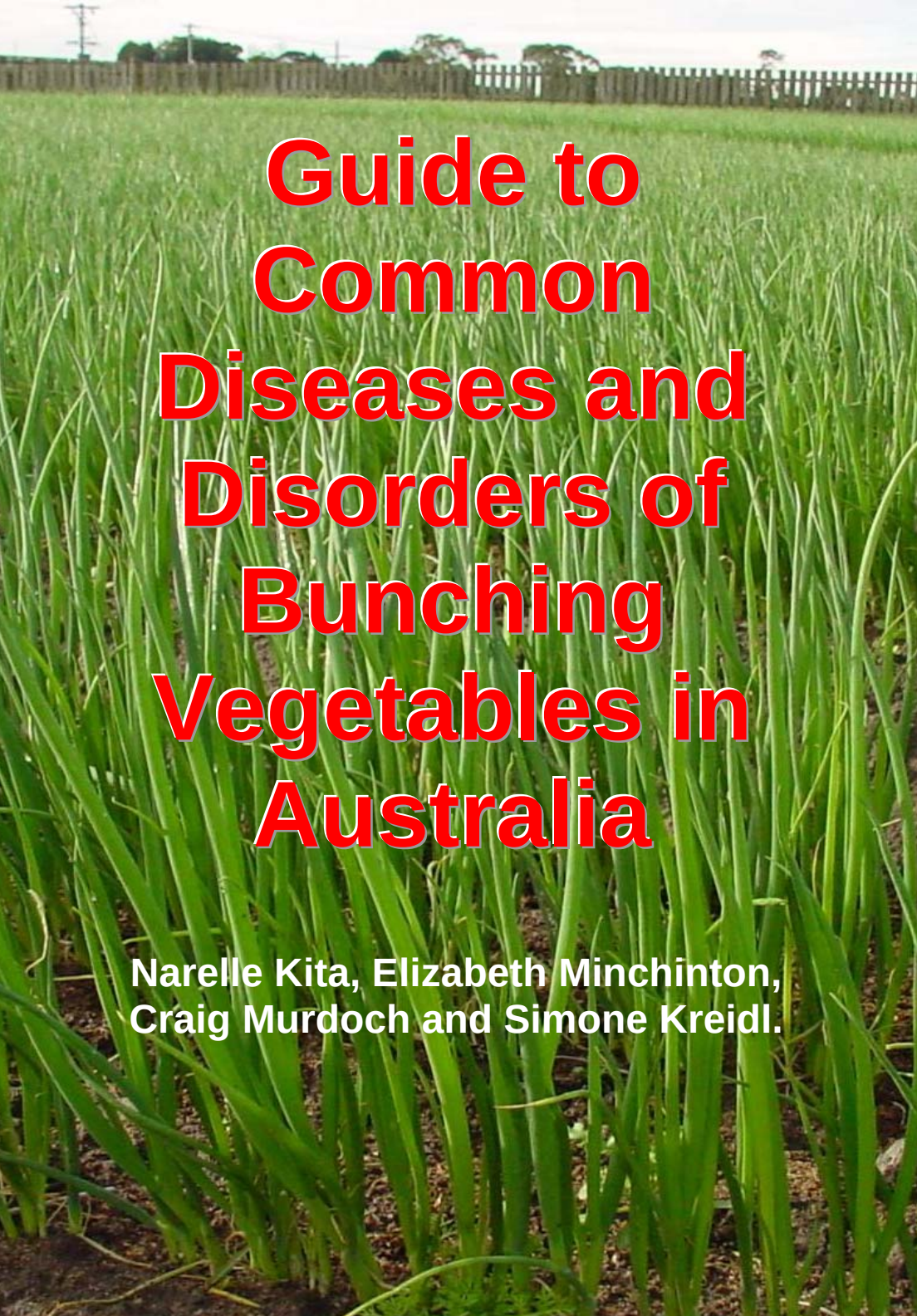

Guide to Common Diseases and Disorders of Bunching Vegetables in Australia

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Front cover: Spring onion field in Victoria.
Back cover: Portable picking shed on an A-frame.

Disclaimer:

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INTRODUCTION

This handbook is part of the project titled 'Disease management strategies for bunching vegetable growers' [Project VG01045] sponsored by the National Vegetable Levy, Horticulture Australia Limited and the Department of Primary Industries, Knoxfield, Victoria.

The diseases and disorders listed in this book are those which commonly occur on bunching vegetables in Australia. Many diseases have not been mentioned because they are either uncommon, or have not been recorded in Australia. The Appendix contains a list of diseases recorded on bunching vegetable lines in Australia. It should not be used for quarantine purposes without prior checking of current references.

When using this handbook it is important to realise that more than one disease can occur on plants at any one time. Also, symptoms are often difficult to distinguish and diagnostic tests may be required to identify pathogens accurately.

Note:

- **The chemical information contained in this book is accurate as of June 2003.**
- **The registration status of chemicals can change.**
- **Always check the label prior to use.**

Management strategy tips

- Where possible avoid watering plants in the evening as this may provide long hours of leaf wetness. Most spores need water to germinate and wet leaf surfaces to infect plants.
- A short, heavy watering is preferable to a long, light watering. If possible avoid overhead irrigation.
- Maintain good air-movement in the environment to lower humidity and thus reduce spore production and infection. This may mean running the rows in the direction of the wind and increasing plant spacing.
- Maintain a balanced program of nutrition.
- Implement/uphold good hygiene practices to avoid moving pests between properties.
- Remove sources of spores, such as volunteer plants and alternative hosts.
- Rotate with non-host crops and do not replant infested sites.
- Avoid sequential planting as fungi can move from older crops to younger crops.
- Avoid damage to the plant, as it may provide a point of entry for fungi and bacteria.
- Combine management practices with a registered fungicide spray program.
- When applying pesticides, implement disease resistance management strategies. Alternate fungicides from different groups of chemicals to avoid fungi developing resistance to fungicides.
- Control insect vectors with registered pesticides.
- Provide staff with a clear map of the property and number bays for easy identification of problem areas.

Leaf showing Phoma lingam leaf spots.

Black spore producing bodies in the centre of a Phoma lingam leaf spot.

BOK CHOY / PAK CHOY

Phoma leaf spot

Cause: The fungus *Phoma lingam*

Symptoms:
Spots on leaves are up to 2 cm in diameter, brown and round to oval. Small black pimple like specks are scattered over the leaf spots but are more pronounced in its centre. The disease is more common on older, lower leaves than younger leaves. The fungus also causes a dry rot of leaf petioles and stem bases. In advanced infections plants wilt and collapse.

Disease development:
Infested seed is the primary means of long-distance dissemination. Spores contained in the black spots are spread locally by wind, rain, crop debris, irrigation water and to a lesser extent by insects. Disease development on foliage is favoured by high relative humidity and temperatures of 15°C - 32°C.

Note:
Phoma lingam is the asexual state of *Leptosphaeria maculans* which causes the disease blackleg on Crucifers.

Control:
- No fungicides are registered as of June 2003 for Phoma leaf spot on bok choy.
- Avoid long hours of leaf wetness.

White blisters on undersurface of bok choy leaf.

Bunch of bok choy showing white blister.

Bok Choy

White blister

Cause: The fungus *Albugo candida*

Symptoms:
Light green spots form on the upper leaf surface and white round to oval blisters develop on the corresponding lower leaf surface. Blisters consist of masses of white dust-like spores.

Disease development:
See Radish White Blister.

Note:
The fungus occurring on *Brassica rapa* (e.g. Chinese cabbage formerly *B. chinensis* and bok choy formerly *B. pekinensis*) has been named as *Albugo candida* Race 7 and is largely confined to this genus and species.

Control:
- See Radish White Blister.

Bacterial leaf spots showing grey centres with purple margins.

BEET

Bacterial leaf spot

Cause: The bacterium *Pseudomonas syringae*

Symptoms:
Bacterial leaf spots are an irregular-round shape and have a grey centre surrounded by a purple margin. Symptoms can be easily confused with Cercospora leaf spot. The failure of fungicides to control these leaf spots also indicates that the symptoms are consistent with bacterial leaf spots and not with fungal leaf spots.

Disease development:
The bacterium can be seed borne. It can survive on plants and on crop debris in the soil. The bacteria are probably spread from the soil to plants or between plants by water splash. Wounding of plants caused by insects or farming practices is probably necessary for infection. The temperature for bacterial growth ranges from 2°C – 35°C with an optimum of 25°C - 30°C.

Control:
- Fungicides will not control this disease.
- No bactericides are registered for bacterial leaf spot on beet as of June 2003.
- Avoid long hours of leaf wetness.
- Avoid wounding plants.

www.inra.fr/Internet/Products/HYP3/images/6030824.jpg

Cercospora leaf spots on a red beet leaf (above), on a silver beet leaf (top right) and close up of spots (bottom right).

Cercospora leaf spot

Cause: The fungus *Cercospora beticola*

Symptoms:
Leaf spots begin as small brown, circular flecks, and on red beet have a pronounced purple border. Under humid conditions, needle like spores can be seen, with a magnifying glass, raised up above the spot. The centres of mature spots turn grey and often become so thin that the dead tissue drops out leaving a hole. As the disease progresses, spots increase in size and often coalesce producing a blighted appearance to leaves, followed by collapse of foliage.

Disease development:
The fungus can survive on beet seed, on weed hosts and on crop debris in the soil for up to 18 months. Favourable conditions for disease development are high temperatures ranging from 25°C - 30°C with night temperatures above 16°C and high humidity (90% - 95%) or long periods of leaf wetness.

Hosts:
Beet root, silverbeet, chard and weeds eg *Atriplex*.

Control:
- Incorporate crop debris well into to the ground.
- Establish new crops of beet well away from the previous crops eg 100m.
- Chemical control: use a product containing mancozeb, registered for control of Cercospora leaf spot on beet in your state. This information is current as of June 2003.

Close up of Phoma leaf spot.

Phoma leaf spot on red beet leaf.

Phoma leaf spot

Cause: The fungus *Phoma beta*

Symptoms:
Spots on leaves are up to 2 cm in diameter, brown, round to oval, with dark concentric rings near the perimeter. Small black raised dots, which contain spores, are found throughout the spots in concentric rings. Older, lower leaves are generally more susceptible to the disease than younger leaves. Phoma leaf spots are bigger in size compared with bacterial and Cercospora leaf spots.

Disease development:
Infested seed is the primary means of long-distance dissemination. Spores are spread locally by wind, rain, wind-blown plant debris, irrigation water and to a lesser extent, insects. Disease development on foliage is favoured by high relative humidity and temperatures of 15°C - 32°C.

Control:
- No fungicides are registered for Phoma leaf spot on beet as of June 2003.

Tip rot of taproot associated with Mycocentrospora.

Tap-root lesion.

Collar rot with split outer root.

Mycocentrospora on coriander showing stunting, yellowing and browning of leaves and rot of roots.

CORIANDER

Collar and root rot

Cause: The fungus *Mycocentrospora acerina*

Symptoms:
Plants are stunted, older leaves turn yellow then brown. The fungus causes a brown rot of the collar and taproot, which is often associated with a splitting of the outer root. Pythium was also isolated from the lateral roots of the coriander and there may be a disease complex between the two fungi.

Mycocentrosppora (*Centrospora*) is responsible for licorice post harvest rot of carrots and collar rot of celery in cold storage. It also causes anthracnose lesions (leaf spot formed of dead tissue) on stems and umbels of caraway, dill and parsnip.

Disease development:
Spores of the fungus survive in soil and can be dispersed in irrigation water. Mechanical damage to plants can promote the disease. Rotting of roots can occur at 0°C, but the optimum temperatures for fungal growth are 17°C - 20°C. The foliage version of the disease is promoted by long periods of leaf wetness and high nitrogen levels.

Control:
- No fungicides are currently registered as of June 2003 for *Mycocentrospora* on coriander.
- Avoid high plant densities.
- Avoid high nitrogen levels.

DUTCH CARROTS

Alternaria leaf blight

Cause: The fungus *Alternaria*

Symptoms:

The foliage of infected crops appears scorched (blighted) from a distance. Small brown water soaked spots, often surrounded by a yellow halo, form initially on older leaves and petioles. These may yellow, collapse and die. This symptom can be confused with bacterial leaf blight. The fungus also attacks seedling stems and upper roots at the soil line producing a post-emergence blight of seedlings, which is similar to damping off, cause by *Pythium*. It differs from *Pythium* damping off by having a drier decay of infected material.

Disease development:

The fungus can survive on seed, volunteer carrots, wild carrots, dead and dying carrot tissue and on carrot debris in the soil for less than one year. Spores are released in the morning as the humidity drops and then disseminated by wind or farming activities. Ideal conditions for infection are prolonged hours of leaf wetness and moderately warm temperatures.

Control:

- Avoid long hours of leaf wetness.
- A spray forecast model, based on leaf wetness and temperature is available for this disease on carrots.
- Contaminated seed can be treated with hot water (50°C for 20 min.) or with a fungicide seed dressing.
- Chemical control: use a product containing either mancozeb, metiram, zineb or cupric hydroxide that is registered for leaf blight on carrots in your state. This information is current as of June 2003.

Photograph courtesy of Violeta Taicevski Vic DPI

Yellowing of young leaves on celery caused by CeMV.

Photograph courtesy of Violeta Taicevski Vic DPI

CeMV on coriander.

Photograph courtesy of Violeta Taicevski Vic DPI

CeMV on parsley.

PARSLEY

Celery mosaic virus

Cause: The celery mosaic virus (CeMV)

Symptoms:
On young leaves the virus causes vein clearing and a yellow or light green coloured inter-veinal mottling. On mature foliage leaflets are narrow, twisted and mottled. Plants may be slightly stunted.

Disease development:
CeMV is not seedborne. The virus can be transmitted mechanically by farming practices and by many species of aphids, after they feed on an infected plant for 5 to 30 seconds. Sources of the virus are umbelliferous crop plants such as celery, carrot and dill as well as umbelliferous weeds. Sequential or overlapping crops are considered to be the most important source of the virus.

Control:
- Remove weed hosts.
- In severe infections implement a host-free period for 1 to 3 months.
- Fungicides will not control viral diseases.

Leaves of flat parsley (above) and curly parsley (left) showing Septoria leaf blight.

Parsley

Leaf blight (rust)

Cause: The fungus *Septoria petroselini*

Symptoms:
Small round-shaped lesions, greyish brown in colour surrounded by a dark brown to red margin are produced on the leaf surface and occasionally on the petioles. As the disease progresses, the foliar tissue becomes yellow and finally dies.

Disease development:
The disease cycle and epidemiology of this pathogen is not well understood. However, the fungus can be seed-borne, and losses of both yield and quality have been reported. The fungus may over-winter on diseased parsley plants. It is spread by wind, rain, irrigation water and workers and machinery moving through wet foliage. The disease occurs on both flat and curly parsley.

Note:
The disease is often called rust by growers, but it is not caused by a true rust fungus.

Control:
- Avoid long periods of leaf wetness.
- No fungicides are currently registered for Septoria leaf blight on parsley as of June 2003.

Photograph courtesy of Julia Telford, IDO Vegetables Qld.

Rot of lower taproot.

Wilt, drop and bleaching of parsley leaves above and rot of taproot below, caused by Erwinia.

Photograph courtesy of Julia Telford, IDO Vegetables Qld.

Leaf drop

Cause: The bacterium *Erwinia.*

Symptoms:
Infected plants may be stunted. Leaves wilt, drop to the ground around the shoot and turn white. A soft watery rot of the taproots occurs along their length making it difficult to remove the root system intact.

Disease development:
Little is known of this disease on parsley. The bacterium is ubiquitous in soils. It most likely survives in crop debris in the soil and is common in surface water sources. Bacteria enter plants through wounds and natural openings. Leaf drop and its associated root rot appear to be triggered by warm temperatures, excessive soil moisture and or mechanical damage to roots.

The photographs opposite show leaf drop on parsley in the tropics after 6 weeks of rain. It is not known if the bacterium *Erwinia* is the primary or secondary cause of parsley leaf drop.

Control:
- No bactericides are currently registered for leaf drop on parsley as of June 2003.
- Avoid over irrigation of soil.

White blisters on underside of radish leaf (above) and on the upperside of a leaf (left).

RADISH

White blister (rust)

Cause: The fungus *Albugo candida*

Symptoms:
Yellow to brown spots form on the upper surface and white, round to oval blisters develop on the corresponding under leaf surface. The blisters consist of masses of white dust-like spores. Badly infected leaves will initially become misshapen, then wilt and die.

Disease development:
The fungus can survive on seed and in crop debris as oospores. Spores produced on the underside of leaves survive for only a few days and are spread by wind, rain and insects. Spores germinate over the temperature range of 1°C - 20°C. Water in the form of dew, fog or rain on leaves, combined with temperatures in the range from 10°C - 25°C favour disease development. The fungus can release its spores and infect plants at anytime of the day or night. The optimum conditions for disease development are 3 hours of leaf wetness at 20°C.

Control:
- No fungicides are currently registered for white blister on radish, however Crop Protection Approvals are currently conducting work with a view to registration of fungicides.
- Avoid long hours of leaf wetness by not irrigating at night (8pm-12pm).

Note: *Albugo candida* Race 1 occurs on *Raphanus sativa* and is largely confined to this genus.

Parsley seedlings showing damping off.

SEEDLINGS

Damping off

Cause: The fungus *Pythium* spp.

Symptoms:

There are two forms of damping off, pre-emergence and post-emergence. The symptoms of pre-emergence damping off are poor crop emergence due to lack of seed germination or seed germinating but seedlings failing to emerge. Post-emergence damping off symptoms can consist of seedlings bending over at a 90° angle to the ground, roots turning dark brown, plants appearing stunted and taproots developing dark patches with laterals often missing. As the disease progresses leaves turn yellow and eventually die back. Younger plants are more susceptible. Badly affected plants may eventually die.

Disease development:

The pathogen can survive for long periods in the soil due to the thick-walled structure of the spore. Plant roots produce exudates under favourable conditions, such as high levels of soil moisture, and this triggers germination of the soil-borne spores. The disease can be spread in water, infecting neighbouring plant roots.

Host Range:

Most seedlings eg. carrot, coriander, radish, spring onions or shallots.

Control:

- Plant into well drained ground.
- No fungicides are currently registered, as of June 2003, for damping off on vegetables.
- Fumigation, as a pre-plant treatment is an option for controlling soil borne diseases.

Under surface of spinach leaves with downy mildew.

SPINACH

Downy mildew

Cause: The fungus *Peronospora farinosa* f. sp. *spinaciae*

Symptoms:
The disease begins as indefinite yellowish areas on the upper leaf surface with a corresponding greyish-violet mat on the lower leaf surface. As the disease develops the lesions enlarge until the whole leaf is affected, at which point it will turn black and die. During wet weather, the infected leaves become water soaked, quickly change to a yellow-brown colour and rot. Plants that survive infection are usually stunted in growth and leaves have a creamy-yellow and wrinkled appearance.

Disease development:
The pathogen is able to over-winter in living plants, in seed for two years and in the soil for about one year. Germination requires wet leaf surfaces and a temperature of about 9°C. A period of 6-7 days at 70-90% relative humidity and 16-24°C is required from the time of infection until spores are produced. Spores produced on leaves survive for about 2 days and may lose viability when exposed to sunlight.

Control:
- Chemical control: use a product containing either copper oxychloride, copper hydroxide, tribasic copper sulfate, copper as cupric hydroxide or mancozeb that is registered for control of downy mildew on spinach in your state. This information is current as of June 2003.
- Avoid long periods of leaf wetness.

Plants showing dieback of older leaves and yellowing of central leaf.

Grey spots or streaking surrounded by brown margins with a wet appearance.

SPRING ONIONS

Bacterial spot

Cause: The bacteria *Pseudomonas syringae*

Symptoms:
Infected tissues develop lesions, which are pale yellow to light brown in colour and have a water-soaked appearance around the margins. As the disease develops, the lesions elongate to an oval shape. Lesions may fuse together as multiple infection sites, affecting whole leaves causing the outer leaves to wither and die. The youngest leaf on an infected plant turns a lemon to light green colour.

Disease development:
Bacteria enter plants through wounds or natural openings. The disease is most common in areas of high rainfall or in wet spots caused by excessive overhead irrigation, or in association with mechanical injury caused by overcrowding, barnyard grass, machinery or workers. Significant crop losses have been reported during summer in Victoria but the disease can also be found at low levels during winter.

Note: The bacterium also infects leeks causing bacterial blight, which appears as a brown streaking on the shank.

Control:
- Avoid excessive overhead irrigation.
- Remove barnyard grass (*Echinochloa crus-galli* and *E. colona*) from crops.
- No bactericides are registered for bacterial spot on spring onions, as of June 2003.

Yellow and green striping on foliage of a chimera affect spring onion

Chimera

Cause: Genetic abnormality

Symptoms:
Often confused with symptoms induced by plant pathogens or abiotic factors, chimeras are leaf variegations, which may appear as linear or mosaic patterns of green, yellow, or white tissue. Variegation may be expressed on individual leaves or whole plants and may affect the development of the plant.

They occur during cell division when all the chloroplasts stay in one daughter cell instead of being distributed between the two daughter cells. The cultivar Paragon often throws a chimera plant.

Grey-violet growth of early downy mildew.

Leaves infected with downy mildew curl downward.

Downy mildew

Cause: The fungus *Peronospora destructor*

Symptoms:
Downy mildew first appears on leaves as pale green, elongate patches, which develop a greyish-violet, furry growth containing spores and spore-producing structures. Later, unreleased spores turn black and other fungi, such as *Alternaria* or *Stemphylium* may invade lesions. Infected leaves curl downward, shrivel, collapse and die.

Disease development:
Severe disease outbreaks occur with cool foggy weather and dewy nights. Spores are produced on foliage overnight and released during the morning. These spores can survive for 1 to 3 days and are spread by wind and rain splash. The fungus is not considered to be seed-borne in spring onions. Dry weather with relative humidity less than 80% and temperatures less than 4°C or greater than 24°C inhibits fungal growth.

Control:
- An increase in potash (K) has been shown to reduce the susceptibility of onions to downy mildew.
- Avoid overhead irrigating especially from 8pm - 12pm.
- Chemical control: use a product containing either mancozeb, copper ammonium acetate, copper oxychloride, cuprous oxide, cupric (II) hydroxide, mancozeb and cupric (II) hydroxide, mancozeb and metalaxyl-M, mancozeb and metalaxyl, dimethomorph, dimethomorph and mancozeb, zineb and propineb or benalaxyl and mancozeb, that is registered for control of downy mildew on spring onions (shallots) in your state. This information is current as of June 2003.

Basal plate rot on spring onion seedlings.

Fusarium basal plate rot

Cause: The fungus *Fusarium oxysporum*

Symptoms:
The disease first appears as curving, yellowing and death of leaf tips, which progresses downwards. The basal stem plate may show a brown discolouration, root growth is sparse, and infected plants may wilt. Plants eventually rot leaving bare patches in the crop. Plants can be affected at any age.

Disease development:
The fungus is commonly found in soils where onions are grown and where soil temperatures do not fall below 15°C. The optimum soil temperatures for disease development are 25°C - 28°C. Mechanical or insect injury increases incidence of the disease. Spores are present in the soil and machinery is a common means of spore dissemination.

Control:
- No fungicides are registered for Fusarium basal plate rot on onions, as at June 2003.
- Avoid mechanical or insect injury to plants.
- Avoid over-irrigation of soil.

Spring Onions

Hail damage

Cause:
Plants are often damaged during strong winds and storms as soil particles, wind-driven sand, hailstones and raindrops strike and injure the exposed leaves.

Symptoms:
Damage is usually limited to the side of the plant, which was physically impacted. Symptoms consist of pale yellow or white spots or flecks. Injury sites may vary in size and shape and are a key entry point for fungi and bacteria.

Hail damage on leaves.

Herbicide damage

Cause:
Temporary or permanent damage can result from the improper use of herbicides. The most common causes include:

- Carryover of chemical residues
- Application at excessive rates
- Application at the incorrect stage of plant development
- Improper mixtures or concentrations of adjuvants.

Symptoms:
Symptoms of herbicide damage can consist of sunken, white, bleached or dead spots, atypical plant growth (leaf curling or twisting) or tip die-back. Generally, plants with herbicide injury recover, and symptoms do not appear on new growth.

Herbicide damage on spring onion leaves.

http://plant-disease.ippc.orst.edu/disease.cfm?RecordID=1368

Field of bulb onions with IYSV (above).

http://www.colostate.edu/Depts/CoopExt/TRA/PLANTA/iysv.html

Close up of some IYSV symptoms.

Iris Yellow Spot Virus

Cause: Iris Yellow Spot Virus

Symptoms:
The disease appears as straw-coloured, dry, diamond-shaped lesions on the leaves of onion plants. Some lesions appear as concentric rings of alternating green and yellow/tan tissue, while others have distinct green centres with yellow or tan borders. Tops of infected plants turn brown, die and fall over. Infected plants may be scattered throughout a field or the whole crop can be infected.

Disease development:
Tospoviruses are only spread by onion thrips. Western flower thrips are not known to carry this virus. The IYS virus is not seed borne and does not carry over in the soil. It does not move from the leaves into the bulb or roots. Volunteer plants from a previous season can carry the virus. A survey of Victorian spring onion crops during summer and autumn of 2003 did not detect the disease.

Control:
- Remove volunteer plants.
- Control onion thrips.
- Do not apply fungicides, as they will not control this viral disease.

Olive brown lesions of Stemphylium leaf blight covered in black spores.

Leaf blight

Cause: The fungus *Stemphylium vesicarium sp.*

Symptoms:
This fungus is usually found co-infecting with *Alternaria porri* and symptoms are very similar to purple blotch. However, Stemphylium leaf blight lesions appear to be a darker, more olive-brown to black in colour than purple blotch lesions. Lesions have a water-soaked appearance and are initially small and light yellow to brown in colour. Lesions often coalesce into long patches, which may reach the leaf tips. These lesions turn a dark brown to black colour when spores are produced.

Disease development:
The fungus normally invades dead, dying or injured onion tissue i.e. dead leaf tips, purple blotch and downy mildew lesions. Lesions are most often seen on the side of the leaf facing the prevailing wind. Optimum conditions for disease development are warm, rainy weather, lasting for more than 24 hours. This fungus causes only minimal damage when plants are healthy.

Control:
- Maintain a balanced program of nutrition.
- Avoid long hours of leaf wetness.
- No chemicals are registered for Stemphylium leaf blight on spring onions, as at June 2003.

www.plantpathology.tamu.edu/Texlab/Vegetables/onions/opb.htm

Purple blotch

Purple blotch

Cause: The fungus *Alternaria porri*

Symptoms:
Lesions first develop on older leaves as small water-soaked spots, which rapidly develop white centres. They quickly enlarge and develop a purple margin surrounded by a yellow zone that extends along the leaf. Concentric light and dark zones later appear over the purple area. Under moist conditions brown spores develop on the lesion surface. Infected leaves will often turn yellow and droop, and in severe cases exhibit dieback.

Disease development:
This disease can quickly spread. The optimum temperature for fungal growth is 25°C with a range of 6°C - 34°C. Spores are produced at night when relative humidity is greater than 90%. They are released into the atmosphere during the early morning (7am-10am) and dispersed by wind, rain, irrigation and spray operations. Purple blotch symptoms appear 1-4 days after infection. The fungus can survive on seed and in crop debris. The former is considered unimportant for fungal dispersal.

Control:
- Avoid long hours of leaf wetness.
- Chemical control: Use a product containing either mancozeb, mancozeb/copper as cupric hydroxide, zineb,. dimethomorph, dimethomorph/mancozeb, mancozeb/metalaxyl, mancozeb/metalaxyl-M or benalaxyl/mancozeb that is registered for purple blotch on spring onions in your state. This information is current as of June 2003.

Yellow rust pustles on leaves typical of early season symptoms.

Photograph courtesy of Dean Metcalf DPIWE Tasmania

Black rust pustles, typical of late season symptoms.

Spring Onions

Rust

Cause: The fungus *Puccinia allii*

Symptoms:
Early symptoms are small white to yellow spots or flecks on leaves that turn yellow to orange as spores are produced in the leaf tissue. Later in the season, dark brown to black spores may form in the pustules. Heavily infected leaves turn yellow and may collapse prematurely.

Disease development:
Weather conditions conducive to outbreaks of rust are low rainfall, 100% relative humidity and temperatures in the range of 10°C - 15°C. While temperatures above 24°C and below 10°C inhibit the fungus. Stressed plants eg. those that are too wet or too dry, or those exposed to excessive nitrogen are more susceptible to the disease.

Control:
- Avoid excessive nitrogen.
- Maintain a balanced irrigation regime and avoid conditions which are too wet or too dry.
- Avoid growing onion and leek crops in the same vicinity.
- No fungicides are currently registered, as of June 2003, for rust (*P. allii*) on spring onions.

Close up of white rot on spring onions (top) and in a field (above).

White rot

Cause: The fungus *Sclerotium cepivorum*

Symptoms:
The first above ground symptoms are a yellowing and dieback of the leaf tips, followed by a collapse of the affected leaves. A soft rot gradually destroys the roots making the plants easy to uproot. A white, fluffy mould (the fungal mycelium) forms on roots and masses of tiny black spherical bodies (sclerotia) form within it. Plants tend to die out in patches.

Disease development:
The sclerotia enable the fungus to remain dormant in the soil for 30 years or more, even in the absence of onion plants. Disease severity depends on sclerotia levels in the soil at planting. Disease can be initiated by one sclerotium per 10 kg of soil and 10-20 sclerotia per kg of soil can result in infection of all plants. Cool soil conditions (14°C – 19°C) and low moisture favour disease development. The disease spreads from plant to plant through root contact. Plant losses become more widespread with each subsequent planting of an *Allium* crop. Sclerotia spread the disease quickly in the field by workers, tools, machinery, or run-off water.

Control:
- Implement good hygiene practices.
- Chemical control: use a product containing procymidone that is registered for control of white rot on spring onions in your state. Note it can be registered as either a seed treatment, in furrow treatment or as a soil spray. This information is current as of June 2003.

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APPENDIX:

Index of pathogens on bunching vegetables

Host scientific name	Host common name	Pathogen	Disease
Allium cepa	bulb onion	*Alternaria alternata*	black bulb scale leaf
		Alternaria porri	purple blotch
		Aspergillus niger	black mould
		Botrytis allii	neck rot
		Botrytis cinerea	foliage blight
		Botrytis squamosa	neck rot and foliage blight
		Collecocrichum circianans	smudge
		Colletotrichum dematium	smudge
		Erwinia carotovora	bacterial soft rot
		Fusarium	basal rot
		Fusarium oxysporum	root rot
		Macrophomina phaseolina	on bulb scale
		Onion yellow dwarf virus	yellow dwarf
		Penicillium sp	blue mould
		Peronospora destructor	downy mildew
		Phoma	leaf tip necrosis
		Phytophthora sp	shanking
		Pleospora herbarum	leaf spot
		Pseudomonas alliicola.	slippery skin
		Pseudomonas cepacea	sour skin
		Pseudomonas gladioli	soft rot
		Pseudomonas sp.	bulb scale disorder
		Pyrenochaeta terrestris	pink rot
		Pythium	damping off
		Rhizoctonia solani	damping off
		Rhizopus stolonifer	storage rot
		Sclerotium cepivorum	white rot
		Stemphylium botryosum	black leaf mould
Allium fistulosum	spring onion	*Puccinia allii*	rust
Beta vulgaris	silver beet, red beet	*Agrobacterium tumefacians*	crown gall
		Alternaria sp	leaf spot
		Beet mosaic virus	beet mosaic
		Beet western yellows virus	yellows of sugar beet
		Beet yellow virus	beet yellows

Host scientific name	Host common name	Pathogen	Disease
		Cercospora beticola	leaf spot
		Colletotrichum sp	anthracnose
		Cucumber mosaic virus	cucumber mosaic
		Erwinia carotovora	bacterial soft rot
		Fusarium oxysporum	root rot, wilt
		Fusarium sp	root rot
		Leptosphaerulina trifolii	petiole spot
		Microdochium tabacimum	root rot
		Oidium sp	powdery mildew
		Peronospora destructor	downy mildew
		Peronospora farinosa	downy mildew
		Phoma betae	stem rot and leaf spot
		Phyllosticta sp	leaf spot
		Pleospora betae	black leg, damping off
		Polymixa betae	club root
		Pythium sp	damping off
		Ramularia beticola	leaf spot
		Ramularia sp.	leaf spot
		Rhizoctonia solani	damping off, crown and root rot
		Sclerotinia sclerotiorum	cottony rot
		Sclerotinia sp	crown rot
		Sclerotium rolfsii	crown rot
		Septoria betae	leaf spot
		Streptomyces scabies	scab
		Subterranean clover red leaf virus	yellows of sugar beet
		Ulocladium atrum	leaf spot
		Uromyces betae	rust
		Uromyces beticola	rust
Brassica rapa (chinensis)	Chinese cabbage	*Albugo candida*	white blister
Brassica pekinensis Rupr.		*Alternaria alternata*	leaf spot
Brassica campestris		*Alternaria brassicae*	leaf spot
L. var chinensis		*Alternaria brassicicola*	leaf spot
		Alternaria sp.	leaf spot
		Cauliflower mosaic virus	mosaic
		Cercosporella brassicae	white spot
		Erwinia sp.	soft rot
		Leptosphaeria maculans	canker, black leg
		Oidium sp.	powdery mildew

Host scientific name	Host common name	Pathogen	Disease
		Peronospora parasitica	downy mildew
		Phoma lingam	canker, black leg
		Plasmodiophora brassicae	club root
		Potyvirus sp	
		Pseudocercosporelle capsellae	leaf spot
		Pythium sp.	damping off
		Turnip mosaic virus	
Coriandrum	coriander	*Alternaria* sp.	flower & leaf blight
		Centrospora acerina	root dieback
		Botrytis cnerea	flower wilt
		Stemphylium sp.	leaf spot
		Septoria sp.	leaf spot
		Septoira petroselini	stem, leaf lesions
		Sclerotinia sclerotiorum	stem rot and leaf spot
		Itersonilia perplexans	Leaf & flower blight
Daucus carota	carrot	*Agrobacterium rumefaciens*	crown gall
		Alternaria dauci	leaf blight
		Alternria radicina	Black rot
		Armillaria sp.	root rot
		Botrytis cimerea	grey mould
		carrot mottle dwarf virus	mottle dwarf
		carrot mottle virus	mottle dwarf
		carrot red leaf virus	mottle dwarf
		Cercospora carotae	leaf spot
		Cylindrocarpon sp	skin blemish
		Erwinia carotovora pv carotovora	soft rot
		Fusarium avenaceum	root rot
		Fusarium solani	root lesions
		Fusarium sp	root rot, black root rot, surface pitting
		Fusarium vencricosum	root rot
		Geotrichum canidium	root rot
		Phoma sp.	root rot
		Phytophthora megasperma	soft rot
		Phytophthora megasperma var. *sojae*	root rot
		Pythium sp	core rot
		Pythium ultimum	root rot
		Rhizoctonia sp	crown rot
		Rhizopus sp	storage rot

Host scientific name	Host common name	Pathogen	Disease
Petroselinum crispum	parsley	*Fusarium oxysporum*	root lesions
		Microdochium tabacinum	Root rot
		Phoma sp.	leaf blight
		Pseudomonas sp.	leaf spot
		Rhizoctonia solani	root lesions
		Sclerotinia minor	stem rot
		Septoria petroselini	leaf spot
Spinacia oleracea	spinach	Cucumber mosaic virus	cucumber mosaic
		Erwinia carotovora	bacterial soft rot
		Fusarium oxysporum	wilt
		Fusarium sp.	root rot
		Peronospora farinosa	downy mildew
		Phytophthora cryptogea	root rot
		Pythium sp.	root rot
		Rhizoctonia sp.	root rot
		Spinach yellows virus	spinach yellows