Wine Australia for Australian Wine

Best practice management guide — Version 2.0 · July 2019

Grapevine trunk disease

Introduction

Eutypa dieback (ED) and botryosphaeria dieback (BD), caused by species of fungi in the *Diatrypaceae* and *Botryosphariaceae* families, respectively, are major grapevine trunk diseases (GTDs) worldwide. Spores of the causal fungi infect vines through pruning wounds and colonise wood, causing dieback and eventual vine death. In the case of the primary ED pathogen *Eutypa lata* (*E.lata*), shoots become stunted and leaves yellow and distorted. Due to the predominance of susceptible cultivars and ageing vineyards, trunk diseases are becoming more prevalent in Australia, threatening the wine sector which contributes $40 billion to the Australian economy. GTDs can be managed by physically removing infected wood and renewing vines from watershoots that emerge from lower, uninfected parts of the vine. Wound treatments can then be applied post-pruning to reduce the likelihood of new infections.

5 key facts

- Caused by fungi that are spread by airborne spores.
- Spores are released from infected dead wood during rainfall.
- Spores infect exposed pruning wounds and the fungus progressively kills spurs, cordons and trunks.
- Wounds are most susceptible to infection in the first 2 weeks after pruning.
- Disease control can be achieved using wound treatments and remedial surgery.

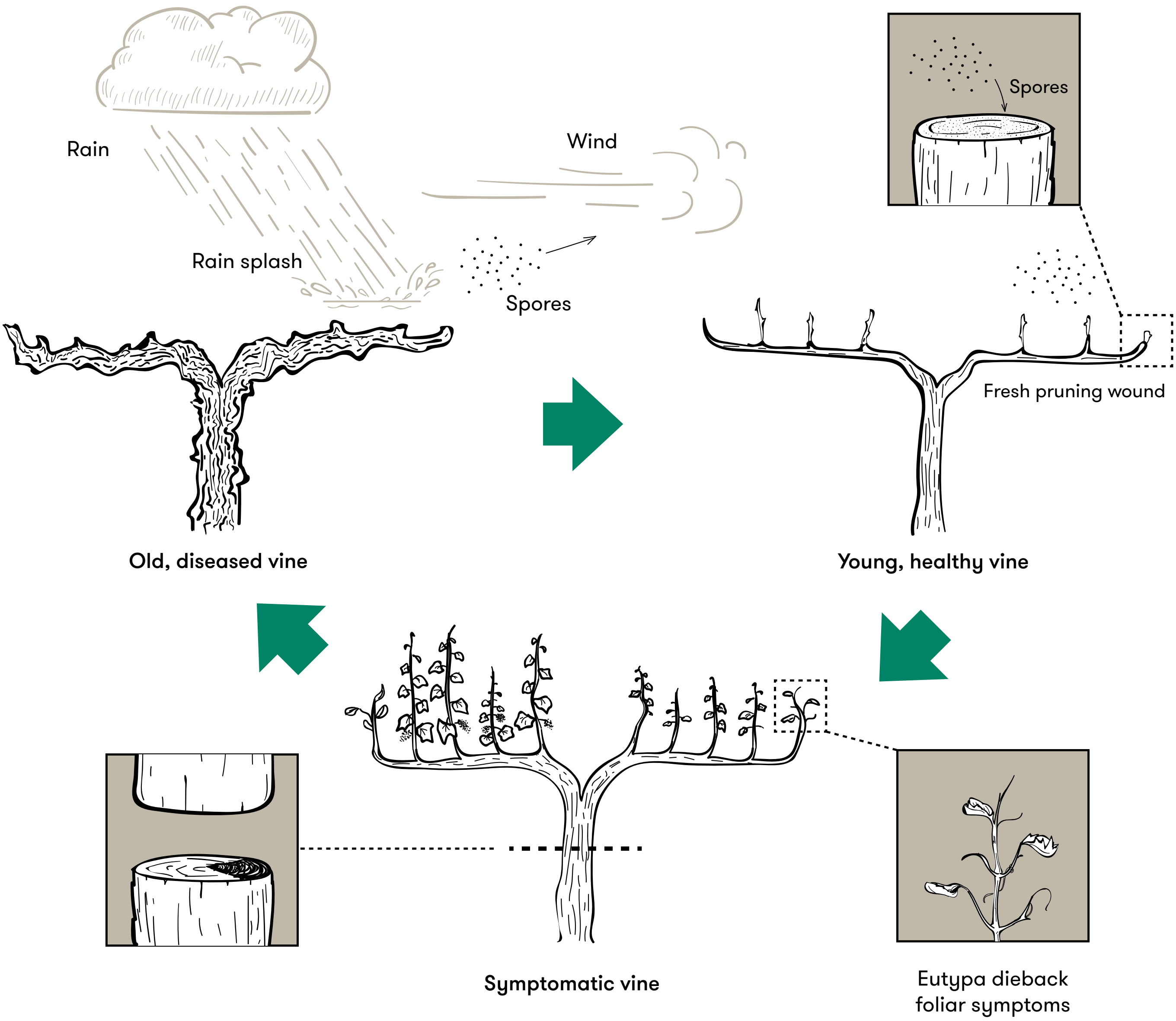

Figure 1. Disease cycle of eutypa and botryosphaeria dieback.

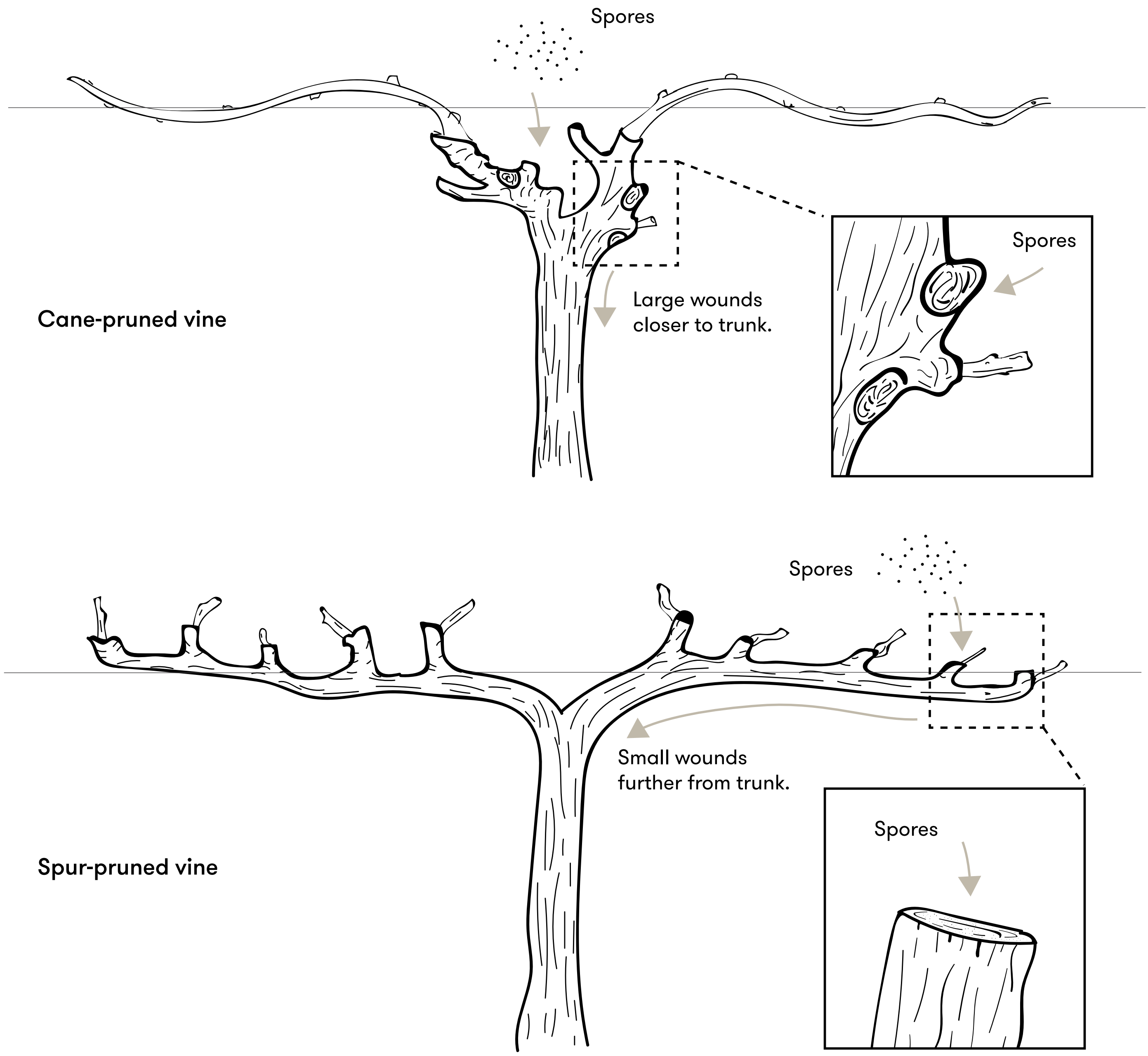

Figure 2. Spur- and cane-pruned vines, showing wound size and proximity to trunk, which affect the progression of eutypa and botryosphaeria dieback.

Disease cycle

The disease cycles of ED and BD are very similar and are illustrated in Figure 1. Spores are released from old, infected wood within 2 hours of wetting by rain or irrigation, and continue to be released for up to 36 hours after rain has stopped. Occasionally, spores have been detected up to 2 weeks after a rainfall event. Spores are not always detected on days with rainfall, possibly due to the delay of 12 days before a new generation of spores is produced in fruiting bodies, ready for release. Spores of *E. lata* can be carried by wind up to 50 kilometres (km) from the source to infect open wounds, whereas spores of BD pathogens are carried predominantly by rain splash for much shorter distances within a vineyard, but have been detected in spore traps located 20 metres (m) from infected vines.

Spores land on open wounds (e.g. pruning cut) and germinate within the woody tissue. The fungi then grow, killing tissue and reducing the transport of water and nutrients to the foliage. In canes that are 1–2 years old, ED and BD pathogens have been reported to advance by as much as 20 cm in a year and, furthermore, pathogens have been recovered up to 20 centimetre (cm) ahead of any visible staining. In older wood of cordons and trunks, dieback has been reported to advance up to 8 cm per year for both ED and BD pathogens. *E. lata* grows to the base of the trunk but not into the roots.

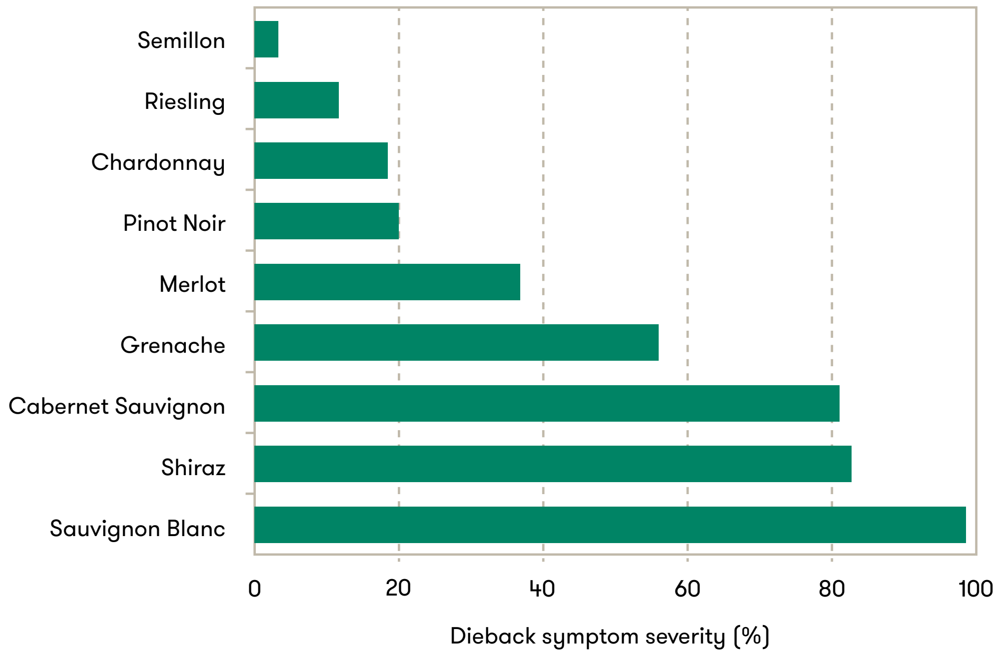

Figure 3. Mean severity of dieback (% of vine affected) observed over two seasons in 30–35 year old vines of commonly grown varieties (at the Nuriootpa Research Centre, South Australia). Causal pathogens of both ED and BD were isolated from symptomatic vines. Symptom severity on all varieties assessed is listed in Appendix 2.

Predisposing factors

Wound size and pruning time influence susceptibility of the vine to infection. Large wounds, typically on older vines, provide a greater surface area for spores to land on, take longer to heal and are considered more vulnerable to infection than small wounds on young vines. Mature spur-pruned vines have been reported to have greater incidence of dieback and foliar symptoms but lower mortality than that of mature cane-pruned vines. This may be due to a greater number and surface area of wounds on spur-pruned vines but, as wounds on cane-pruned vines are larger and closer to the crown, the fungus could rapidly spread into the trunk and eventually kill the vine (Figure 2).

Dispersal of spores of ED and BD pathogens is sporadic, can occur at any time of the year and varies between regions, season and years. In temperate climates, ED and BD spores are primarily detected in late winter and early spring while in sub-tropical climates, a high number of spores are also detected over summer. Spores are generally detected during or immediately after rain.

Wounds are most susceptible to infection by ED and BD pathogen spores immediately after cuts are made, and susceptibility decreases to low levels within 2–3 weeks, indicating this to be the most important period for wound protection. Wound susceptibility varies little throughout the pruning season.

Research indicates that water deficit may not increase the susceptibility of grapevine canes to pruning wound infection and colonisation by trunk disease pathogens and, for ED, there is evidence of decreased susceptibility to colonisation in vines under severe water deficit. This suggests that drought and deficit irrigation practices are not likely to contribute to the increased prevalence of trunk disease.

Alternative hosts

Eutypa lata is known to infect 88 perennial plant species, including fruit trees such as apricot, peach, nectarine, plum, cherry, apple, pear, quince, lemon, fig, olive and walnut (Appendix 1). In stone fruit, disease symptoms appear as gummosis. *E. lata* has not commonly been recorded on Australian native plants. Other *Diatrypaceae* species that cause ED have a wide host-range, but they often exist as saprophytes on other plant species. *Botryosphaeriaceae* species that cause BD are ubiquitous in the environment and can infect and cause disease on a wide range of annual and perennial plant species, including Australian native species. Dead, diseased branches of alternative host plants may provide a source of spores for nearby vineyards.

Varietal susceptibility

All wine grape varieties are susceptible to infection by ED and BD pathogens but symptoms can vary, and are most pronounced in the commonly planted Sauvignon Blanc, Shiraz and Cabernet Sauvignon (Figure 3; Appendix 2). Furthermore, recent observations have revealed variation in expression of symptoms among clones of the same variety. Inoculation of wounds with ED and BD pathogens has confirmed that the extent of colonisation in canes varies among varieties and rootstocks, including scions of the same variety grafted onto different rootstocks. There is evidence that lignin content and xylem vessel diameter may influence the susceptibility of varieties to infection by trunk disease.

Figure 4. Distribution of eutypa dieback in Australia. Botryosphaeria dieback occurs in most wine regions of Australia.

Distribution

ED and BD occur worldwide. In Australia, surveys have confirmed the presence of ED on grapevines in South Australia, Victoria, Tasmania and southern New South Wales (Figure 4). BD occurs in most wine regions of Australia, and is most common in the warm climatic regions of Western Australia and New South Wales.

Impact of eutypa dieback

Dieback has been recorded on vines as young as 5 years in south-eastern Australia (Figure 4), and ED foliar symptoms on vines as young as 7 years. It can take three to eight years for foliar symptoms to appear after infection has occurred, suggesting that infections may occur from the first year of pruning. Therefore, it is important to protect pruning wounds from infection from the first pruning season.

Incidence of symptoms increases with age, with some vineyards recorded to have more than 80 per cent of vines symptomatic by 15–20 years of age (Figure 5). As vines age, they are more likely to become infected via successive pruning or reworking events, and symptoms become more severe as the fungus progressively colonises the wood of infected vines. However, some older vineyards have little dieback, which may be due in part to varietal susceptibility but also the result of effective disease management.

Yield loss due to ED in Shiraz was estimated at 0.8 tonnes per hectare (t/ha) where 30% of vines displayed some level of foliar symptoms. For vineyards with 50 per cent incidence, this increased to 1.5 t/ha and could be as high as 2.6 t/ha at 80 per cent foliar symptoms (Figure 5).

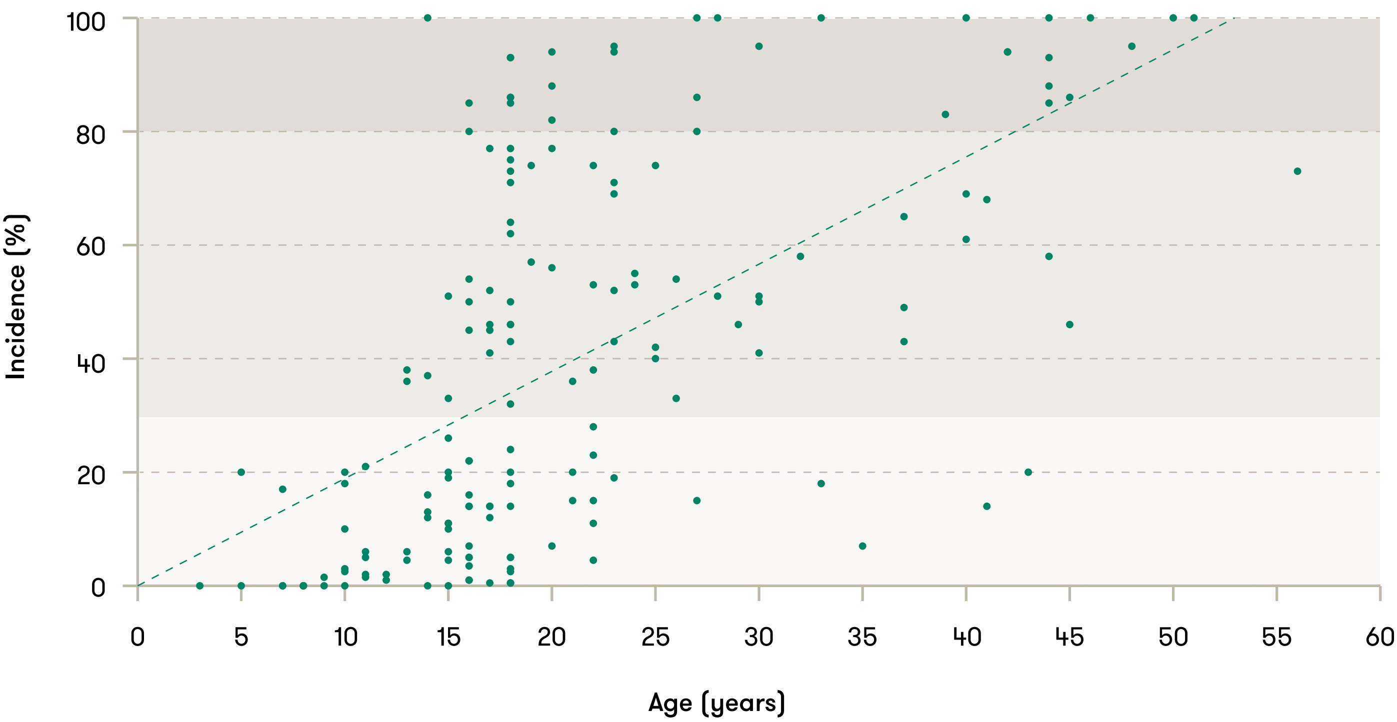

Figure 5. The effect of vine age on incidence of vines with dieback symptoms (at least one spur with stunted shoots or two dead spurs) in a survey in south-eastern Australia in 2012. Shading indicates level of impact on production (dark grey: high >2.6 t/ha, grey: medium 0.8–2.6 t/ha, light grey: low <0.8 t/ha).

Disease monitoring

Symptoms

Foliar symptoms
Eutypa dieback is characterised by distinctive foliar symptoms, which are caused by toxic metabolites produced by *E. lata* in the wood and translocated to the shoots. Thus, the fungus cannot be isolated from green shoots. Foliar symptoms include yellowing and stunted shoots with leaves often cupped and with dead margins (Figure 6 a–d). Foliar symptoms can appear three to eight years after infection, and symptom severity can vary from year to year. These foliar symptoms are not associated with BD, but green shoots can be infected by BD fungi (Figure 6 e). Eutypa dieback foliar symptoms can be confused with other damage including herbicide effects, salt toxicity, earwigs, frost and mites (Figure 7).

Cordon and trunk symptoms
In the case of both ED and BD, the fungus enters via a pruning wound and kills the woody tissue around the infection point (usually a spur), then kills other spurs along the cordon as it progresses toward the base of the trunk (Figure 8 a–b). If bark is peeled back, stained brown (dead) wood can be seen extending towards the trunk (Figure 8 c) and appears as a wedge if the trunk is cut in a cross-section (Figure 8 d).

On trunks, cankers are evident as the bark will fall off the trunk (Figure 9 a–b). If the diseased trunk is cut through, discolouration appears as a wedge in cross-section (Figure 9 c–d), or in the case of BD it can also appear as central staining (Figure 9 e).

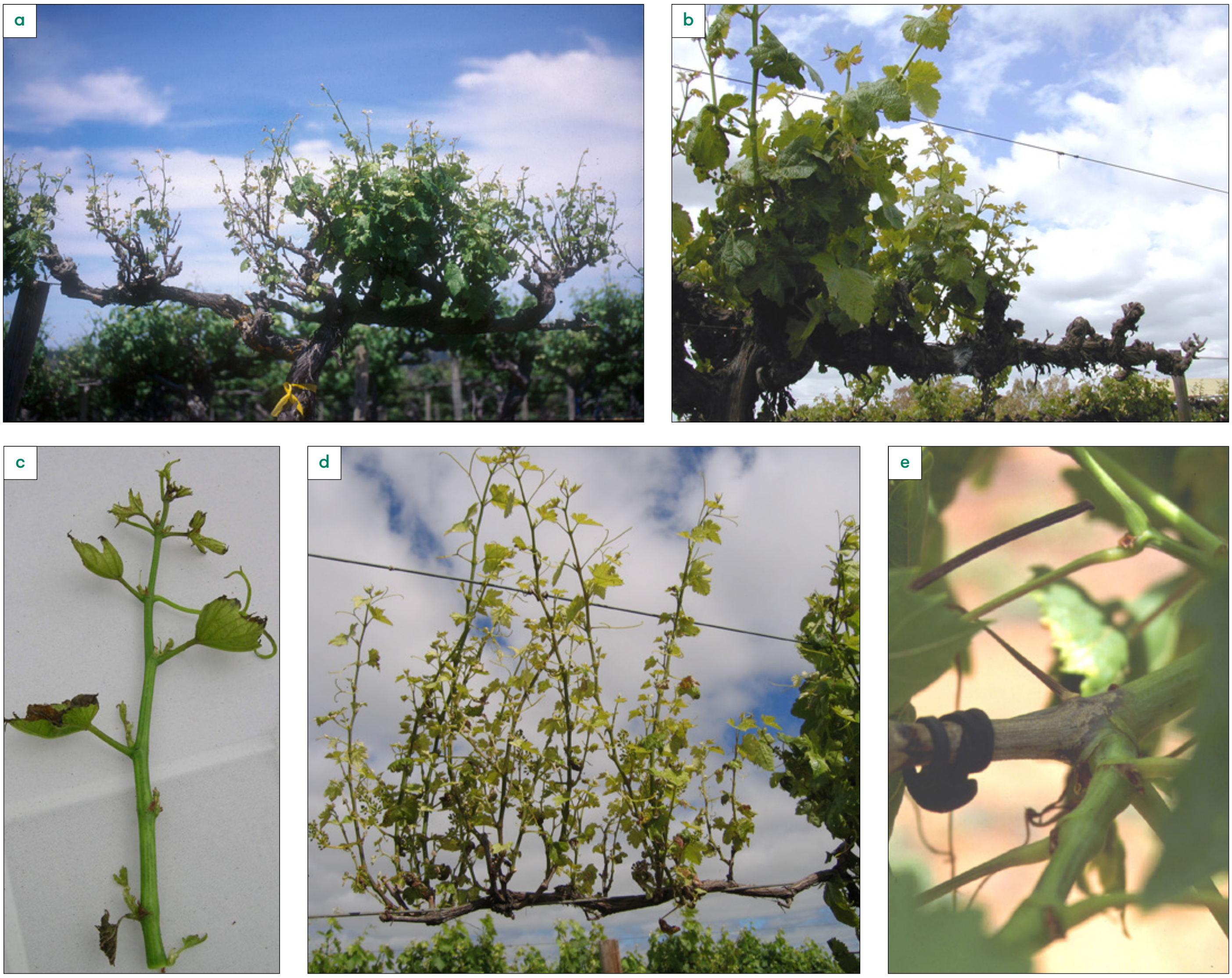

Figure 6. ED foliar symptoms: a) stunted shoots, b) cordon dieback, c–d) chlorotic shoots and cupped leaves with dead margins, and e) BD pathogen infection in green shoot. Figure 6 e taken by P. Wood (Department of Primary Industries and Regional Development, Western Australia).

Figure 7. ED symptoms can be confused with damage caused by: a–b) herbicides, having distorted leaves with no necrotic edge, c–d) salt toxicity, having necrotic edges on leaves but no yellowing, cupping or stunted shoots, e) earwigs, having distorted leaves with no necrotic edges or shoot stunting, f) frost, having necrotic edges with no stunting or yellowing of leaves and g–h) bud mite damage, having very similar appearance to eutypa symptoms.

Spores are released from fungal fruiting bodies which develop on the surface of old, infected wood. On grapevine wood, fruiting bodies of ED appear as a darkened, almost charcoal-like, surface with small bumps (Figure 9 f) and fruiting bodies of BD appear as black pimple like structures (Figure 9 g).

Fruit symptoms

Grapevines affected by ED and BD often have reduced bunch weight due to fewer and smaller berries. ED fruit symptoms include uneven ripening (Figure 10 a), which can cause the resulting wine to be out of balance, with undesirable green flavour, aroma and poor colour.
In cases of severe infection, berries do not set and entire bunches can be aborted, resulting in significantly lower yield (Figure 10 b). BD has been reported to cause bunch rots close to harvest in sub-tropical climates of Australia (Figure 10 c).

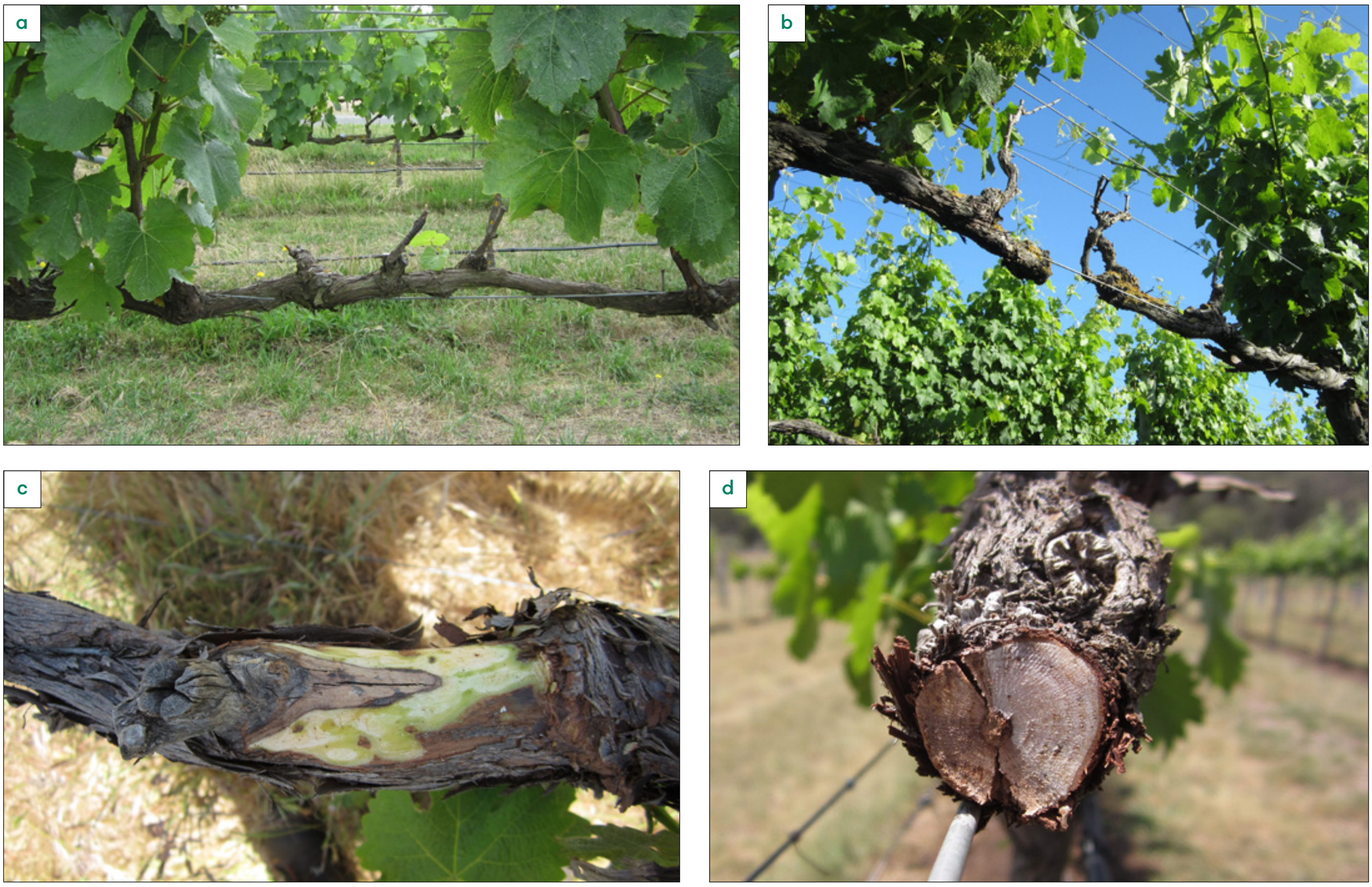

Figure 8. Cordon symptoms of ED and BD: a–b) dead spurs on cordon, c) canker extending from spur under bark and d) cross-section of infected cordon.

Figure 9. Trunk disease symptoms: a–b) trunk cankers, c–d) wedge-shaped stained wood internal to trunk cankers, e) central staining associated with BD, f) ED and g) BD fungal fruiting bodies on surface of dead wood. Figure 9 g supplied by J.R. Úrbez Torres (Summerland Research and Development Centre – Agriculture and Agri-Food Canada).

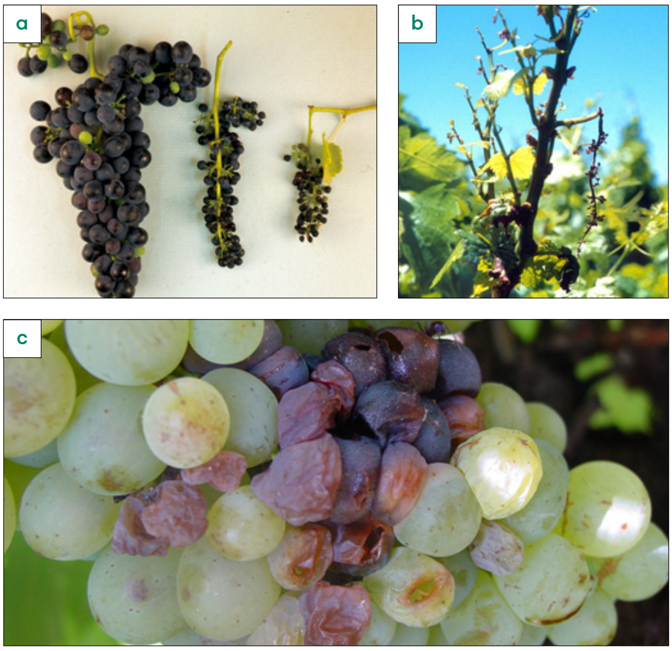

Figure 10. ED fruit symptoms: a) uneven ripening and reduced bunch size and b) shrivelled bunch and c) botryosphaeria bunch rot. Figure 10 c supplied by A. Taylor (Department of Primary Industries and Regional Development, Western Australia).

Diagnosis

Foliar symptoms of ED are most obvious in spring when shoots are 30–70 cm long. This provides enough time for healthy shoots to outgrow symptomatic shoots but not obscure them, creating the greatest contrast in foliage. Later in the season, as healthy shoots continue to grow symptomatic shoots are often masked and more difficult to see.

Wood symptoms of ED and BD can be observed as dieback of and 'cankers' on spurs, cordons and trunks, or by dissecting the cordon or trunk to reveal wedge-shaped or central staining.

Once the cordon or trunk has been cut, a slice of woody tissue (at least 2 cm thick) can be removed, ensuring the interface of dead and live wood is included for diagnosis. Samples can be placed in double-layered plastic bags and sent promptly to a diagnostic laboratory for confirmation of ED or BD pathogens, typically done by isolation of the pathogens into culture. Contact your local diagnostic laboratory prior to sending:

SA	SARDI Horticulture Pathology Diagnostics	(08) 8303 9585
Vic	DEDJTR Crop Health Services	(03) 9032 7515
NSW	DPI Plant Health Diagnostic Service	1800 675 623
Tas	DPIPWE Plant Health Laboratories	(03) 6165 3777
WA	AGWEST Plant Laboratories	(08) 9368 3721
Qld	DAF Grow Help Australia	(07) 3255 4365

Vineyard survey methods

Vineyard assessment allows a vineyard manager to understand the extent of dieback across each block in order to develop a management plan. Surveys should be conducted during spring (as noted above), when shoots are between 30 and 70 cm long, before healthy shoots begin to overgrow dead or missing cordon. Vines can be assessed visually for incidence or severity of dieback symptoms.

Incidence

Assessment of incidence is a quick approach to estimate disease to prioritise blocks requiring attention (can be done at walking pace). Select an area/series of rows that is representative of the whole block (i.e. avoid low lying areas or those with poor soil). Assess a section of at least 200 vines consecutively within 2–4 rows, counting any vines with typical ED foliar symptoms (Figure 6), or at least two dead spurs on a cordon (Figure 8). For cane-pruned vines, look for dead or unproductive areas on the head of vines (Figure 11). Once complete, calculate the percentage of vines with symptoms. This should be repeated annually in a regular monitoring program.

Severity

Assessment of severity is a slower approach (10–15 seconds per vine), but provides a more accurate measurement of the extent of dieback in the block for developing a management plan. As above, select a representative area/rows of vines and assess at least 200 vines. For each vine, estimate the percentage of unproductive cordon (i.e. dead/missing cordon or stunted shoots unlikely to be fruitful, Figure 12), or for cane-pruned vines, the percentage area of dead or unproductive wood on the head of vines, and then average across all vines for an overall percentage of dieback severity in the vineyard.

Figure 11. Dead or unproductive areas on head of cane-pruned grapevines.

Grape Assess smartphone app is a convenient tool that will make monitoring grapevine trunk disease in the vineyard easier. Each vine assessment can be entered on the screen and incidence and severity then calculated automatically. Information can be emailed as a spreadsheet, including GPS coordinates, for subsequent analysis to target management of the disease. Grape Assess can be downloaded for free from the Android and Apple app stores.

Figure 12. Grapevine trunk disease severity rating scale for spur-pruned vines. Percentage of unproductive cordon (i.e. dead/ missing cordon or stunted shoots unlikely to be fruitful).

Disease management

Control

Remedial surgery

Vines showing foliar and dieback symptoms of ED or BD should be tagged in spring when symptoms are most obvious. The vineyard manager can then easily return to the same vine even if the symptoms are no longer obvious. Infected wood can be removed at any time of the year and burnt, buried or removed from the vineyard. Any discoloured cordon and trunk wood should be cut out and an additional 20 cm of cordon or trunk cut away to ensure all infected wood has been removed. This process of cutting the vine off at the trunk is known as remedial surgery.

The lower the cuts are made on trunks, the greater the likelihood of eradicating the pathogen from the vine (Figure 13). Wounds must be protected from new infections with a paint, paste and/or registered fungicide.

The missing part of the vine is then replaced in the following spring using new shoots arising from the cordon, or watershoots arising from the trunk. However, cutting low on the trunk may reduce the likelihood of new shoot production, particularly with grafted vines, and so may require regrafting or vine replacement. Depending on the situation, vines undergoing remedial surgery will return to full production within 2–3 years (Figure 14).

Remedial surgery is most suitable for own-rooted vines, as grafted vines often tend to shoot from the rootstock instead of scion after trunks are cut.

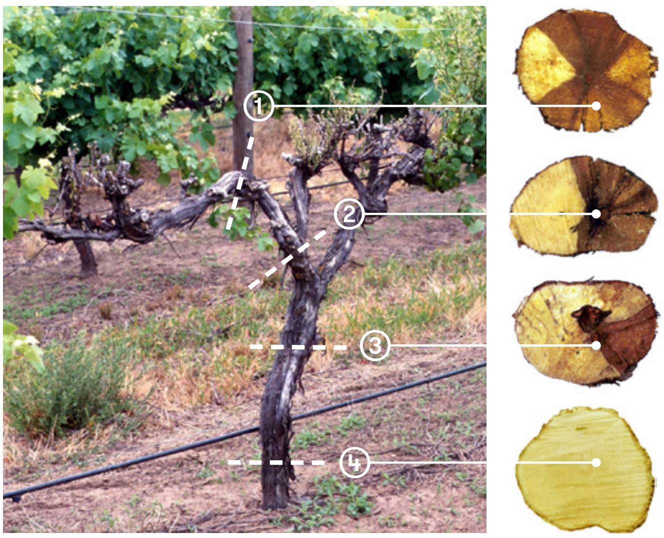

Figure 13. If cross-sectional cuts are made sequentially along the trunk, the wedge of dead wood gets smaller as you progress downwards.

Figure 14. a) Vine with stunted shoots caused by ED on the left cordon emerging from high on the trunk above infected wood and healthy shoots on the right cordon emerging from the bottom of the trunk below infected wood. b) Dead vine in the foreground which was reworked five years earlier from the top of an infected trunk and healthy vines in the background where shoots were trained from low down on the trunk.

Layering

If infection has reached ground level in trunks of own-rooted vines, layering can be used to replace missing vines. This involves taking a lignified cane and burying at least 20 cm of the cane beneath the soil surface. The tip of the cane should remain just above the soil surface. ED is not likely to be spread through layering, as 1-year-old non-wounded canes are not infected with *E. lata* and the fungus moves predominantly back towards the trunk. BD may be present on the surface of 1-year-old canes and may spread more rapidly, so layers should be cut as soon as the new vine is self-sufficient. Layering can be used as a future replacement of an affected vine (self-layering) (Figure 15 a–b) or used to replace a diseased or dead neighbouring vine (Figure 15 c–d). Layering provides an advantage over replanting as it uses the existing mature root system of the parent vine, making successful establishment in a mature vineyard much more likely.

Figure 15. Grapevines rejuvenated by self-layering (a–b) or by layering from a neighbouring vine (c–d).

Decision making

Remedial surgery significantly increases the longevity of a trunk disease-affected vineyard but is a costly and labour intensive exercise. Acting early will reduce crop loss and management costs considerably and lead to better disease control.

The decision about when to act and what to do needs to be made on a case by case basis for each vineyard (Figures 16 and 17).

Assess incidence of trunk disease

Conduct visual assessment for foliar and dieback symptoms (min. 200 vines) in spring (shoots 30–70 cm).

Confirm presence of wood symptoms by cutting cordon and trunks of several symptomatic vines to inspect for stained wood.

Confirm diagnosis with photos/inspection by experienced viticulturist and/or laboratory testing.

Prioritise blocks that maximise vineyard profitability.

Determine extent of infection

Select 20–40 symptomatic vines and cut cordon/trunk every 30 cm to assess extent of stained wood. Use as guide for the height of trunk cuts required.

Consider block profitability

Including long term grape price, demand, predicted yield losses. For lower value grapes, apply the whole row/block approach. For higher value grapes, apply the individual vine approach.

Consider remedial surgery costs

Including cutting vines and wires, removal of vine cordon/trunks and wire, burning/burial of vines, disposal of wire, painting wounds, wire replacement, retraining, modified weed management etc.

Develop a long term management plan

Balancing yield losses, costs and labour required over several years to ensure the project is manageable.

Whole row/block approach

Use on lower value grapes with widespread or high percentage of symptoms (large areas). Minimise yield loss by reworking 20 per cent of block each year.

Individual vine approach

Use on higher value grapes with contained or low percentage of symptoms (smaller areas).

Figure 16. Decision tree for developing a remedial management plan for vines affected with trunk disease.

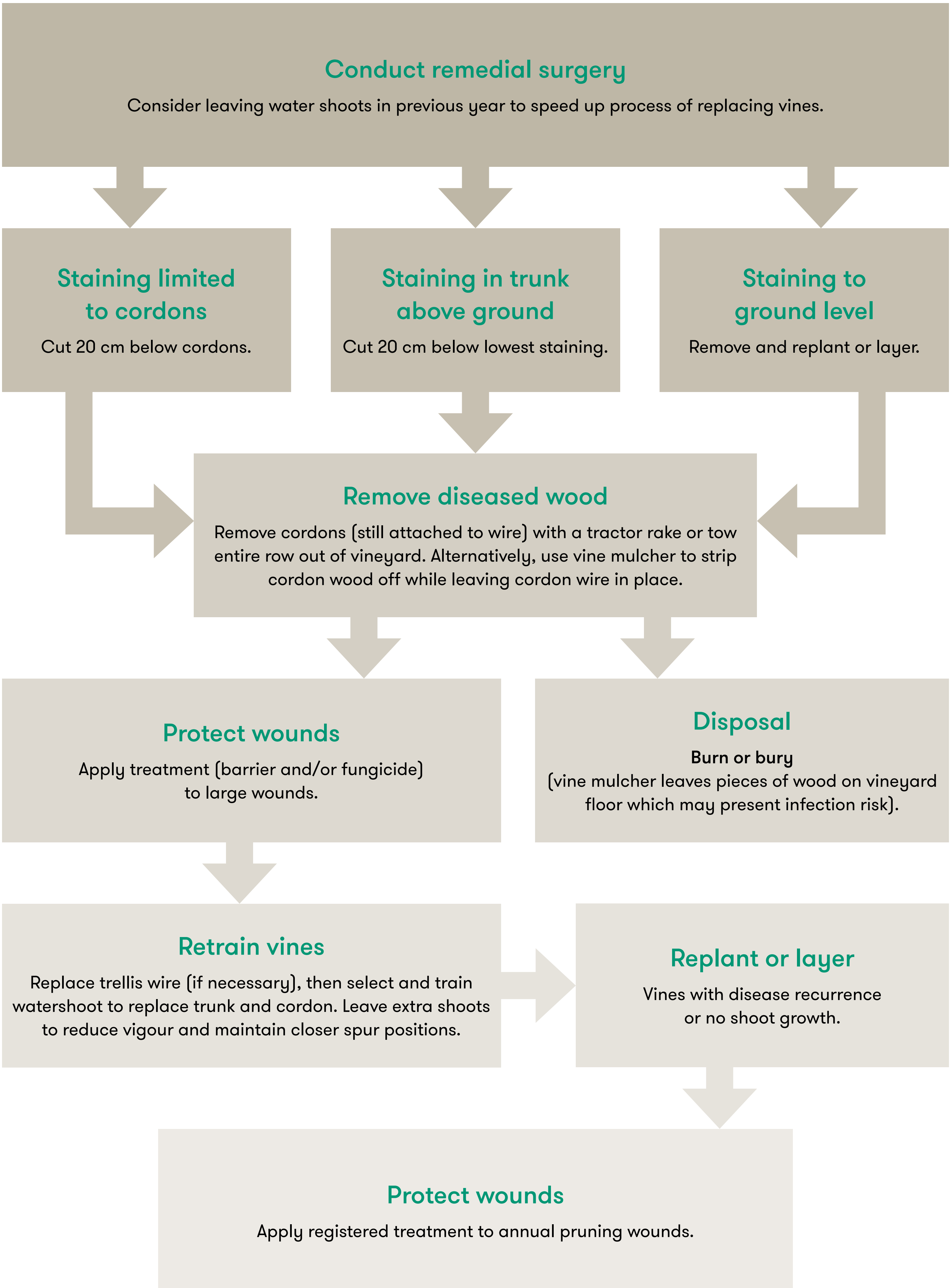

Figure 17. Decision tree for conducting remedial surgery on vines affected with trunk disease.

Treatment	Trade name	Active ingredient	Application method
Paint/paste	Acrylic paint	n/a	Paint brush
	Greenseal™	Tebuconazole	Bottle top applicator
	Garrison Rapid®	Cyproconazole + Iodocarb	Bottle top applicator
Fungicide	Emblem®	Fluazinam	Sprayer
	Gelseal™	Tebuconazole	Sprayer
Biological	Vinevax™ Wound Dressing	*Trichoderma atroviride*	Paint brush / hand trigger or backpack sprayer

Table 1. Treatments registered for use as a wound treatment to control ED. Follow instructions on label when using registered products. Recent research has confirmed that these treatments are also effective for control of BD.

Prevention

Cultural practice

Eradication of wind-blown spores is almost impossible, but removal of dead wood from grapevines and alternative hosts in and around the vineyard will reduce the local inoculum levels.

Spores are released into the air after rain, and release can continue for up to two weeks. Whenever possible, avoid pruning in wet weather and preferably, delay to late winter when wound healing is more rapid.

In situations where delaying pruning due to wet weather is unrealistic, 'double pruning' can be a useful solution for spur pruned vines. This involves mechanical pre-pruning (in any weather) where longer spurs (e.g. 5 buds or longer) are left, followed by hand-pruning to short spurs in late winter. However, if the late winter pruning coincides with rain, this will still pose a risk of infection.

Contamination of pruning tools is not a major means of spreading trunk disease, and disinfectant is not required if a registered fungicide is used to protect fresh pruning wounds.

Removal of watershoots and shoot thinning during or immediately following rain may pose a risk, but the likelihood of infection is low. Where possible, it is still advisable to avoid wet weather.

Products and wound protection treatment

A number of wound treatments are registered for control of ED (Table 1). Research has confirmed that these treatments are also effective for control of BD.

Large wounds made during remedial surgery should be treated with a paint or paste applied with a paint brush or applicator, to provide a physical barrier for maximum protection; the incorporation of fungicide provides extra protection in case the barrier is compromised (Figure 18 a–b).

Smaller wounds can be treated by application of registered fungicides using a knapsack or canopy sprayer with nozzles targeting the cordon (Figure 18 c–d). When canopy sprayers are used it is crucial to ensure maximum coverage of wounds, by turning off fans (no air), applying high water rates at low pressure, selecting spray nozzles that produce large droplet size and focusing nozzles towards the pruning wound zone. Recycle sprayers are ideal, maximising efficiency of targeting wounds on dormant vines. Wound coverage should be checked regularly using water sensitive paper or by adding dye to the water used to dilute fungicides.

Preventative wound protection practices should start in one-year-old grapevines following the first pruning and continue each year thereafter. Disease prevention is significantly less costly than remedial surgery and will maximise grape quality and long-term profitability.

Critical timing for wound protection

Paints or pastes should be applied immediately after a large wound is made. Remedial surgery usually involves someone painting wounds immediately behind the chainsaw operator. If sap is flowing liberally, once it has stopped, paint or paste can be applied over hardened exudate or following removal of exudate with a knife. If sap flow is light, then apply paint/paste immediately, as thoroughly as possible. Re-application may be required.

During normal spur/cane pruning, a registered fungicide should be applied within one week of pruning, which will provide up to three weeks of protection. This will cover the most susceptible period of two weeks post-pruning.

Vinevax Wound Dressing (biological product) should be applied during dry periods when trunk disease pathogen spores are not likely to be present. Vinevax Wound Dressing requires time to colonise wounds before it can prevent infection.

Figure 18. Applying wound treatments to large reworking wounds with paint brush (a) and bottle top applicator (b), and to annual pruning wounds with a knapsack (c) and canopy sprayer (d).

Further information

www.wineaustralia.com/au/growing-making/pest-and-disease-management/eutypa-dieback

www.awri.com.au/industry_support/viticulture/agrochemicals/agrochemical_booklet

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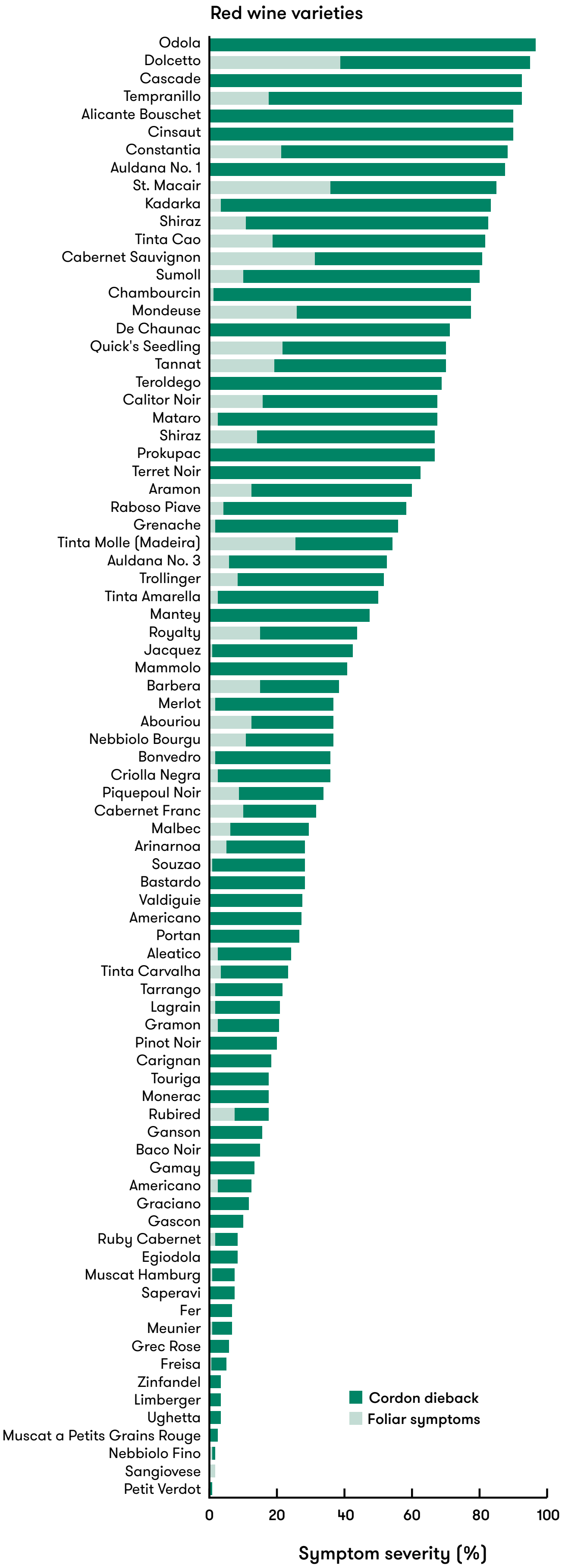
Appendices

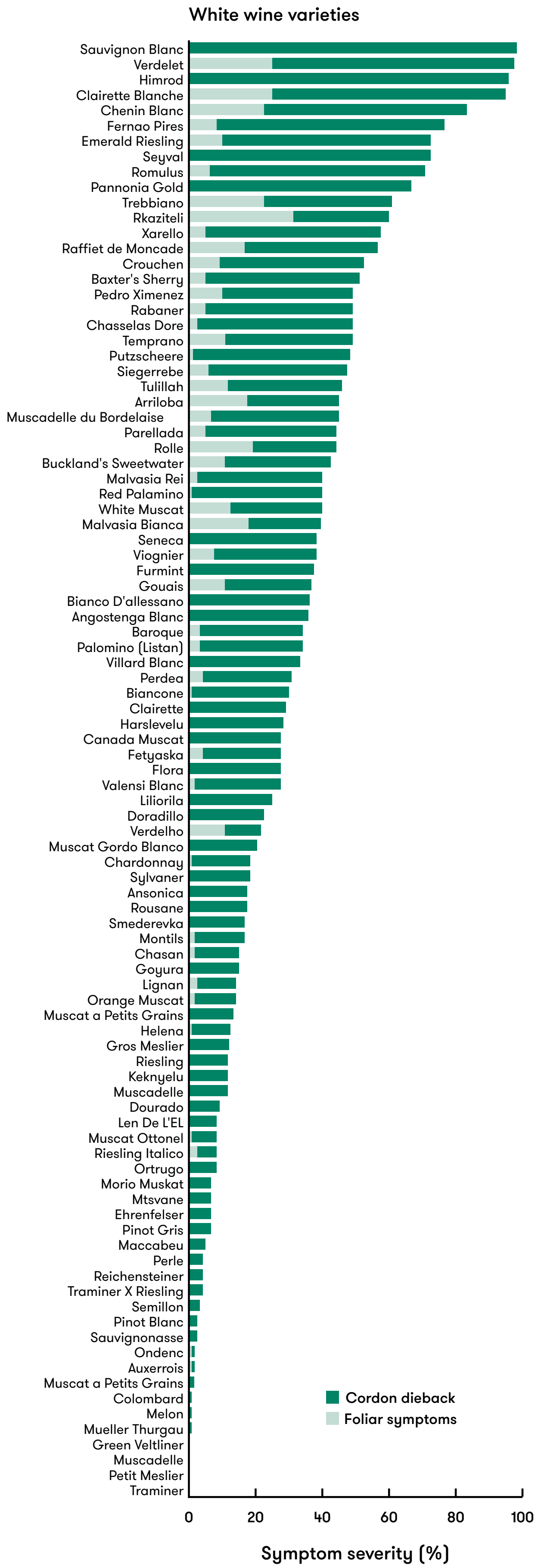
Appendix 1. List of reported hosts for *Eutypa lata*, adapted from Carter 1991, originally compiled by A. Bolay. Regions reported from: A=Australasia, E=Europe, NA=North America, SA=South Africa.

Family	Genera/species	Common name/s	Region
Aceraceae	*Acer campestre* L.	Field Maple, Hedge Maple	E
Anacardiaceae	*Pistacia lentiscus* L.	Mastic Tree	E
	P. terebinthus L.	Terebinth Tree, Turpentine Tree	E
	Schinus molle L.	Peruvian Pepper, Peppercorn Tree	A
	S. terebinthifolius Raddi	Brazilian Pepper	A
Apocynaceae	*Nerium oleander* L.	Oleander	A
Araliaceae	*Hedera helix* L.	English Ivy	E
Berberidaceae	*Berberis darwinii* Hook.	Darwin's Barberry, Berberis	A
Betulaceae	*Carpinus betulus* L.	Hornbeam, European Hornbeam	E
	Corylus avellana L.	Hazel, Hazelnut, Common Filbert	E
Caprifoliaceae	*Lonicera alpigena* L.	Alpine Honeysuckle	E
	L. xylosteum L.	Dwarf or Fly Honeysuckle	E
	Symphoricarpos orbiculatus Moench	Coralberry, Indian currant, Buckbrush	A, E
	Viburnum lantana L.	Wayfaring Tree	E
	V. opulus L.	European or American Cranberrybush, Guelder Rose	A, E
	V. tinus L.	Laurustinus	A
Cornaceae	*Cornus sanguinea* L.	Common Dogwood	E
	C. alba L.	Redosier Dogwood	E
Ebenaceae	*Diospyros kaki* L.	Japanese Persimmon	A
Ericaceae	*Arctostaphylos stanfordiana* var. *hispidula* (Howell) Adams	Gasquet Manzanita	NA
Fagaceae	*Fagus sylvatica* L.	European or Common Beech	E
	Quercus suber L.	Cork Oak	A
	Quercus sp.	American Red or Southern Oak	E
Grossulariaceae	*Ribes nigrum* L.	European Blackcurrant	E
	R. petraeum Wulf.	Currant	E
	R. rubrum L.	Cultivated Currant	E
	R. sanguinea Pursh.	Redflower Currant	E
	R. uva-crispa L.	European Gooseberry	E
Juglandaceae	*Juglans regia* L.	English Walnut	A, E
Leguminosae	*Acacia dealbata* Link	Silver or Blue Wattle, Mimosa	E
	Genista monspessulana L. Johnston	Cape or Montpellier Broom	A
	Genista sp.	Broom	E
Moraceae	*Ficus carica* L.	Common Fig	E
Oleaceae	*Fraxinus excelsior* L.	European or Common Ash	A, E
	Jasminum mesnyi Hance	Japanese Jasmine	A
	Ligustrum vulgare L.	European, Common or Golden Privet	E
	Olea europea L.	African or Black Olive	E
	Syringa vulgaris L.	Common Lilac	E
Pittosporaceae	*Pittosporum undulatum* Vent.	Native Daphne, Sweet Pittosporum, Snowdrop Tree, Mock Orange	A
Platanaceae	*Platanus acerifolia* Willd.	London Plane Tree	A, E

Family	Genera/species	Common name/s	Region
Rhamnaceae	Ceanothus cyaneus Eastw.	San Diego Buckbrush	NA
	C. megacarpus Nutt.	Bigpod Ceanothus	NA
	C. spinosus Nutt.	Redheart, Greenbark	NA
	C. thyrsiflorus Esch.	Blue Brush, Blueblossom	A, NA
	Frangula alnus Mill.	Glossy Buckthorn	E
	Rhamnus alaternus L.	Italian Buckthorn	A
	R. alpina L.	Cascara, Bayberry, bearberry, Californian buckthorn	E
	R. cathartica L.	Common Buckthorn	E
Rosaceae	Chaenomeles japonica Lindl.	Quince, Dwarf or Japanese flowering or ex Spach Maule's	E
	Cotoneaster glaucophyllus Franch.	Large-leaf Cotoneaster	A
	C. pannosus Franch.	Velvet Cotoneaster	A
	C. salicifolius Franch.	Willowleaf Cotoneaster	E
	Crataegus monogyna Jacq.	Hawthorn	A,E
	Crataegus sp.	Common Hawthorn	E
	Cydonia oblonga Miller	Quince	A
	Eriobotrya japonica (Thunb.) Lindl.	Loquat, Japanese Loquat	A
	Malus domestica Borkh.	Apple	A, E, NA
	Prunus armeniaca L.	Apricot	A, E, NA, SA
	P. avium L.	Sweet Cherry	E
	P. demissa (Nutt.) Walp.	Western Chokecherry	NA
	P. domestica L.	European Plum	A, E, SA, NA
	P. dulcis (Mill.) Webb	Sweet Almond	A, E
	P. persica L.	Peach	A, E
	P. salicina Lindl.	Japanese Plum	A
	P. spinosa L.	Blackthorn	A
	Pyrus communis L.	Common Pear	A, E
	Rosa spp.	Rose	A, E
	Sorbus aria (L.) Crantz.	Chess-Apple, Whitebeam	E
	S. aucuparia L.	Rowan, Mountain Ash	E
Rutaceae	Choisya ternata Kunth.	Mexican Orange Flower	E
	Citrus limon (L.) Burm. F.	Lemon	A, E
Salicaceae	Populus italica Mönch	Lombardy Poplar	A, E
	Salix caprea L.	Goat Willow, Kilmarnock Willow, Pussy Willow	E
Sambucaceae	Sambucus nigra L.	Black Elderberry, Elder	E
Tamaricaceae	Tamarix sp.	Athel Pine, Saltcedar, Tamarisk	A
Tiliaceae	Tilia cordata Mill.	Smal Leaf Lime, Littleleaf Linden	E
	T. platyphyllos Scop.	Large Leaf Lime, Largeleaf Linden	E
Ulmaceae	Ulmus scabra Miller	Scotch Elm, Broad-leaf Elm, Wych Elm	E
Verbenaceae	Gmelina leichardtii F. Muell.	White Beech	A
	Lantana camara L.	Lantana	A
Vitaceae	Cissus hypoglauca A. Gray	Water Vine, Jungle Vine, Native Grape	A
	Vitis labrusca L.	Fox Grape	NA
	V. rupestris Scheele	Sand Grape	SA
	V. silvestris C. Gmelin	Wild Grapevine	E
	V. vinifera L.	Wine Grape	A, E, NA, SA
	V. spp. American and French hybrids	Grapevine	E, NA

Appendix 2. Severity of eutypa dieback foliar symptoms (stunted shoots, yellowing with cupped and necrotic leaves) and eutypa and botryosphaeria dieback (at least two dead spurs on a cordon) in 30–35 year old vines in a germplasm collection at the Nuriootpa Research Centre in South Australia. Causal pathogens of both eutypa and botryosphaeria dieback were isolated from symptomatic vines.





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