citri</i>	Citrus: grapefruit, orange, mandarins, lemon, etc.
<i>A. cucumerina</i>	<i>Citrullus lanatus</i> , <i>Cucumis melo</i> , <i>C. sativus</i> , <i>Cucurbita</i> spp
<i>A. dauci</i>	<i>Apium graveolens</i> , <i>Daucus carota</i> , <i>Fumaria muralis</i> , <i>Lactuca</i> spp., <i>Pastinaca saliva</i> , <i>Petroselinum crispum</i>
<i>A. dianthicola</i>	<i>Dianthus barbatus</i> , <i>D. caesius</i> , <i>D. caryophyllus</i> . Plantain (<i>Musa paradisiaca</i>)
<i>A. helianthi</i>	<i>Helianthus annuus</i> , <i>H. argophyllus</i> , <i>H. debilis</i>
<i>A. panax</i>	Araliaceae: <i>Aralia</i> , <i>Brassaia</i> , <i>Dizygotheca</i> , <i>Fatsia</i> , ginseng, <i>Mertya</i> , <i>Nothopanax</i> , <i>Polyscias</i> , <i>Pseudopanax</i> , <i>Schefflera</i> , <i>Tupidanthus</i>
<i>A. radicina</i>	<i>Daucus carota</i> , <i>Apium graveolens</i> , <i>Petroselinum crispum</i> , <i>Pastinaca sativa</i> , <i>Anethum graveolens</i>
<i>A. solani</i>	<i>Datura</i> , potato, tomato and other solanaceous crops, <i>Brassica</i> spp. (cabbage, cauliflower)
<i>A. zinniae</i>	<i>Ageratum</i> , <i>Aster</i> , <i>Bidens</i> , <i>Calendula</i> , <i>Callistephus</i> , <i>Chrysanthemum</i> , <i>Coreopsis</i> , <i>Cosmos</i> , <i>Dahlia</i> , <i>Gaillardia</i> , <i>Galinsoga</i> , <i>Gerbera</i> , <i>Helianthus</i> , <i>Notonia</i> , <i>Parthenium</i> , <i>Sphaeranthus indicus</i> , <i>Tagetes</i> , <i>Tithonia</i> , <i>Volutarella</i> , <i>Xanthium</i> , <i>Zinnia</i>

- As spores can be spread by water splash, avoid overhead irrigation especially at night. If possible water early in the day so that foliage dries out before evening.
- Promote air circulation and reduce periods of leaf wetness by thinning plant canopies and avoiding close packing of plants/cuttings.
- Do not handle plants when wet.
- Avoid injuries and control insect/mite pests.
- Remove and discard severely affected plants.
- Prune out and discard diseased twigs, shoots, leaves and fruit and remove any leaf litter accumulating at the base of plants to minimise the build-up of spores.
- Propagate from pathogen-free stock and seed.
- Minimise plant stress (e.g. provide optimal water, nutrition and temperature).

Early diagnosis of a problem is also critical since choosing appropriate control measures depends upon an accurate diagnosis. *Alternaria* leaf spot can often be confused with leaf spots caused by other fungi, e.g. *Colletotrichum* in particular, but also other fungal and bacterial pathogens. Spots caused by abiotic conditions may sometimes cause leaf spots that superficially resemble *Alternaria* leaf spot. It is therefore important to submit samples to a recognised diagnostic laboratory for identification.

Use fungicides only when necessary as they can mask after-sale symptoms. In some cases however, it may be appropriate to apply a protectant fungicide (e.g. mancozeb, chlorothalonil, copper-based fungicides and iprodione) to prevent infection from occurring in the first place or to protect uninfected stock after having removed infected plant material. Systemic fungicides with post-infection activity can also be used as a protectant but always rotate between products from multiple chemical groups. This is important as once a fungal population becomes resistant to a fungicides, such as the strobilurins (e.g. the active azoxystrobin), it

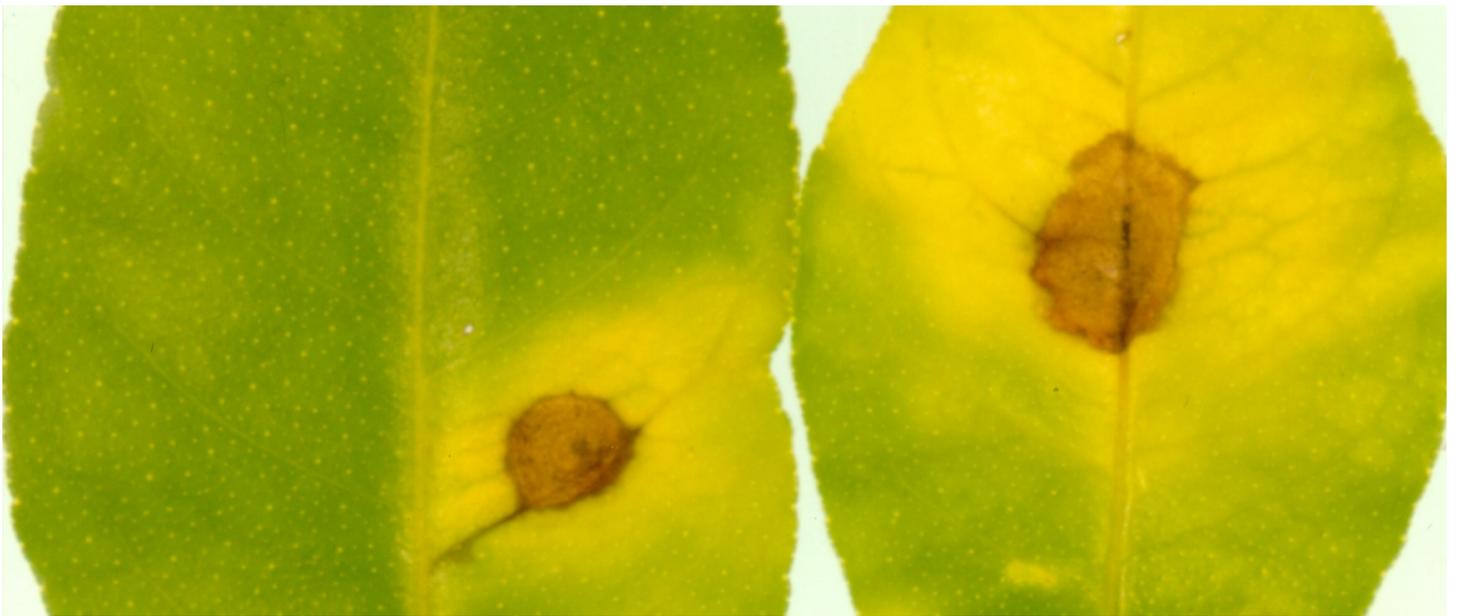


Fig. 4. *Alternaria* leaf and stem blight on *Peplus* (above). *Alternaria* diseases on citrus including blackening and blighting of young shoots (middle left), brown spot symptoms on leaves, shoots and young fruit (middle right), and leaf spots on seedling leaves where leaf spots are surrounded by chlorotic tissue and leaf veins turn brown from toxins produced by *Alternaria* (below).

is unlikely to regain efficacy. In some cases it may be necessary to pre-treat cuttings and scion material with a fungicide prior to grafting.

Active ingredients with systemic properties that have registrations or minor use permits in Australia include: azoxystrobin (PER11517) and metiram +pyraclostrobin (PER13459 – note that metiram has no systemic activity). Active ingredients without systemic properties include: chlorothalonil, copper in various formulations (PER13702, PER 13328), dimethomorph + mancozeb (PER 14768, 11546), mancozeb, potassium bicarbonate (PER13793), wettable sulfur and zineb.

If you need to use a fungicide, always check that the product is appropriately registered or has a current permit for use on the crop you are intending to treat by searching the APVMA or Infopest databases and follow directions carefully to avoid phytotoxicity and potential failure of the products.

Biosecurity threats relating to *Alternaria* diseases

Most diseases of nursery crops caused by *Alternaria* species are commonly found throughout the world. However, there are a number of strains (pathotypes) of *Alternaria alternata*, which is the most common species of *Alternaria* on ornamentals, which may not be present in Australia. Some strains of this species have a very wide host range, whereas others only affect a small number of host plant species or varieties. If you see anything unusual, contact your local agricultural department or call the Exotic Plant Health Hotline on 1800 084 881.

Further reading

Mamgain, A., et al. (2013). "Alternaria pathogenicity and its strategic controls." Research Journal of Biology 1: 1-9.

Salo, P. M., et al. (2006). "Exposure to *Alternaria alternata* in US homes is associated with asthma symptoms." Journal of Allergy and Clinical Immunology 118: 892-898.

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Fig. 5. Halo effect around *Alternaria* spots due to release of phytotoxins on *Brunfelsia* sp (above). *Alternaria cinerariae* leaf spot on *Cinererea* sp. (middle). *Alternaria* leaf spot on *Convolvulus cneorum* (silverbush - below).