









CAPSICUM, CHILLI AND EGGPLANT

| Bacterial wilt | Damping off | Phomopsis blight /Fruit rot | Pythium root rot |
|---|---|---|---|
| Page 46 | Page 50 | Page 54 | Page 58 |
|  |  |  |  |

| Root-knot nematode | Sclerotinia (white mould) | Sclerotium rot | Verticillium wilt |
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| Page 62 | Page 66 | Page 70 | Page 74 |
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BACTERIAL WILT

Ralstonia solanacearum

WHAT SHOULD I LOOK FOR?



Leaf yellowing, wilting and death in warm conditions within days of infection

M. Furlong, University of Queensland




Dissecting the lower stem reveals brown discolouration of internal tissue

Clemson University - USDA Cooperative Extension Slide Series, Bugwood.org




To help identify bacterial wilt, cut the stem of an infected plant and place in a clear container with water. Look for a white milky liquid flowing from the stem

WHERE WILL I SEE SYMPTOMS?




LEAVES




STEM

FAVOURABLE CONDITIONS FOR DISEASE DEVELOPMENT




HOT

• 25-35°C



HIGH HUMIDITY



WET

• Moist soil favours disease

DISTRIBUTION IN THE FIELD

SCATTERED

Individual/small patches of infected plants



HOW DOES IT SPREAD?



INFECTED SEED/ SEEDLINGS



MOVEMENT OF CONTAMINATED SOIL



FREE WATER
















CONTAMINATED PLANT DEBRIS

SURVIVAL TIME WITHOUT HOST

More than 10 years

HOW DO I CONTROL IT?

| | | | | | | |
|----------------------|---|--|--|---|--|--|
| FALLOW/COVER CROP | <p>FARM HYGIENE</p> <p>Stop movement of contaminated soil, water, plants and equipment</p>  | <p>HOST-FREE ZONE</p> <p>Control volunteer host plants and weeds</p>  | <p>IMPROVE SOIL HEALTH</p> <p>Add organic matter or amendments to boost beneficial microbes</p>  | <p>BIO FUMIGATION</p> <p>Grow a biofumigant crop</p>  | | |
| PLANTING PREPARATION | <p>CROP SELECTION</p> <p>Choose a resistant/less susceptible cultivar</p>  | <p>GRAFTING</p> <p>Use transplants grafted onto resistant rootstock</p>  | <p>DRAINAGE</p> <p>Plant on raised beds or well-draining soil</p>  | <p>SOIL PH</p> <p>Use amendments to adjust soil pH</p>  | <p>NO RESIDUE AT PLANTING</p> <p>Ensure no plant residues from host crops at planting</p>  | <p>ADJUST DATE</p> <p>Adjust planting/harvest date to reduce infection risk</p>  |
| POST-PLANT | <p>IRRIGATION MANAGEMENT</p> <p>Monitor crop and soil to optimize amount and timing</p>  | <p>AVOID PLANT INJURY</p> <p>Avoid any physical damage to plant</p>  | <p>GOOD NUTRITION</p> <p>Ensure plants' nutritional needs are met</p>  | | | <ul style="list-style-type: none"> • Avoid planting during high temperatures |
| | | | | <ul style="list-style-type: none"> • Adjust pH to 5.5-7 | | |
| | | | | | | <ul style="list-style-type: none"> • Avoid excess nitrogen |

HOST RANGE

Wide host range including most solanaceae vegetable crops

DAMPING OFF

Pythium spp. | *Phytophthora* spp. | *Rhizoctonia* spp.

WHAT SHOULD I LOOK FOR?



Infection may cause seed rot, resulting in large bare patches where the seed has failed to germinate

Penn State Department of Plant Pathology & Environmental Microbiology Archives, Penn State University, Bugwood.org



Seedlings that do emerge may have yellow to light brown discoloration around the stem at ground level. As the disease progresses stems eventually collapse leading to wilting and death

G. Holmes, California Polytechnic State University, Bugwood.org

WHERE WILL I SEE SYMPTOMS?

ROOTS
STEM BASE

FAVOURABLE CONDITIONS FOR DISEASE DEVELOPMENT

COOL

WATERLOGGED SOIL

DELAYED SEEDLING EMERGENCE

• 13-15°C Some *Pythium* spp. prefer warmer temperatures

DISTRIBUTION IN THE FIELD

LARGE AREAS

Large areas of infected plants clearly visible

HOW DOES IT SPREAD?

WIND

MOVEMENT OF CONTAMINATED SOIL















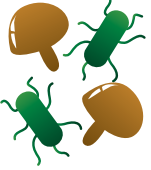

FREE WATER

INSECTS

CONTAMINATED PLANT DEBRIS

SURVIVAL TIME WITHOUT HOST | More than 10 years

HOW DO I CONTROL IT?

| | | | | | | |
|-----------------------------|---|--|--|--|--|--|
| FALLOW/COVER CROP | <p>FARM HYGIENE</p> <p>Stop movement of contaminated soil, water, plants and equipment</p>  | <p>HOST-FREE ZONE</p> <p>Control volunteer host plants and weeds</p>  | <p>CROP ROTATION</p> <p>Select non-host rotation or cover crops</p>  | <p>IMPROVE SOIL HEALTH</p> <p>Add organic matter or amendments to boost beneficial microbes</p>  | <p>BIO FUMIGATION</p> <p>Grow a biofumigant crop</p>  | |
| PLANTING PREPARATION | <p>DRAINAGE</p> <p>Plant on raised beds or well-draining soil</p>  | <p>CHEMICAL FUMIGATION</p> <p>Always use with care and as per label</p>  | <p>TRANSPLANTS</p> <p>Use seedling transplants - not direct seeding</p>  | <p>SOIL TEST</p> <p>Conduct a pre-sowing soil test to help predict level of risk</p>  | <p>NO RESIDUE AT PLANTING</p> <p>Ensure no plant residues from host crops at planting</p>  | <p>CHEMICAL TREATMENT</p> <p>Treat seed/seedlings with registered fungicide</p>  |
| POST-PLANT | <p>IRRIGATION MANAGEMENT</p> <p>Monitor crop and soil to optimize amount and timing</p>  | <p>AVOID PLANT INJURY</p> <p>Avoid any physical damage to plant</p>  | <p>GOOD NUTRITION</p> <p>Ensure plants' nutritional needs are met</p>  | <p>BIOCONTROL PRODUCTS</p>  | <p>CONTROL PESTS</p> <p>Control insect pests that spread spores</p>  | |

• Consult APVMA or InfoPest website for current registered products

HOST RANGE

Wide - potatoes, eggplant, chilli, capsicum, brassicas, carrots, cucurbits, lettuce etc.

PHOMOPSIS BLIGHT/FRUIT ROT

Phomopsis vexans

WHAT SHOULD I LOOK FOR?



Small grey to light brown lesions with light coloured centres that expand, covering large areas on leaf, stem or fruit. Leaves eventually wilt and drop. Stems develop large sunken cracked cankers *Yuan-Min Shen, Taichung District Agricultural Research and Extension Station, Bugwood.org*



Fruit lesions may be (a) sunken and soft with tiny black dots (fruiting bodies) around the margin or in rings and (b) in dry conditions fruit may shrivel

(a) D. Langston, University of Georgia, Bugwood.org (b) B. Olson, Oklahoma State University, Bugwood.org

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| <p>WHERE WILL I SEE SYMPTOMS?</p> | <p>FAVOURABLE CONDITIONS FOR DISEASE DEVELOPMENT</p> <p>• > 28°C Fruit rot occurs >29°C</p> |
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| <p>DISTRIBUTION IN THE FIELD</p> <p>SCATTERED</p> <p>Individual/small patches of infected plants</p> | <p>HOW DOES IT SPREAD?</p> <p>SURVIVAL TIME WITHOUT HOST 3-10 years</p> |
|--|---|











WHAT SHOULD I LOOK FOR?



With age small black bumps (pycnidia) can be seen within the lesion

B. Olson, Oklahoma State University, Bugwood.org

HOW DO I CONTROL IT?

| | | | | |
|--------------------------|---|--|--|--|
| FALLOW/COVER CROP | <p>FARM HYGIENE</p> <p>Stop movement of contaminated soil, water, plants and equipment</p>  | <p>CROP ROTATION</p> <p>Select non-host rotation or cover crops</p>  | <p>HOST-FREE ZONE</p> <p>Control volunteer host plants and weeds</p>  | |
| | <p>PLANTING PREPARATION</p> <p>AIR CIRCULATION</p> <p>Increase row/plant spacing to improve air flow</p>  | <p>CROP SELECTION</p> <p>Choose a resistant/less susceptible cultivar</p>  | <p>NO RESIDUE AT PLANTING</p> <p>Ensure no plant residues from host crops at planting</p>  | <p>USE CLEAN SEED OR SEEDLINGS</p> <p>Source seed/seedlings from a certified reputable source</p>  |
| | <p>POST-PLANT</p> <p>AVOID PLANT INJURY</p> <p>Avoid any physical damage to plant</p>  | <p>CONTROL PESTS</p> <p>Control insect pests that spread spores</p>  | <p>AVOID CONTACT WITH SOIL</p> <p>Use plastic mulch to avoid plant-soil contact</p>  | <p>• 3 year break between eggplant crops</p> <p>• Consider plastic mulch to avoid soil contact</p> <p>• Plastic mulch</p> |

HOST RANGE

Eggplants

PYTHIUM ROOT ROT

Pythium aphanidermatum

WHAT SHOULD I LOOK FOR?



Aboveground, plants will appear wilted with yellowing of leaves that will eventually die
L.Tesoriero, Crop Doc Consulting



Sunken dark lesions may occur on lower stems or a rot of the roots may develop
Penn State University, Bugwood.org

WHERE WILL I SEE SYMPTOMS?

ROOTS | WHOLE ABOVE GROUND PLANT

FAVOURABLE CONDITIONS FOR DISEASE DEVELOPMENT

OR

HOT | COOL

• 12-18°C

Can develop in hot or cold conditions

DISTRIBUTION IN THE FIELD

LARGE AREAS

Large areas of infected plants clearly visible

HOW DOES IT SPREAD?

WIND

MOVEMENT OF CONTAMINATED SOIL

FREE WATER













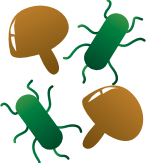

INSECTS

CONTAMINATED PLANT DEBRIS

SURVIVAL TIME WITHOUT HOST

More than 10 years

HOW DO I CONTROL IT?

| | | | | | | |
|------------------------------------|---|--|--|--|--|---|
| <p>FALLOW/COVER CROP</p> | <p>FARM HYGIENE</p> <p>Stop movement of contaminated soil, water, plants and equipment</p>  | <p>HOST-FREE ZONE</p> <p>Control volunteer host plants and weeds</p>  | <p>CROP ROTATION</p> <p>Select non-host rotation or cover crops</p>  | <p>CHEMICAL FUMIGATION</p> <p>Always use with care and as per label</p>  | <p>• 3 year break between eggplant crops</p> <p>• Consult APVMA or InfoPest website for current registered products</p> | |
| <p>PLANTING PREPARATION</p> | <p>CHEMICAL TREATMENT</p> <p>Use registered soil drench at planting</p>  | <p>DRAINAGE</p> <p>Plant on raised beds or well-draining soil</p>  | <p>SOIL TEST</p> <p>Conduct a pre-sowing soil test to help predict level of risk</p>  | <p>NO RESIDUE AT PLANTING</p> <p>Ensure no plant residues from host crops at planting</p>  | <p>CHEMICAL TREATMENT</p> <p>Treat seed/seedlings with registered fungicide</p>  | <p>• Consult APVMA or InfoPest website for current registered products</p> <p>• Consult APVMA or InfoPest website for current registered products</p> |
| <p>POST-PLANT</p> | <p>IRRIGATION MANAGEMENT</p> <p>Monitor crop and soil to optimize amount and timing</p>  | <p>AVOID PLANT INJURY</p> <p>Avoid any physical damage to plant</p>  | <p>GOOD NUTRITION</p> <p>Ensure plants' nutritional needs are met</p>  | <p>BIOCONTROL PRODUCTS</p>  | <p>CONTROL PESTS</p> <p>Control insect pests that spread spores</p>  | |

HOST RANGE

Capsicum

ROOT-KNOT NEMATODE

WARM CLIMATE SPECIES: *Meloidogyne incognita* | *Meloidogyne javanica* | *Meloidogyne arenaria*

COOL-CLIMATE SPECIES: *Meloidogyne hapla* | *Meloidogyne fallax*

WHAT SHOULD I LOOK FOR?



Aboveground plants may appear chlorotic and stunted
G. Holmes, California Polytechnic State University












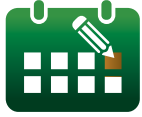


Belowground roots develop characteristic swelling and galls

S. Nelson FLICKR

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| <p>WHERE WILL I SEE SYMPTOMS?</p> | <p>FAVOURABLE CONDITIONS FOR DISEASE DEVELOPMENT</p> <div style="display: flex; justify-content: space-around;"> <div style="text-align: center;"> <p>WARM</p> <p>• Active 15°C +</p> </div> <div style="text-align: center;"> <p>SANDY SOIL</p> </div> <div style="text-align: center;"> <p>COOL</p> <p>• Active 8.5°C +</p> </div> <div style="text-align: center;"> <p>SANDY SOIL</p> </div> </div> |
|--|---|

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| <p>DISTRIBUTION IN THE FIELD</p> <p>LARGE AREAS</p> <p>Large areas of infected plants clearly visible</p> | <p>HOW DOES IT SPREAD?</p> <div style="display: flex; justify-content: space-around;"> <div style="text-align: center;"> <p>CONTAMINATED PLANT DEBRIS</p> </div> <div style="text-align: center;"> <p>MOVEMENT OF CONTAMINATED SOIL</p> </div> <div style="text-align: center;"> <p>FREE WATER</p> </div> </div> <p>SURVIVAL TIME WITHOUT HOST Less than 3 years</p> |
|---|--|

HOW DO I CONTROL IT?

| | | | | | | |
|----------------------|---|--|--|--|--|--|
| FALLOW/COVER CROP | <p>FARM HYGIENE</p> <p>Stop movement of contaminated soil, water, plants and equipment</p>  | <p>HOST-FREE ZONE</p> <p>Control volunteer host plants and weeds</p>  | <p>CROP ROTATION</p> <p>Select non-host rotation or cover crops</p>  | <p>CHEMICAL FUMIGATION</p> <p>Always use with care and as per label</p>  | <p>BIO FUMIGATION</p> <p>Grow a biofumigant crop</p>  | <p>IMPROVE SOIL HEALTH</p> <p>Add organic matter or amendments to boost beneficial microbes</p>  |
| PLANTING PREPARATION | <p>CROP SELECTION</p> <p>Choose a resistant/less susceptible cultivar</p>  | <p>SOIL SOLARISATION</p> <p>Cover soil with a tarp and kill harmful pathogens</p>  | <p>CHEMICAL TREATMENT</p> <p>Use registered soil drench at planting</p>  | <p>ADJUST DATE</p> <p>Adjust planting/harvest date to reduce infection risk</p>  | <p>NO RESIDUE AT PLANTING</p> <p>Ensure no plant residues from host crops at planting</p>  | <p>SOIL TEST</p> <p>Conduct a pre-sowing soil test to help predict level of risk</p>  |

- Consult APVMA or InfoPest website for current registered products

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- Maximise growth in cool conditions when nematode activity is low. Harvest early in high risk situations

- e.g. PREDICTA® B testing service. If numbers are high consider fallow or non-host break crop

HOST RANGE

Very wide with over 2000 plant species acting as hosts to root-knot nematode

SCLEROTINIA ROT (WHITE MOULD)

Sclerotinia sclerotiorum | *Sclerotinia minor*

WHAT SHOULD I LOOK FOR?






Symptoms begin as water-soaked lesions on the stem or fruit, which eventually rot and collapse

C. Ocamb, PNW Handbooks















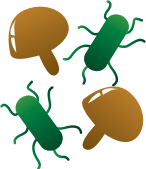
As the disease progresses, characteristic white fluffy growth develops followed by black fruiting bodies (sclerotia). *S. sclerotiorum* can produce sclerotia up to 25mm long and *S. minor* produce much smaller sclerotia (up to 3mm long)

C. Ocamb, PNW Handbooks

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| <p>WHERE WILL I SEE SYMPTOMS?</p>  <p>WHOLE PLANT</p> | <p>FAVOURABLE CONDITIONS FOR DISEASE DEVELOPMENT</p> <div style="display: flex; justify-content: space-around;">   </div> <p>COOL WET</p> <p>•13-18°C</p> |
|---|--|

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|--|---|
| <p>DISTRIBUTION IN THE FIELD</p> <p>SCATTERED</p> <p>Individual/small patches of infected plants</p>  | <p>HOW DOES IT SPREAD?</p> <div style="display: flex; justify-content: space-around;">     </div> <p>WIND MOVEMENT OF CONTAMINATED SOIL FREE WATER CONTAMINATED PLANT DEBRIS</p> <p>SURVIVAL TIME WITHOUT HOST 3-10 years</p> |
|--|---|

HOW DO I CONTROL IT?

| | | | | | | |
|----------------------|--|--|--|--|--|---|
| FALLOW/COVER CROP | <p>FARM HYGIENE</p> <p>Stop movement of contaminated soil, water, plants and equipment</p>  | <p>HOST-FREE ZONE</p> <p>Control volunteer host plants and weeds</p>  | <p>CROP ROTATION</p> <p>Select non-host rotation or cover crops</p>  | <p>CHEMICAL FUMIGATION</p> <p>Always use with care and as per label</p>  | <p>IMPROVE SOIL HEALTH</p> <p>Add organic matter or amendments to boost beneficial microbes</p>  | <p>BIO FUMIGATION</p> <p>Grow a biofumigant crop</p>  |
| PLANTING PREPARATION | <p>AIR CIRCULATION</p> <p>Increase row/plant spacing to improve air flow</p>  | <p>DRAINAGE</p> <p>Plant on raised beds or well-draining soil</p>  | <p>NO RESIDUE AT PLANTING</p> <p>Ensure no plant residues from host crops at planting</p>  | <ul style="list-style-type: none"> • Consult APVMA or InfoPest website for current registered products | | |
| POST-PLANT | <p>AVOID OVER IRRIGATION</p> <p>Saturated soils favour disease development and spread</p>  | <p>CHEMICAL TREATMENT</p> <p>Treat plant with registered foliar fungicide</p>  | <p>GOOD NUTRITION</p> <p>Ensure plants' nutritional needs are met</p>  | <p>BIOCONTROL PRODUCTS</p>  | <ul style="list-style-type: none"> • Consult APVMA or InfoPest website for current registered products | |

HOST RANGE

Very wide (more than 400 different plant species) including most vegetables and weeds in the pepper family

SCLEROTIUM ROT

Sclerotium rolfsii

WHAT SHOULD I LOOK FOR?

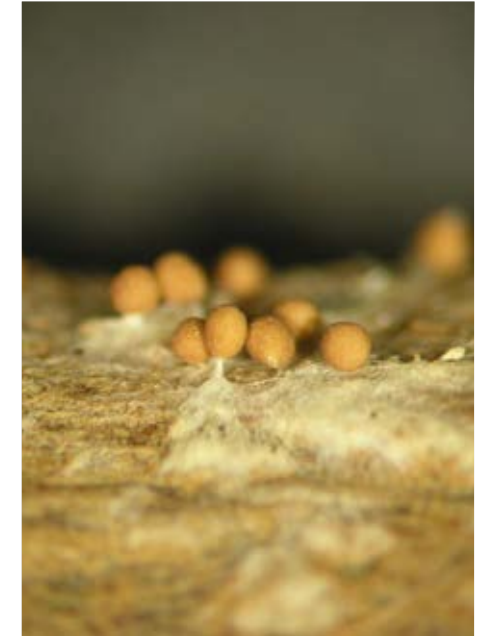


Begins as a watery rot on stem or fruit that eventually leads to collapse of infected area. Infection of the lower stem can cause plant wilting and potential death
 G. Holmes, California Polytechnic State University, Bugwood.org





Characteristic white "ropey" fungal growth develops along with light brown survival structures (sclerotia)

G. Holmes, California Polytechnic State University, Bugwood.org














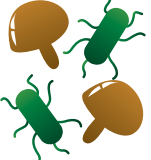
Survival structures may develop on the infected tissue or soil surface and resemble mustard seeds

P. Bachi, University of Kentucky Research and Education Center, Bugwood.org

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|---|--|
| <p>WHERE WILL I SEE SYMPTOMS?</p>  <p>STEM PODS</p> | <p>FAVOURABLE CONDITIONS FOR DISEASE DEVELOPMENT</p>  <p>WARM WET pH < 7 ACIDIC SOIL</p> <p>• 25-35°C</p> |
|---|--|

| | |
|--|--|
| <p>DISTRIBUTION IN THE FIELD</p> <p>SCATTERED</p> <p>Individual/small patches of infected plants</p>  | <p>HOW DOES IT SPREAD?</p>  <p>WIND MOVEMENT OF CONTAMINATED SOIL FREE WATER CONTAMINATED PLANT DEBRIS</p> <p>SURVIVAL TIME WITHOUT HOST 3-10 years</p> |
|--|--|

HOW DO I CONTROL IT?

| | | | | | |
|----------------------|---|--|--|---|--|
| FALLOW/COVER CROP | <p>FARM HYGIENE</p> <p>Stop movement of contaminated soil, water, plants and equipment</p>  | <p>HOST-FREE ZONE</p> <p>Control volunteer host plants and weeds</p>  | <p>CROP ROTATION</p> <p>Select non-host rotation or cover crops</p>  | <p>BIO FUMIGATION</p> <p>Grow a biofumigant crop</p>  | <p>IMPROVE SOIL HEALTH</p> <p>Add organic matter or amendments to boost beneficial microbes</p>  |
| PLANTING PREPARATION | <p>AIR CIRCULATION</p> <p>Increase row/plant spacing to improve air flow</p>  | <p>DRAINAGE</p> <p>Plant on raised beds or well-draining soil</p>  | <p>NO RESIDUE AT PLANTING</p> <p>Ensure no plant residues from host crops at planting</p>  | | |
| POST-PLANT | <p>IRRIGATION MANAGEMENT</p> <p>Monitor crop and soil to optimize amount and timing</p>  | <p>CHEMICAL TREATMENT</p> <p>Treat plant with registered foliar fungicide</p>  | <p>GOOD NUTRITION</p> <p>Ensure plants' nutritional needs are met</p>  | <p>BIOCONTROL PRODUCTS</p>  | |

- Consult APVMA or InfoPest website for current registered products

HOST RANGE

Very wide (more than 500 different plant species) including capsicum and chilli

VERTICILLIUM WILT

Verticillium dahliae

WHAT SHOULD I LOOK FOR?



Symptoms begin as pale green blotches between veins and leaf margins. Eventually leaf will wilt, turn brown and die as the disease moves up the plant; often only on one side of the plant

A. Vieira, Ontario Crop IPM, OMAFRA



Stunting of plants may also occur, as shown here with verticillium infected peppers on the right compared to healthy plants on the left



A. Vieira, Ontario Crop IPM, OMAFRA






Cutting open the stem reveals brown flecks of discoloured vascular tissue, often in a V-shape

A. Vieira, Ontario Crop IPM, OMAFRA

WHERE WILL I SEE SYMPTOMS?

 LEAVES
  STEM


FAVOURABLE CONDITIONS FOR DISEASE DEVELOPMENT

 WARM
• Air 23-25°C
Optimum for infection
  NUTRITIONAL IMBALANCE
  pH > 7
ALKALINE SOIL




DISTRIBUTION IN THE FIELD

SCATTERED

Individual/small patches of infected plants
















HOW DOES IT SPREAD?

 MOVEMENT OF CONTAMINATED SOIL
  FREE WATER
  CONTAMINATED PLANT DEBRIS

SURVIVAL TIME WITHOUT HOST
More than 10 years

HOW DO I CONTROL IT?

| | | | | | | |
|----------------------|---|--|--|--|--|--|
| FALLOW/COVER CROP | <p>FARM HYGIENE</p> <p>Stop movement of contaminated soil, water, plants and equipment</p>  | <p>CROP ROTATION</p> <p>Select non-host rotation or cover crops</p>  | <p>BIO FUMIGATION</p> <p>Grow a biofumigant crop</p>  | <p>SOIL SOLARISATION</p> <p>Cover soil with a tarp and kill harmful pathogens</p>  | <p>CHEMICAL FUMIGATION</p> <p>Always use with care and as per label</p>  | |
| PLANTING PREPARATION | <p>FERTILISER SELECTION</p>  | <p>IMPROVE SOIL HEALTH</p> <p>Add organic matter or amendments to boost beneficial microbes</p>  | <p>SOIL TEST</p> <p>Conduct a pre-sowing soil test to help predict level of risk</p>  | <p>CROP SELECTION</p> <p>Choose a resistant/less susceptible cultivar</p>  | <p>NO RESIDUE AT PLANTING</p> <p>Ensure no plant residues from host crops at planting</p>  | |
| POST-PLANT | <p>AVOID PLANT INJURY</p> <p>Avoid any physical damage to plant</p>  | <p>AVOID WATER STRESS</p> <p>Ensure plants receive adequate water</p>  | <p>GOOD NUTRITION</p> <p>Ensure plants' nutritional needs are met</p>  | | | |

• Consult APVMA or InfoPest website for current registered products

• Ammonium fertilisers help suppress disease

HOST RANGE

Eggplant, tomato, olive trees, brassica crops and weeds