Managing Downy and Powdery Mildew, Anthracnose and White Blister

Efficacy and economic benefit of control options

- Plant resistant varieties.
- Irrigate crops in the morning to reduce leaf wetness and infection.
- Manage nutrients as they impact on disease.
- Use disease forecasting models when cropping susceptible varieties.

KEY MESSAGES
Efficacy and economic benefit of control options: variety, nutrition, predictive models and management of irrigation for white blister, downy mildew and anthracnose.

Resistance to Downy Mildew and Anthracnose in Lettuce

In glasshouse trials on lettuce seedlings only 4 of the 21 lettuce varieties tested, were susceptible to a South Australian isolate of downy mildew (*Bremia lactucae*). These were ‘Fortune’ (DMR none); ‘Sureshot’ (DMR 1-4); ‘Winter Select’ (DMR none) and ‘Constanza’ (DMR 1-16, 19, 21, 23). In similar experiments none of the 20 lettuce varieties tested, were resistant to anthracnose (*Microdochium panattonianum*) but three varieties, ‘Tekero’, ‘Fortune’ and ‘Bernadinas’ had some tolerance to the disease (Fig 1).

Resistance to White Blister

*Brassica rapa* (Chinese cabbage and pak choi)

Seedlings of only one of four pak choi varieties ‘Seven Gates’, showed some level of resistance to white blister (Fig 2). Blisters were small and surrounded by brown margins.

*Brassica oleracea* (broccoli, cauliflower, Brussels sprouts and cabbage, Fig 3).

- In glasshouse trials seedlings of Brussels sprouts ‘Abacus’ and ‘Romulus’ and cauliflower ‘Avalanche’ were resistant to white blister.
- In field trials cauliflowers ‘Discovery’ and ‘Skywalker’ were susceptible, but no blisters formed on heads. Broccoli ‘Booster’ and ‘Tyson’ had resistance, ‘Belstar’ and ‘Rhumba’ had some resistance but ‘Profit’, ‘Ironman’, ‘Grevillea’ and ‘Agassi’ were susceptible. Commercial varieties of cabbage are still resistant to the Australian white blister.
- Australian strains of *Albugo candida* differ from European strains so continuous screening for resistance is necessary in case new strains appear.

Management of White Blister with Variety and Time of Irrigation

Variety:

Growing broccoli varieties resistant to white blister can reduce the levels of the disease on heads by 97% or more (Figs 4 & 5).

Irrigation:

Irrigating broccoli crops in the morning (~4.00 am) instead of the evening (~8.00 pm) reduced the incidence of white blister on the heads of a susceptible broccoli variety by 50% (Fig 4).
Disease Predictive Models

White blister disease risk predictive model Brassica\textsuperscript{spot}\textsuperscript{™}

**Broccoli**
- The Brassica\textsuperscript{spot}\textsuperscript{™} is a disease risk predictive model, which forecasts when white blister will appear in crops, based on temperature and leaf wetness conditions in the crop (Fig 7).
- The model is most effective in timing sprays on broccoli varieties susceptible to white blister, but not those tolerant to it.
- There are two versions of the model. Spraying according to both versions give the same level of white blister control and equivalent yield as Weekly spray programs (Fig 8).
- Brassica\textsuperscript{spot}\textsuperscript{™} can reduce up to 90% of Weekly sprays on broccoli whilst producing the same level of control as routine spray programs.

**Chinese cabbage**
In a Victorian field trial a single spray of a registered systemic fungicide 14 days before harvest reduced the incidence of white blister by 52% on the 4 wrap leaves around the head, which is probably the best phenological time to protect the wrap leaves from white blister. No blister developed on the heads in the trial.

Lettuce downy mildew predictive models BremCast and DownCast
- Currently both DownCast and BremCast disease predictive models generally forecast the reduction of one fungicide spray or the same number of sprays as Weekly sprays or Farm Best Practice spray programs (Figs 11 & 12). Both models can over-predict by one spray in summer.
- Fungicides applied on the basis of the model predictions generally produced the same, or better control of downy mildew than Weekly sprays or Farm Best Practice spray programs (Figs 11 & 12).
- BremCast appears to give better control of lettuce downy mildew compared with DownCast, but is not as user friendly as DownCast. Consequently useful aspects of both models are currently being combined.

In-field Spore Test Kit for White Blister

A spore test kit is being developed in collaboration with UK scientists (Fig 9). It is designed for use in conjunction with the white blister disease risk predictive model (Fig 7). The model predicts microclimate conditions conducive for infection (red bars) and the spore test kit will confirm the presence of spores for infection. The spore trap (Fig 10) collects air samples above a broccoli field, which are then tested for the presence of A. candida in the spore test kit (Fig 9). The specificity of the spore test to Australian white blister races was recently confirmed.

Figure 6. Weather station.

Figure 7. The Brassica\textsuperscript{spot}\textsuperscript{™} model output. No bars- no risk, Green bars- low risk, Yellow bars- moderate risk, Red bars- high risk of white blister appearing in the crop in 7, 14 or 21 days.

**Figure 8.** Comparison of Brassica\textsuperscript{spot}\textsuperscript{™} models and weekly sprays to control white blister on broccoli heads.

**Figure 9.** In-field spore test kit.

**Figure 10.** Spore trap for use with the in-field test kit.

**Figure 11.** Efficacy of treatments to control downy mildew on cos lettuce.

**Figure 12.** Efficacy of treatments to control downy mildew on iceberg lettuce.
**Fungicide Alternatives**

**Lettuce**
- Some fungicide alternatives, such as Bion and Bozyl had a similar efficacy to control downy mildew on cos lettuce as Weekly sprays or sprays applied based on DownCast and BremCast models (Fig 11). Bion was variable, if rates and timing are inappropriate it can cause phytotoxicity or have no efficacy.
- Under high disease pressure 10 weekly sprays of either B. subtilis or a fungicide only reduced downy mildew on wrap leaves but not on heads.
- It appears that under low disease pressure some of the fungicide alternatives have efficacy.

**Brassicas**

**Seedlings**
- On broccoli seedlings Bion and B. subtilis reduced white blister by 40-60% and 72%, respectively, but Vapor Gard and Nu-Film had no efficacy (Fig 13).
- On seedlings of Chinese cabbage and Pak Choi neither Du-wet, Nu-film nor Bacillus subtilis had efficacy to reduce white blister, and Bion was phytotoxic (Fig 14).

**Foliage**
In field trials on foliage of broccoli ‘Grevillea’, neither sodium lauryl sulphate nor Streptomyces lydicus, applied as weekly sprays, controlled white blister. Neither Bion nor B. subtilis controlled it on ‘Rhumba’. Either Agral, Du-Wett or Designer mixed with a copper fungicide reduced the severity but not the incidence of white blister on foliage of broccoli ‘Shamrock’ in Tasmania (Fig 15).

**Heads**
In field trials white blister was reduced on heads of broccoli ‘Grevillea’ by 40% with sodium lauryl sulphate and by 60% with S. lydicus. None of these treatments were as effective as weekly copper sprays which reduced white blister on heads by 96% (Fig 16).

**Effects of Nitrogen Sources on Lettuce Downy Mildew and Anthracnose**

Glasshouse experiments on the effects of three different nitrogen compounds, found interactions between nitrogen source (calcium nitrate, ammonium nitrate and potassium nitrate), variety susceptibility and rate of nitrogen applied. These factors affected the development of downy mildew and anthracnose on lettuce seedlings:
- A high rate of potassium nitrate (KNO₃) promoted downy mildew but had no effect on Anthracnose.
- High rates of calcium nitrate Ca(NO₃)₂ resulted in a reduced incidence of Anthracnose.
- Ammonium nitrate (NH₄NO₃) was associated with high levels of both downy mildew and anthracnose.
- A strong varietal response in disease susceptibility and response to nitrogen indicates that balanced nitrogen schedules need to be tailored to the different lettuce varieties.

**Economics**

- Growing a white blister resistant broccoli variety increases profits by 22%.
- Irrigating in the morning (4.00 am) rather than the evening (8.00 pm) increases profits by 5%.
- The Brassicaₚₗₚ models for white blister can increase profits by 25%, especially on white blister susceptible varieties.
- The BremCast model for downy mildew on lettuce is as good as, or better than, Farm Best Practice or Weekly sprays for contribution to farm profit. It can achieve a 6% increase in profit.
- Bion, if effective has the biggest contribution to farm profit, but is currently not available for vegetable production.