Grower Summary

FV 341

Asparagus: integrated management of Stemphylium purple spot

Final 2012

Disclaimer

The results and conclusions in this report may be based on an investigation conducted over one year. Therefore, care must be taken with the interpretation of the results.

Use of pesticides

Only officially approved pesticides may be used in the UK. Approvals are normally granted only in relation to individual products and for specified uses. It is an offence to use non-approved products or to use approved products in a manner that does not comply with the statutory conditions of use, except where the crop or situation is the subject of an off-label extension of use.

Before using all pesticides check the approval status and conditions of use.

Read the label before use: use pesticides safely.

Further information

If you would like a copy of the full report, please email the HDC office (hdc@hdc.ahdb.org.uk), quoting your HDC number, alternatively contact the HDC at the address below.

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Headline

Management strategies for Stemphylium purple spot on asparagus crops are given in this report. These strategies plus information on disease biology is summarised in HDC factsheet 24/12.

Background and expected deliverables

Stemphylium purple spot on asparagus spears and ferns is caused by the fungus *Stemphylium vesicarium* (also known as *Pleospora herbarum*). Purple lesions can occur on spears during the harvest season but mainly develop on the asparagus ferns, affecting needles, secondary branches and main stems. Severe infection often results in premature defoliation and can significantly reduce yields in subsequent seasons. Survival structures of the fungus can overwinter on fern debris and this is often the main source of the disease during the following harvest season.

Despite the availability of suitable fungicides, UK growers still report *Stemphylium* outbreaks. The sporadic nature of the disease means that it may not be cost effective to use a prophylactic spray programme. However, disease development can occur rapidly and control may be lost when the timing of specific fungicide applications is not optimised in relation to infection events.

HDC Factsheet 18/07 summarised available information on *Stemphylium* biology and potential management strategies. Based on knowledge gaps identified in the factsheet, experimental work was planned to develop integrated strategies for the management of *Stemphylium* on asparagus. The specific objectives were to:

1. Determine the efficacy of approved and potential fungicides for control of asparagus *Stemphylium* in inoculated pot experiments.
2. Monitor leaf wetness and temperature and record *Stemphylium* development in untreated crop areas, to determine the frequency of infection periods and provide the basis for setting thresholds in a disease model (TOMcast).
3. Evaluate fungicide programmes for *Stemphylium* control on asparagus ferns and effects on root carbohydrate levels.
4. Determine the efficacy of some chemical practices for reducing inoculum of *Stemphylium* overwintering on asparagus fern debris.
5. Prepare an updated factsheet on integrated management of asparagus *Stemphylium*.

Summary of the project and main conclusions

Development of Stemphylium purple spot

Development of *Stemphylium* symptoms on different parts of asparagus fern was monitored at two commercial sites in 2008 and 2009 to gain insight into sources of inoculum and disease spread. At the Warwickshire (both years) and Norfolk (2008) sites, where infested debris was abundant on the soil surface, the disease commenced from stem bases (Figure 1). Although all plant parts were subsequently affected, stem bases remained most severely affected through the season. This pattern of symptom development was consistent with a series of primary infections being initiated from ascospores of *S. vesicarium* released from fruiting bodies (pseudothecia) on asparagus debris. At Norfolk (2009), infested debris was less abundant on the soil surface and disease severity remained lower throughout the season. Symptoms were also first observed at stem bases but were subsequently more prevalent on mid-stems and secondary branches, indicative of secondary spread of the disease via conidia (spores) of *S. vesicarium*, either from stem base lesions or incoming from neighbouring asparagus crops.

Figure 1. Lesions of Stemphylium purple spot on the stem base of asparagus fern.

Efficacy of fungicides for Stemphylium control in inoculated pot experiments

Pot experiments were established in 2008 August and September 2009 on a hard-standing area at ADAS Boxworth (Cambs) to determine the efficacy of fungicides applied at different times in relation to infection (Figure 2). In both years, fungicides were applied to asparagus fern (var. Gijnlim) 3 days before or 3 days after artificial inoculation with a spore suspension of *Stemphylium vesicarium*. Fungicides used (all at full rates) were Amistar (azoxystrobin), Amistar Top (azoxystrobin + difenoconazole), Dithane 945 (mancozeb), Olympus (azoxystrobin + chlorothalonil), Plover (difenoconazole), Signum (boscalid + pyraclostrobin), Rovral WP (iprodione) (2008 only) and Switch (cyprodinil + fludioxonil).

In 2008, there was a trend for reduced disease severity on all plant parts in comparison with an untreated control when one of the following fungicides was applied to asparagus 3 days before artificial inoculation with *Stemphylium vesicarium*: Amistar, Amistar Top, Dithane 945, Olympus, Plover, Rovral WP, Signum or Switch. Of the fungicides tested, Plover appeared the most effective. Sprays applied post-inoculation were less effective.

The same fungicides (except Rovral WP, which had been revoked) were evaluated in 2009. Under conditions of low disease severity, the fungicides did not reduce disease incidence or severity on the lower sections of the stem or the secondary branches, perhaps due to trace levels of natural infection present prior to artificial inoculation. However, protectant sprays of each of the fungicides (except Switch) were effective in reducing or preventing disease development on the tops of stems and tertiary branches/needles, compared with the untreated control. Plover was again the most effective, being the only fungicide to control the disease (no lesions present) on stem tops and needles when applied either 3 days before or after inoculation (Table 1).

None of the fungicide treatments tested had phytotoxic effects on the plants during these experiments.

Figure 2. Fungicide activity was examined in inoculated trials on pot grown asparagus

Table 1. Effect of fungicides applied at different timings on *Stemphylium* incidence (% plants affected) on asparagus tertiary branches/needles, 21 days after inoculation, ADAS Boxworth 2009

Treatment	Spray application with reference to inoculation time:	
	3 d before	3 d after
1. Water	6.3	18.8
2. Amistar	0.0	6.3
3. Amistar Top	0.0	18.8
4. Dithane 945	0.0	6.3
5. Olympus	0.0	6.3
6. Plover	0.0	0.0
7. Signum	0.0	12.5
8. Switch	18.8	6.3

Monitoring of leaf wetness and temperature

Research in Michigan State, USA and France has shown that use of a simple forecasting programme (TOMcast) can help to minimise sprays for *Stemphylium* control without compromising fern health, because sprays are only applied when environmental conditions are high risk for disease development. Experimental work is required to determine appropriate thresholds for spray timing in the UK, since results from France and the USA vary in this respect.

In the TOMcast programme, leaf wetness duration and the average temperature during wetness periods are used to derive Disease Severity Values (DSVs) and associated thresholds from which spray timing is determined. Researchers in Michigan State showed that fungicides applied to asparagus according to TOMcast using a DSV of 15, resulted in a reduction in number of sprays compared with routine 7, 10 and 14-day programmes.

In this project, leaf wetness and temperatures were monitored using a sensor (Spectrum Technologies) at two commercial sites during fern production in 2008 and 2009. Examination of the data using the TOMcast disease model established the number of sprays that would have been triggered at each site, based on different DSV thresholds. DSVs of 5 and 7 gave spray numbers comparable to successful commercial programmes although at different timings to grower applications. DSVs of 10 or higher would have triggered fewer sprays than commercial programmes at both sites / seasons. Results from this study were used as the basis for a field trial in 2010, comparing disease development following spray programmes based on DSVs of 5, 7 and 10 in TOMcast.

Evaluation of fungicide programmes

Field experiments were conducted in 2008, 2009 and 2010 at commercial asparagus holdings on fields with a history of Stemphylium purple spot to determine the effect of fungicide programmes on the severity of *Stemphylium* during the fern production season using currently approved fungicides. The effect of disease development and fungicide programmes on subsequent root carbohydrate levels was also determined to provide an estimate of the longer-term impact of *Stemphylium* on the test crops. Root carbohydrate measurements were determined as Brix values (One degree Brix (°Bx) is equal to one gram of sucrose per 100g of solution and is often therefore described as Brix% in practice) in roots through use of the *AspireUK* decision support system (validated in HDC project FV 271).

2008

At two commercial sites, grower fungicide programmes commencing in late June and ending in early October (six sprays at Warwickshire, seven sprays at Norfolk) significantly reduced the severity of *Stemphylium* symptoms but did not eliminate the disease. It was noticeable that several strobilurin products were included in each programme, highlighting the need for careful programming in future to reduce resistance risk.

Root carbohydrate levels, measured at dormancy in an untreated area of asparagus crop with severe *Stemphylium* in Norfolk, were significantly reduced compared with a fungicide-treated area of the crop where disease levels were less severe (Figure 3). This suggests that severe symptoms due to *S. vesicarium* led to a reduction in transfer of carbohydrates from foliage to roots, indicating potential longer-term impact of the disease on the crop. The results confirmed that sampling Brix% in asparagus roots at dormancy could provide a useful measurement of the impact of *Stemphylium* on crop health. This technique was used subsequently for field experiments in 2009 and 2010.

Figure 3. Asparagus fern untreated (left) and treated with fungicides (right), Norfolk, October 2008.

2009

Seven fungicide programmes reduced the severity of Stemphylium purple spot at a commercial site (Warwickshire) with high disease pressure; two of these programme reduced disease at a second site (Norfolk) with lower disease pressure. While there was no individual programme that performed considerably better than others, a programme of Signum-Plover-Dithane 945-Plover-Signum, at 2-3 weeks intervals was the most consistent. At Warwickshire, this programme reduced disease incidence and severity (Figure 4), reduced the incidence of dead stems and resulted in higher root carbohydrate levels (Table 2). In addition, there was a trend for lower disease incidence (Norfolk) and higher Brix% values (both sites). This five-spray programme (commencing around 5 weeks after close of harvest) performed as well as other programmes comprising six applications, indicating that timing of appropriate products to coincide with high risk conditions for disease development, is likely to be more important for effective control than numbers of applications.

Overall, programmes that performed well included two applications of Signum alternating with difenoconazole products, and use of Dithane 945 as a protectant mid-season. Equivalent programmes using Amistar in place of Signum were less effective, suggesting that Signum may be a stronger product for control of *Stemphylium* on asparagus. Good results were also obtained from a programme commencing with Amistar Top, then alternating Switch with Plover, although this programme did not contribute to delayed senescence as effectively as programmes that contained two or three strobilurin products and finished with a strobilurin.

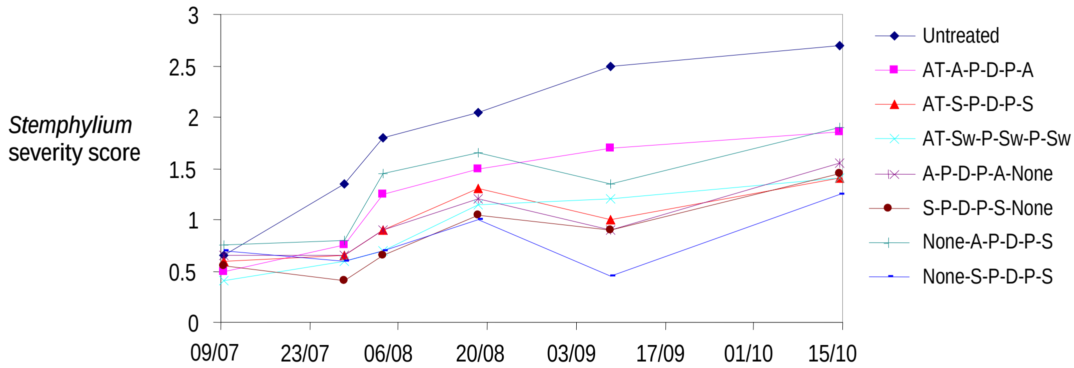

Figure 4. Effect of fungicide programmes on the development of Stemphylium purple spot on asparagus stem bases, Warwickshire, 2009.
Severity score: 0 = no symptoms, 1 = 1-10 lesions, 2 = 11-100 lesions, 3 = >100 lesions
Key: A - Amistar; AT - Amistar Top; D - Dithane 945; P - Plover; S - Signum; Sw - Switch

Table 2. Effect of fungicide programmes on the incidence of Stemphylium purple spot on different parts of asparagus fern (18 August 2009, Warwickshire)

	Fungicide programme	% incidence Stemphylium purple spot				
		Base stem	Mid stem	Top stem	Secondary branches	Tertiary branches / needles
1	Untreated control	95	95	65	35	40
2	AT–A–P–D–P–A	100	85	65	40	25
3	AT–S–P–D–P–S	95	**55**	30	20	**5**
4	AT–Sw–P–Sw–P–Sw	90	60	20	10	**5**
5	A–P–D–P–A–None	85	85	25	30	15
6	S–P–D–P–S–None	85	**45**	**10**	15	**0**
7	None–A–P–D–P–S	100	95	75	40	35
8	None–S–P–D–P–S	**70**	**55**	20	10	**0**

Values in bold are significantly less than the untreated control at P<0.05

2010

At the Warwickshire site, three routine fungicide programmes (six fortnightly sprays using different products) were compared with six programmes that were scheduled according to three different DSV thresholds calculated within TOMcast. A further variable was whether the TOMcast programmes commenced with a protectant spray soon after close of harvest or only once the appropriate DSV had been obtained.

Stemphylium was abundant in the crop and severe disease developed on untreated plants. The scheduled programmes were all highly effective in reducing the impact of *Stemphylium* on the crop, as shown by reduced disease severity (August – October), longer green fern retention (October), fewer dead stems (November) and higher root carbohydrate levels (December) compared with the untreated control treatment (Table 3).The scheduled programmes all commenced with Signum (early fern development) and ended with Signum (early September), and alternated a range of other available products from different chemical groups to minimise the risk of resistance development from overuse of QoI products.

The TOMcast programmes triggered between two and four spray applications compared with six in the scheduled programmes. Some programmes commenced at the end of June while the others did not start until triggered by the disease model in late July. In general, the TOMcast guided programmes reduced the severity of *Stemphylium* to the same extent as the scheduled programmes but were not as effective for reducing longer-term impacts of the disease (e.g. reduced transfer of carbohydrates to storage roots) (Table 3). Nevertheless, even a two-spray programme of Signum (late July) followed by Amistar Top (late August) provided useful *Stemphylium* control, indicating that a reduction in spray numbers from five or six sprays per season may be warranted, depending on risk factors for disease development (e.g. inoculum levels at start of season, early disease development on stem bases and weather conditions).

From September onwards, disease severity became increasingly difficult to quantify as symptoms progressed from discrete lesions to fern yellowing and necrosis. As an alternative method of assessment, vegetative 'greenness' was quantified for each treatment using ‘Crop Circle’ equipment. All fungicide programmes significantly increased vegetative greenness compared with the untreated control. This equipment could provide a useful technique for further work quantifying impact of e.g. pests and disease on asparagus fern.

Use of the TOMcast system had the advantage of highlighting when conditions were becoming high risk for *Stemphylium* development and demonstrated that spray numbers could be reduced without losing effective *Stemphylium* control. However, the similarity in results from the TOMcast programmes, despite different numbers of applications and timing (based on DSV thresholds) and products, suggests that investment in the equipment and software required for individual growers to collect leaf wetness and temperature data and to run the TOMcast disease model may not be warranted. Moreover, a disadvantage of the system was that sprays were triggered by an accumulation of DSVs based on previous conditions that were high risk for *Stemphylium* development, rather than use of protectant products in advance of high risk environmental conditions. A simpler approach could involve identifying relevant risk factors for *Stemphylium* development at different stages of fern production and basing spray recommendations on these risks. A summary scheme based on project findings is provided in ‘Action points for Growers’.

Table 3. Effect of fungicide programmes on *Stemphylium* severity on fern, vegetative greenness (NDVI), crop senescence (% dead stems) and Brix% values at dormancy, Warwickshire 2010

	Programme description	Fungicide programme	*Stemphylium* severity score** (20 Sep)	NDVI (24 Sep)	% dead stems (11 Nov)	Mean Brix% value** (Dec)
1	Untreated control	-	3.7	0.544	87.3	16.9
2	Scheduled sprays (A) x 6	S–P–AT–P–AT–S	**1.7**	**0.633**	**33.3**	**20.8**
3	Scheduled sprays (B) x 6	S–P–O–P–O–S	**2.0**	**0.628**	**35.5**	**21.2**
4	Scheduled sprays (C) x 6	S–P–Sw–P–Sw–S	**1.4**	**0.606**	**33.7**	**20.9**
5	TOMcast A (4 sprays)	S–AT–P–S	**2.2**	**0.611**	**53.5**	**19.8**
6	TOMcast B (3 sprays)	S–AT–S	**1.9**	**0.611**	**66.5**	NA
7	TOMcast C (3 sprays)	S–AT–D	**2.0**	**0.623**	**53.6**	18.5
8	TOMcast D (2 sprays)*	S–AT	**2.0**	**0.605**	**58.3**	NA
9	TOMcast E (2 sprays)*	S–AT	**2.3**	**0.604**	**63.8**	NA
10	TOMcast F (2 sprays)*	S–AT	**1.8**	**0.616**	**63.4**	18.6

* Timings varied with programme.
** 0=no disease; 1=trace, 2=moderate, 3=severe, 4=fern yellowing & defoliation, 5=fern completely dead.
NA not assessed.
Key: A – Amistar; AT – Amistar Top; D – Dithane 945; O – Olympus;, P – Plover; S – Signum; Sw – Switch.
Values shown in bold are significantly different from the untreated.

Evaluation of chemicals for reducing Stemphylium inoculum overwintering on asparagus fern debris

Previous research to control blackleg (*Leptosphaeria maculans*) on oilseed rape showed that treatment of stubble with products such as urea and certain adjuvants could reduce inoculum survival between seasons. A similar approach was evaluated to reduce survival of *Stemphylium* on asparagus crop debris between seasons. From August 2008 to March 2009, microscopic examination of asparagus debris was done to determine the timing of development of different stages of the pathogen life-cycle on asparagus fern, to give insight into the timing at which treatment of debris might be effective. Fruiting bodies (pseudothecia) of the overwintering stage of the *Stemphylium* fungus developed from August onwards in crops with *Stemphylium* lesions (Figure 5). Maturation of ascospores contained in the fruiting bodies occurred 5 months later (from January).

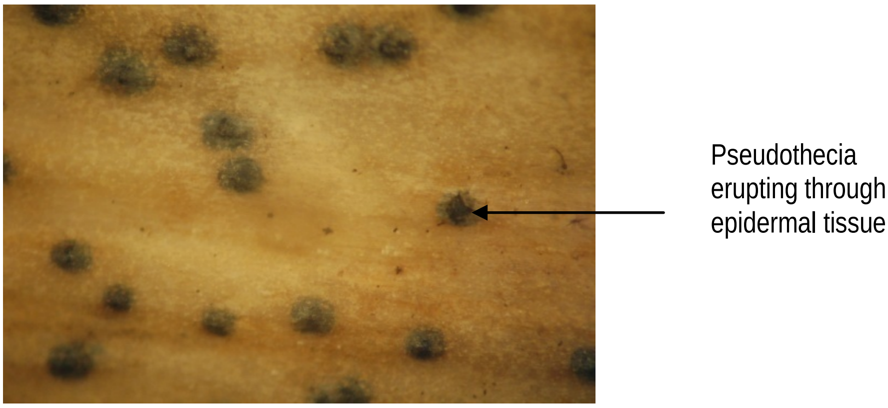

Figure 5. Pseudothecia (fruiting bodies) of *Stemphylium* on dead asparagus stems.

Twelve products comprising five fungicides, two biofungicides, two herbicides, two fertilisers and a wetter were applied to asparagus fern debris in February and March 2012. Replicate debris samples were taken at 1 and 14 days after each treatment and examined for discharge of viable *Stemphylium* spores following humid incubation for 48 hours. The proportion of untreated debris pieces releasing spores increased from 65% when sampled on 29 February to 98% when sampled on 13 March. Almost all spores produced germinated rapidly on agar. Amistar, Plover, Reglone (diquat), Serenade ASO (*Bacillus subtilis*), Switch, Phorce (foliar fertilizer product) and urea reduced spore production; five other products (potassium bicarbonate, Prestop (*Gliocladium catenulatum*), Signum, Stomp Aqua (pendimethalin) and a wetter) had no or inconsistent effect. When all assessment data were combined, Switch and urea were the two most effective products; Switch had the largest initial effect whereas urea had the better persistent effect.

Conclusions

- Five and six-spray fungicide programmes based on Signum and Plover reduced Stemphylium purple spot on asparagus in field crops and increased root carbohydrate (CHO) levels at crown dormancy, compared with untreated crop areas.
- Seven fungicide products reduced Stemphylium purple spot. Plover (difenoconazole) was the most effective.
- Fungicide programmes with 2-4 applications timed according to the TOMcast disease model also reduced disease severity but did not increase root carbohydrate levels.
- Switch and urea were found to be the two most effective products for reducing spore release from overwintered asparagus debris. Switch had the largest initial effect whereas urea had the better persistent effect.

Financial benefits

Financial losses due to *Stemphylium* have not been quantified in the UK but severe fern damage in one season can have a deleterious effect on spear yield in subsequent seasons. Financial losses can also occur due to application of unnecessary fungicides when conditions are low risk for disease development. The expected benefit to the industry is a set of guidelines to enable effective management of *Stemphylium* on asparagus with minimum fungicide usage.

Action points for growers

- Read HDC Factsheet 24/12 on this disease to be aware of *Stemphylium* symptoms, the disease cycle and high risk conditions for disease development.
- Be aware that *Stemphylium* survives on asparagus debris between seasons. Infested debris on the soil surface is an important source of the disease. Ridging-up so that debris is covered by soil can help to reduce this risk.
- Regularly monitor spears during harvest and developing fern (particularly at stem bases) for symptoms of *Stemphylium*.
- Be aware that spores of *Stemphylium* can spread in the air between fern of neighbouring crops.
- Note that premature fern senescence and needle drop due to severe *Stemphylium* can lead to decreased carbohydrate transfer to roots with subsequent effect on yields in subsequent seasons.

- The following fungicides approved for use on asparagus (February 2012) were shown to reduce the incidence and/or severity of asparagus *Stemphylium* in inoculated experiments when applied as protectants: Amistar (azoxystrobin), Amistar Top (azoxystrobin + difenoconazole), Olympus (azoxystrobin + chlorothalonil), Plover (difenoconazole), Signum (boscalid + pyraclostrobin) and Switch (cyprodinil + fludioxonil). Plover was found to be effective when applied either a few days before or after infection had occurred.
- Rovral WP and Dithane 945 are no longer approved for use on asparagus.
- Five or six-spray programmes commencing in late June and ending in early to mid-September (commencing and ending with Signum) were highly effective for reducing *Stemphylium* severity, prolonging green fern retention and resulting in higher root carbohydrate levels (at dormancy) compared with unsprayed control treatments. See guidelines below for suggested product sequences.
- Programmes with two to four sprays were also effective in reducing *Stemphylium* severity when sprays were applied at appropriate timings. These programmes were less effective for increasing root carbohydrate levels.
- When using fungicides for *Stemphylium* control, be aware of FRAG guidelines (see www.pesticides.gov.uk) and manufacturer's guidelines for minimising risk of developing fungicide resistance risk through over-use of strobilurin products. The suggested product sequence is compliant with these guidelines.
- See the following guidelines on risk factors for *Stemphylium* development at different stages of fern development in relation to spray timing.
- Consider treating dormant crop with a high volume spray of urea in the January-March period in order to reduce sporulation of *Stemphylium* from old crop debris. Switch could also be used providing the total number of sprays of this product applied to the crop during the year does not exceed three and provided that harvest intervals are adhered to.

Guidelines for the management of Stemphylium on asparagus using fungicides

The following example sequence of fungicides is effective for control of *Stemphylium*:
Signum – Plover – Amistar Top – Plover – Switch – Signum
Use the guidelines below to determine whether sprays are warranted at different stages of fern production. If fewer sprays are required, it is recommended that the programme still finishes with a Signum (in early to mid-September).

Stage of season: Mid-June (or close of harvest) to mid-July

Key observations	Risk of *Stemphylium* development	Spray recommendation
• No *Stemphylium* lesions observed on spears during harvest • No infested trash present on soil surface • No history of *Stemphylium* in the crop • Dry settled weather forecast	Low	Nil sprays
• No *Stemphylium* lesions on spears during harvest • Some infested trash present on soil surface • *Stemphylium* previously recorded in the crop • Unsettled weather forecast	Medium	1 spray
• *Stemphylium* lesions observed on spears at harvest • Infested trash abundant on the soil surface • *Stemphylium* previously recorded in the crop • Neighbouring asparagus crops with *Stemphylium* history • Wet weather forecast and/or rain in previous 2 weeks	High	2 sprays at a 14-day interval

Stage of season: Mid-July to mid-August

Key observations	Risk of *Stemphylium* development	Spray recommendation
• No *Stemphylium* lesions present on stem bases or in the fern canopy • No infested trash present on soil surface • No *Stemphylium* in neighbouring crops • Dry settled weather forecast	Low	Nil sprays
• *Stemphylium* lesions developing at stem bases • No lesions visible in the fern canopy • Some infested trash present on soil surface • *Stemphylium* starting to develop in neighbouring crops • Unsettled weather forecast	Medium	1 spray (at least 14 d after any previous spray)
• *Stemphylium* lesions abundant at stem bases and starting to develop in the fern canopy • Infested trash abundant on the soil surface • *Stemphylium* symptoms visible in neighbouring crops • Wet weather forecast	High	2 sprays at a 14-day interval (and 14 d after any previous spray)

Stage of season: Mid-August to mid-September

Key observations	Risk of *Stemphylium* development	Spray recommendation*
• Nil or trace levels of *Stemphylium* lesions present on stem bases or in the fern canopy • Nil or trace levels of *Stemphylium* in neighbouring crops • Dry settled weather forecast	Low	Nil sprays
• *Stemphylium* lesions abundant at stem bases and increasing in the fern canopy • *Stemphylium* symptoms in neighbouring crops • Unsettled weather forecast	Medium	1 spray (at least 14 d after any previous spray)
• *Stemphylium* lesions abundant at stem bases and in the fern canopy • Fern yellowing and death; premature needle drop • *Stemphylium* symptoms abundant in neighbouring crops • Wet weather forecast	High	2 sprays at a 14-day interval (and 14 d after any previous spray)