

Vegetable Industry Development Program

Mega Pests

Managing Soilborne Diseases



What is the nature of soilborne organisms?

There are hundreds of soilborne plant pathogens. The most common and important ones are fungi. The fungi considered in this fact sheet survive in the soil for long periods even in the absence of their preferred weed and crop hosts. These fungi generally have wide host ranges amongst vegetables but 'clubroot' (a disease caused by *Plasmodiophora brassicae*) only affects cruciferous crops and weeds. *Sclerotium cepivorum* only affects *Allium* spp., but *S. rolfii* attacks many vegetables.

Many of these fungi may be present together in cultivated soils; some also in virgin soils. Once present on your farm they will remain an on-going concern for as long as you are growing susceptible crops. The fungi can infect roots, stems and other plant parts. Depending on their population levels in soil, the environmental conditions, the root system and crop type, these fungi may cause serious or minor losses, every year or sporadically. They may kill plants, or reduce plant yields and quality.

The diseases caused by these fungi are expensive and difficult to manage, especially when fungicide applications are the only crop management measure adopted. Such programs have not provided a consistent solution for most growers.

Why is their control difficult?

Commonly reported reasons for inconsistent results with chemicals include resistance to the chemical, a lack of effective chemistry, and poor application (coverage, timing, placement). Despite inconsistent performance, fungicides and chemical fumigants have remained a common approach to managing these soilborne fungi. Their expense however and increasing awareness of their environmental impact, have motivated many growers to explore more effective and affordable, integrated crop protection (ICP) approaches. ICP (also referred to as Integrated Pest Management (IPM)) considers the production system as a whole, including all pests, the crop and soil health. ICP approaches supplement chemical treatments and limit dependence on them.

A few alternative controls to chemicals, including biocontrol agents have been developed for controlling soilborne pathogens in Australia. Cultural practices, such as rotation with non-host crops and biofumigation with Brassica

green manure crops, and pre-plant soil treatment with biostimulants of sclerotial germination, have effectively reduced populations of some soilborne fungal pathogens.

How can I protect my farm from these soilborne fungi?

If you are raising crops susceptible to soilborne pathogens, make sure you avoid inadvertent spread of the pathogens from infested to clean blocks. The potential for introduction in water, on soil attached to equipment or vehicles, or on planting material, is high. Use pathogen-free planting material and compost/mulch from certified suppliers, and limit people and equipment movement around your property.

ICP tips for managing soilborne diseases

- Read the fact sheet: Mega Pests - The Basics of Protecting Your Crops
- Understand the pathogen survival mechanisms and the crop and environmental conditions that favour disease development
- Implement farm sanitation practices to remove or reduce pathogen carryover - in weeds, crop debris and volunteer hosts
- Consider your planting sequences. Rotation with non-host crops will limit the build-up of pathogen populations
- Test soils to identify heavily infested blocks before planting susceptible crops
- Use clean planting material and resistant varieties
- Manage soils to increase organic matter and improve soil health, while disadvantaging soilborne pathogens
- Monitor blocks and keep records on crop and disease history to aid decision-making
- Remove and destroy infected plants to reduce disease spread within a crop and carryover to the next crop



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How can I manage these soilborne pathogens if I grow susceptible crops?

By knowing your crop's stages of susceptibility to the fungi and understanding the conditions that influence the pathogens' long-term survival and pathogenicity, the on-farm activities required to manage the crop and the diseases, will become clearer.

Clubroot

If your farm is free of this organism, avoid its introduction! Be meticulous about nursery and farm hygiene, and accept only clean transplants in new trays/boxes. Transplants received in re-used containers or with soil in the growing medium, are at greater risk than those grown according to 'best practice' guidelines. Restrict equipment, livestock, water and people movement around your production areas. Do not plant susceptible varieties in infested soils, especially in summer, if the soil population of this fungus exceeds 1,000 spores per gram of soil. Clubroot affects the roots of cruciferous vegetables and weeds like wild turnip and radish. The most susceptible crop is Chinese cabbage followed by cauliflower. Some broccoli varieties are tolerant to clubroot. A few varieties of Asian vegetables, cabbage and cauliflower are resistant and meet Australian market requirements.

If clubroot has occurred on your farm, start with a number of cultural practices to minimise its spread and impact. Remove mustard weed and include non-brassicacs in your crop rotation so that the disease carryover from crop to crop is minimised.

Site preparation – before planting make sure plants and roots from the previous crop have been removed and that areas that were infection 'hot spots' in the previous crop, are treated. Spot fumigation may be needed.

Soil modifications – before planting a susceptible crop, increase soil pH to 7.0 - 7.5 by adding lime. During the early production period, maintain higher calcium and boron levels as this appears to reduce the potential for gall formation on roots.

Water management – ensure each block receives clean water rather than run-off from nearby infested blocks. Good drainage is essential because 'warm, acid soils with standing water' are the conditions that favour rapid growth of the fungus.

Pythium species

Site selection and irrigation management are particularly important in managing this fungus, which thrives in wet conditions. Irrigation water, whether it is sourced from bores, mains, rivers or a re-circulation system, should be tested regularly for *Pythium* species. When viable spores exist in water, every irrigation is a threat that may result in new fungal infections and disease spread.

Because soil or water movement can spread the fungus, use foot baths, and clean wheel wells and equipment. Disinfestation is worthwhile! Drainage is also important as saturated conditions and standing water increase the potential for infection by *Pythium* species.

Planting dates that promote quicker plant emergence from soil can minimise root rots due to *Pythium* species. Fungicidal treatments (as seed treatments, protectants or eradicants) are needed at times when soil conditions favour root infection.

Fusarium species

These fungi have been managed well in many crops through the development of resistant varieties and through seed treatments with fungicides. Cultural integrated practices that assist in management of these fungi, include rotation with non-host crops, roguing (i.e. removing and destroying) infected plants and minimisation of plant stress (environmental, nutritional or due to other pests like nematodes, *Rhizoctonia* spp. or *Pythium* spp.).

Rhizoctonia species

These fungi have a very wide host range amongst vegetables and they also survive well in soil in the absence of a host plant. Clean transplants (also tubers, stolons, runners), seed treatments, site selection and planting times are important considerations in the management of *Rhizoctonia* spp.



Plant roots infected with clubroot on right
(Source: Ian Porter VIC DPI)



Cauliflower plants infected with clubroot
(Source: Ian Porter VIC DPI)



Checking carrots and soil for presence of soilborne diseases



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Sclerotinia and Sclerotium species

Several pathogens in these fungal genera have wide host ranges. *Sclerotinia minor*, *S. sclerotiorum* and *Sclerotium rolfsii* attack many plants, but *Sclerotium cepivorum* only infects onions, garlic and related *Alliums*.

These fungi have survival structures (sclerotia) that remain viable in soil for long periods (10-15 years). *S. sclerotiorum* also produces airborne spores for above-ground attack. Management of these diseases must include consideration of site selection, cropping sequences and rotations, and minimisation of sclerotia formation and survival.

Pre-plant soil tests, crop histories, and monitoring of disease in previous crops should guide site selection and crop choices. Soil inversion and deep burial of sclerotia, and rotation with non-host green manure or biofumigant crops have shown some benefit in reducing the number of sclerotia and the potential threat to the next crop.

Other cropping and cultural practices that may reduce the severity of infection and losses include variety selection to minimise leaf contact with the soil, planting density to reduce contact between plants and duration of leaf wetness. Roguing of diseased plants, removal of weeds and improved soil health can reduce the impact of *Sclerotinia* and *Sclerotium* species and of other soilborne pathogens.

Case Study

Successful management of 'onion white rot' using ICP approaches

Tasmanian and Victorian growers of bunching and bulb onions have begun implementing sustainable practices on their farms for the management of onion white rot, caused by *Sclerotium cepivorum*.

What inspired the ICP approach amongst onion growers?



Footbath

(Source: Natalie Moore - NSW I&I)

White rot management with various fungicides has been tried throughout the world for decades. Although fungicides applied at drilling, in-furrow, or over the plants have been successful, often they have not provided commercially-acceptable disease control under high disease pressure.

The ICP approach for white rot control has been assisted by the use of disease predictions based on pre-plant, sclerotial

population counts. Growers in Tasmania and Victoria now test their planting sites in advance and avoid heavily infested ground. Both states have private and state run testing laboratories that give advice on potential losses due to white rot, depending on the time of sowing.

Onion farm hygiene is particularly important. Its aim is to prevent the entry or spread of sclerotia by restricting soil movement on vehicles. The provision and use of washdown areas for equipment and boots is important. Soil washed off is kept away from cropping fields, and infested blocks are planted after new or clean blocks to prevent the spread of sclerotia in soil attached to equipment.

Other ICP steps utilise knowledge of the growth conditions that favour or disadvantage the fungus. Early planted crops (May) are most at risk because they grow during periods when soil conditions are optimal for the fungus to attack. Late plantings (September) are therefore more suitable for infested fields.

Potential new ICP 'tools' for managing diseases caused by *Sclerotinia* and *Sclerotium* species

Highly antagonistic and formulated strains of *Coniothyrium minitans* and *Trichoderma* species are capable of parasitising and killing sclerotia, and therefore of protecting some plants against infection by *Sclerotinia* spp. Similarly, *Trichoderma* formulations can protect *Allium* roots against white rot. A native Tasmanian strain of *Trichoderma* has been shown in trials to be a potentially useful tool for integration with other ICP practices for control of onion white rot. It has been applied to seed beds as pellets, or within enriched composts, and in some cases was sprayed on as a wettable powder formulation. Trials were conducted by Dean Metcalf as part of the HAL-funded project, VN05008 - "Non-chemical and biological fungicide options for the control of onion white rot".

Amending soil with organic sources (eg. molasses) can increase biological activity and competition in soil. This indirectly can reduce the viable life of sclerotia in soil. Biofumigation is also a useful tool and new Brassica green manure crops with increased biofumigant compound content are now available. Mustard oil extracted from Brassica seed has also shown biocidal activity against sclerotia.

A synthetic version of diallyl disulphide (DADS), a volatile compound emitted naturally by roots of *Allium* crops, has been used successfully as a pre-plant soil treatment to stimulate sclerotial germination. Sclerotia that germinate in the absence of a host plant soon die. The DADS 'trick' has been trialled in infested onion blocks in Australia, NZ and in the US where it has lowered populations of sclerotia before the onions are sown, and subsequently, white rot losses. Recently, a research permit for commercial-scale DADS trials in Australia was granted, with a view to registering this product in Australia.



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A selection of helpful resources

There are many additional useful resources that can be accessed within the secure area of the AUSVEG website.

Go to the 'Technical Insights' page and then to the R+D Insights Database (search engine) where you can initiate a search using key words.

Available resources include:

1. **Managing Soilborne Diseases in Vegetables.** 2010. A factsheet produced as part of the Vegetable Pathology Program. Download from: http://www.vgavic.org.au/pdf/VG07125_Soilborne_Diseases_brochure.pdf
2. **Managing Sclerotinia Diseases in Vegetables.** 2010. A factsheet produced as part of the Vegetable Pathology Program. Download from: http://www.vgavic.org.au/pdf/VG07126_Sclerotinia_brochure.pdf
3. **Improving Soil Health for Yield and Profit in Vegetables.** 2010. A factsheet produced by the VIC DPI Vegetable Soil Health Team. Download from: http://www.vgavic.org.au/pdf/VG07008_Soil_Health_brochure.pdf
4. **Clubroot factsheets.** 2005. Website providing access to a series of 10 factsheets that discuss the important aspects of clubroot disease of brassica vegetables and the range of control measures available. Access via: http://www.vgavic.org.au/communication/research_and_development_shop/clubroot_factsheets.htm
5. **Integrated Control Strategy for Onion White Rot Disease in Spring Onions and Other Bunching Allium Crops.** 2004. A 16-page report on key outcomes from laboratory and field trials including trials with diallyl disulphide (DADS). Access via: http://www.vgavic.org.au/research_and_development/Researchers_PDFs/vg01096_integrated_control_of_onion_white_rot.htm
6. **Final Report for Horticulture Australia Ltd (HAL) project VN05009 – Optimising diallyl disulphide (DADS) for the management of white rot of onions.** Obtain from HAL website: in Projects area select 'Order a Final Report.': <http://www.horticulture.com.au>

Acknowledgement

Original text was prepared by Scholefield Robinson Horticultural Services Pty Ltd. This version was reviewed and updated by Oscar Villalta, VIC DPI, in March 2012.