Factsheet 24/12 (Project FV 341)

Field Vegetables

Management of Stemphylium purple spot on UK asparagus crops

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Stemphylium purple spot affects asparagus spears and fern, and when severe can result in premature fern defoliation followed by reduced yields in subsequent seasons. Despite the availability of several fungicides for use on asparagus, UK growers still report outbreaks of Stemphylium purple spot. This factsheet summarises available information on disease biology and management strategies, and incorporates findings from HDC project FV 341.

Action points

- Know the symptoms and biology of Stemphylium purple spot on asparagus spears, fern and crop debris.
- Bury or remove asparagus crop debris to reduce the risk of Stemphylium purple spot.
- Be aware of the environmental conditions that are high and low risk for Stemphylium purple spot on asparagus. Infection and disease development are favoured by prolonged rainfall. Disease progress is delayed under dry conditions.
- Monitor developing fern regularly, particularly at stem bases, in order to detect early symptoms of the disease.
- Use preventative fungicide programmes to protect fern, adjusting timings to disease risk and weather. Refer to the 'fungicide programme guidelines' in this factsheet.
- Adhere to the fungicide label and off-label recommendations regarding maximum number of applications and dose, to minimise the risk of fungicide resistance.

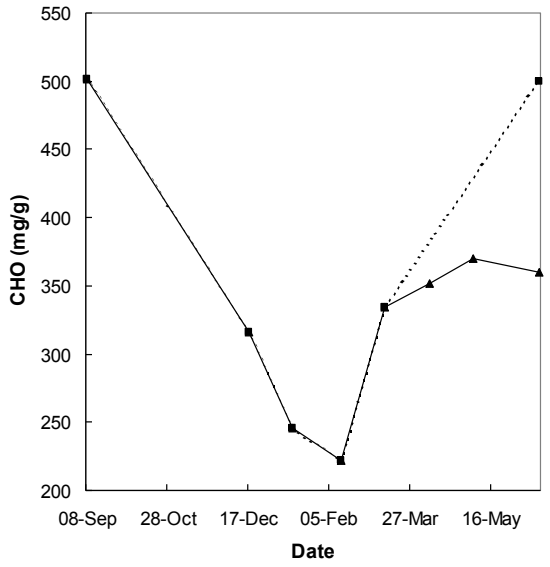
1. **Untreated asparagus fern defoliated due to Stemphylium purple spot (left) compared with fungicide-treated fern in October (right)**

Background

Stemphylium purple spot on asparagus is caused by the fungus *Stemphylium vesicarium* (also known as *Pleospora herbarum*). The disease is common on UK asparagus, and also affects crops in other asparagus production regions of Europe, the USA and New Zealand. Disease severity can be extremely variable from year to year, dependent on levels of the fungus present and environmental conditions. In recent years, several UK growers have reported severe outbreaks of Stemphylium purple spot on fern followed by premature defoliation, despite use of comprehensive spray programmes incorporating a range of fungicide products.

Financial losses due to Stemphylium have not been quantified for UK asparagus. In addition to reduced marketability of affected spears, poor management of Stemphylium in summer and autumn can reduce yields in subsequent seasons. Infected crop debris can act as a source of the disease the next spring, resulting in affected spears during harvest. In addition, premature fern defoliation can have a deleterious effect on the transfer of carbohydrates from fern to roots, potentially reducing future yields (Figure 1, previous page and Figure 2). In the long term, Stemphylium purple spot along with other biotic and abiotic factors, is likely to contribute to asparagus decline, which can reduce the economic life of a crop from 15 to 7 years.

In the UK, untreated asparagus plots had lower root carbohydrate levels at dormancy compared with plots in which Stemphylium was controlled using fungicides (HDC Project FV 341). In Michigan State USA, it was demonstrated that untreated control plots of asparagus yielded 17-23% less than plots in which Stemphylium purple spot on fern was managed successfully with fungicides in the previous season. Conversely, financial loss can also occur due to application of unnecessary fungicides when conditions are low risk for disease development.

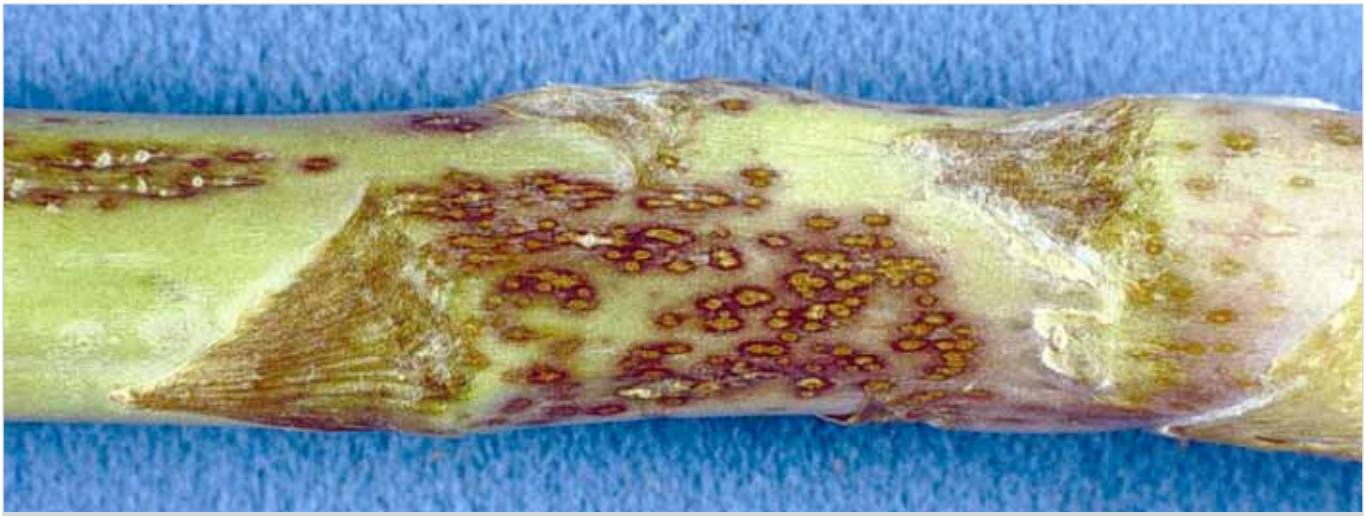


2. Pattern of root carbohydrate content in a New Zealand asparagus crop damaged by Stemphylium purple spot (triangles, solid line), and the expected pattern (squares, dashed line) (Source: Wilson *et al*., 2002)

Symptoms

During the harvest season, symptoms of the disease may be seen as dark purple spots on emerging spears (Figure 3). The spots are elliptical in shape, slightly sunken and usually 1-2 mm in diameter. Although the lesions are mainly superficial and infection does not penetrate deeply into the spear tissue, affected spears may be rejected by retailers. Under high disease pressure, many lesions may develop on each spear. Lesions are sometimes more abundant on one side of a spear than the other, and this may result from wind movement and impaction of spores on the windward side of spears.

On asparagus fern, dark brown lesions with dark red or purple margins can occur anywhere on the main stem, secondary branches and needles (Figures 4, 5 and 6). At the beginning of fern production (June/July), lesions tend to be most prevalent at fern stem bases. The lesion centres become paler on mature fern but retain the dark red borders and the needles become yellow (Figure 7). When infection is severe, the needles turn brown and drop prematurely (Figure 1).



3. The development of purple lesions due to *Stemphylium vesicarium* on asparagus spears can result in rejection by retailers

4. Symptoms of Stemphylium purple spot can develop on main stems and secondary branches of asparagus fern

5. In June and July, lesions are most common at fern stem bases

6. Stemphylium purple spot lesion on asparagus needle

7. Severe infection by *Stemphylium vesicarium* on asparagus fern can lead to yellowing and premature needle drop

Biology of the disease

This section summarises current knowledge of the biology of Stemphylium purple spot on asparagus, based on experimental results from the UK (HDC project FV 341) and the USA (see references).

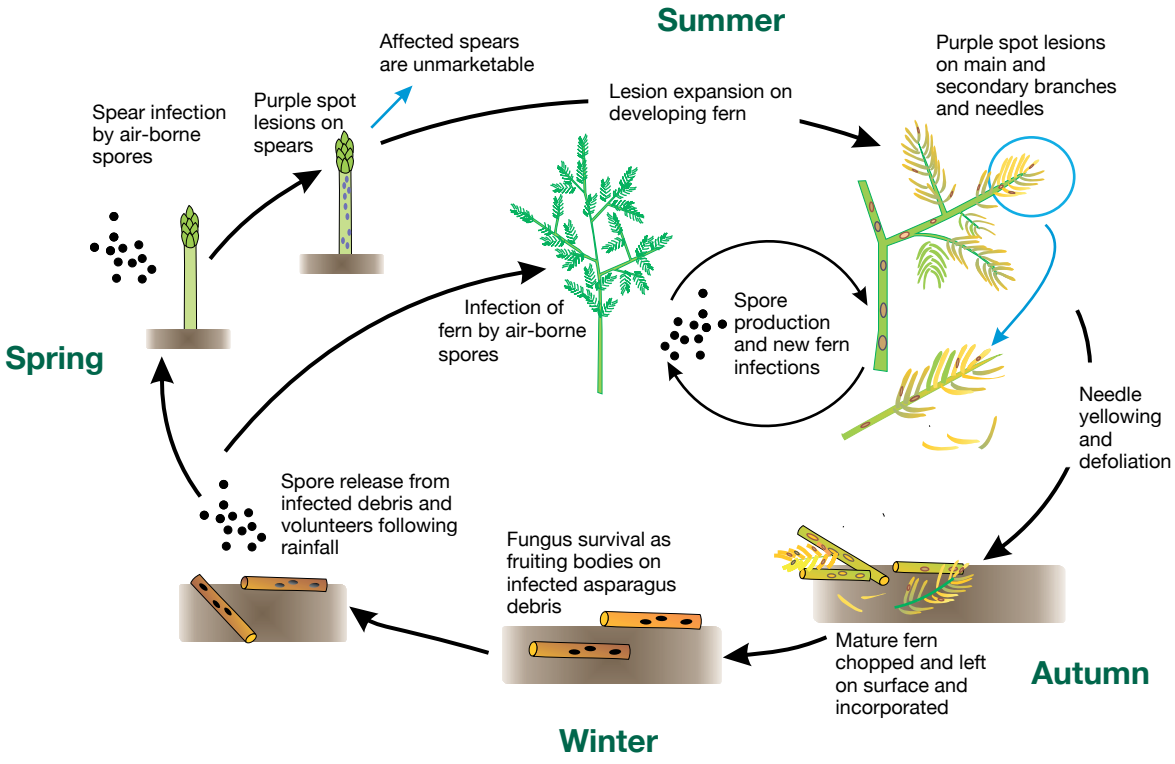
Sources and spread

Fruiting bodies of the fungus on the surface of dried asparagus stems from the previous summer's fern growth are the main source of the disease for spears emerging in the spring. Secondary spread of the disease can then occur from either infected spears, volunteer seedlings or fern.

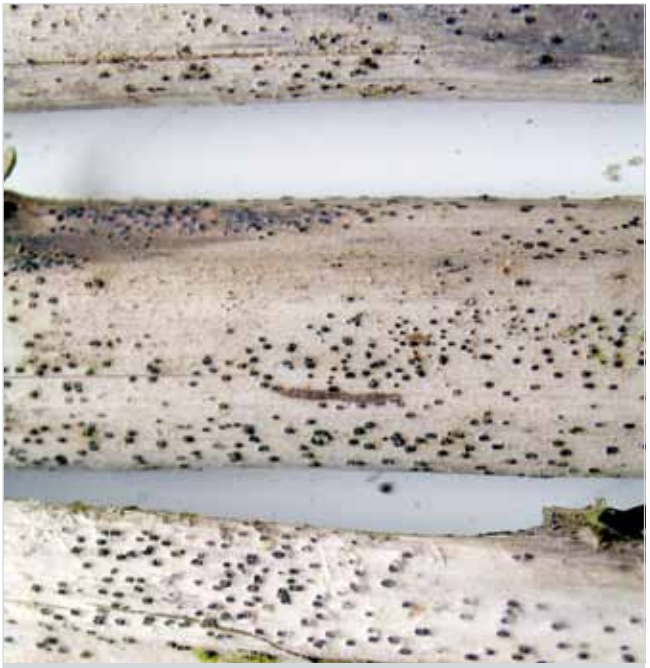
Disease cycle

The disease cycle for Stemphylium purple spot on asparagus is summarised in Figure 8 overleaf. The fungus overwinters as black spherical fruiting bodies that measure up to 0.5 mm in diameter and are visible on the surface of crop residues and fern debris (Figure 9 overleaf). In spring and summer, two spore types are produced; ascospores are forcibly discharged from the fruiting bodies on debris, while conidia may either be produced directly from infected debris, or from lesions on infected volunteers or fern. The relative importance of the different spore types in the disease cycle is unclear. However, it is thought that ascospores are the main source of the disease on emerging spears and at the stem bases of developing fern. Conidia, which are produced in higher numbers later in the year, may be more important for the infection of the fern canopy and secondary spread of the disease. In the autumn, fruiting bodies develop on infected mature fern. Dried fern is either incorporated or left on the soil surface, depending on cultivation practices. Ascospores develop within the fruiting bodies during the winter, and are released when mature the

following spring. Air-borne transmission of ascospores to emerging spears or fern is most likely when infected debris remains on the soil surface rather than when it is buried in soil. Neither the fruiting bodies nor the different spore types persist in soil in the absence of asparagus crop debris.



8. Disease cycle for Stemphylium purple spot on asparagus



9. Fruiting bodies overwintering on asparagus crop debris are an important source of the disease in the following spring

Factors affecting disease development

The release of ascospores from fruiting bodies on asparagus debris is associated with rainfall, since surface water is required for the rupture of spore-containing structures and spore discharge. Once spores are released they may be impacted directly on adjacent asparagus plants or may be carried further by air currents.

It was originally thought that wounding (eg by wind-blown sandy soil) was required for infection of asparagus spears by spores of *S. vesicarium*. However, it was later demonstrated that infection also occurs via plant pores (stomata), although infections are more numerous and develop after shorter periods of surface wetness on wounded than on non-wounded plants. In laboratory experiments, wounds on asparagus spears produced by blowing sand, remained susceptible to infection by *S. vesicarium* spores for up to 48 hours after injury.

Laboratory and pot experiments showed that when *S. vesicarium* spores are present on non-wounded asparagus spears, a wetness duration of at least 4 hours is required for infection to occur. For both wounded and non-wounded asparagus spears, the number of lesions increases as the wet period increases from 3 to 24 hours. Symptoms may also be more severe when infection is followed by conditions of prolonged high humidity (48-72 hours).

In field experiments, disease severity on asparagus spears was associated with rainfall, with symptoms increasing after periods of heavy rainfall when air temperatures were between 0 and 20°C. Disease severity was more closely related to the difference between rainfall and evaporation, than rainfall amount alone, indicating that the duration of leaf wetness is more important than the amount of rain. Symptoms may develop as soon as 48 hours after infection.

In the USA, Stemphylium purple spot has become more damaging in recent years, due in part to the adoption of no-till asparagus cultivation, in which chopped debris (which may be infected with *S. vesicarium*) is left on the soil surface rather than being incorporated during cultivation. UK studies also show that crops are at higher risk of Stemphylium development when infected debris is abundant on the soil surface during

harvest and fern growth. The severity of Stemphylium purple spot on spears can be reduced when asparagus debris from the previous season is chopped and incorporated into the soil (4-9 cm depth) either in later autumn (November) or winter (February), compared to leaving debris on the soil surface. Fruiting bodies on crop debris do not decompose during burial (up to 14 weeks) but because of incorporation in soil, ascospores are physically prevented from becoming air-borne and reaching susceptible asparagus tissue. The rate of ascospore development in the fruiting bodies varies, but occurs more rapidly when the crop debris has a high moisture content.

Integrated disease management

Cultural controls

Host resistance

There are currently no asparagus cultivars available commercially that are resistant to Stemphylium purple spot, however there may be differences in cultivar susceptibility. Cultivars that give short compact plants with low branches tend to be more susceptible than tall erect types.

Crop hygiene

Since infected crop debris can be an important source of Stemphylium purple spot during the harvest season, a key management practice is to minimise fern residues remaining on the soil surface from the previous season. This may be achieved in several ways. The most common method is to chop and incorporate the fern into the soil in late autumn. Ridging up the rows may also be effective if debris is buried by soil. Burial of debris does not kill the overwintering fungus but prevents the release of air-borne ascospores in the spring. This practice can, however, cause other problems such as mechanical damage to roots and crowns that may favour infection by *Fusarium* species. Other options include removal and disposal of fern debris from the field prior to emergence of spears in spring, or use of a tractor-mounted propane burner to destroy fern debris by flaming. Chemical treatments may also have potential for reducing levels of spores released from infected debris (see 'Chemical control').

Crop management

Use of cover crops, mulches (e.g. rye) or wind barriers is sometimes recommended in the USA to minimise spear wounding by wind-blown soil particles. These measures may reduce the risk of Stemphylium development, but are unlikely to provide adequate control alone if environmental conditions are favourable and disease pressure is high. Other factors that may reduce Stemphylium risk are good drainage, adequate spacing and orientation of rows to allow air movement through the crop.

Chemical control

Debris treatments

In HDC Project FV 341, a range of fungicides, herbicides and fertilisers were applied to infected asparagus fern debris in February and March 2012 and evaluated for effects on Stemphylium spore release. Spore production was reduced by Amistar (azoxystrobin), Plover (difenoconazole), Reglone (diquat), Serenade ASO (*Bacillus subtilis*), Switch (cyprodinil + fludioxonil), Phorce (foliar fertiliser product) and urea. When all assessment data were combined, Switch (1 kg/ha) and urea (200 kg/ha) were the two most effective products; Switch had the largest initial effect whereas urea had the better persistent effect. These treatments have not as yet been trialled commercially but could potentially be used in combination with cultural practices to reduce inoculum levels on infected debris in January-March, prior to the start of spear harvest.

Fungicide strategy

Despite UK approvals for a range of fungicides on asparagus fern, annual outbreaks of Stemphylium occur. The sporadic nature of the disease and the duration of the fern growth period (approximately 4 months) mean that it may not be cost effective to use a routine prophylactic spray programme. However, disease development can occur rapidly under favourable environmental conditions and control may be lost when the timing of fungicide applications is not optimised in relation to infection events.

Fungicide application to spears is not permitted because of the likelihood of residues and it is also impractical for control of Stemphylium purple spot because new, unprotected spears emerge daily. Therefore, fungicidal control of Stemphylium purple spot relies on protection of developing fern. Fungicides that are approved on outdoor asparagus and that have potential activity against Stemphylium purple spot are listed in Table 1.

Table 1. Fungicides and a biofungicide approved for use on outdoor asparagus (April 2012) with potential activity against Stemphylium purple spot

Active ingredient(s)	Example products	Approval type	Mode of action
Azoxystrobin	Amistar	On-label	Protectant and locally systemic
Azoxystrobin/difenoconazole	Amistar Top	Off-label	Protectant and curative
Azoxystrobin/chlorothalonil	Olympus	On-label	Protectant and systemic
Bacillus subtilis	Serenade ASO	Off-label	Various
Boscalid/pyraclostrobin	Signum	Off-label	Protectant and systemic
Cyprodinil/fludioxonil	Switch	Off-label	Protectant and systemic
Difenoconazole	Difcor 250 EC Plover	Off-label	Protectant and curative

Please note: Always read and follow the product labels and off-label approval notices

General guidelines for use of different fungicide products for Stemphylium control are as follows: Products such as Amistar, Olympus, Signum and Switch are protectant and/or locally systemic so should be applied before or during the early stages of infection, since these fungicides have no curative activity. Products such as Amistar Top and Plover containing difenoconazole have some curative activity such that the fungus can be killed even if the product is applied after infection has taken place. In pot studies (HDC Project FV 341), the following fungicides approved for use on asparagus were found to be effective for reducing levels of Stemphylium purple spot when applied to the fern 3 days before infection took place: Amistar, Amistar Top, Olympus, Plover, Signum and Switch. Of these products, Plover was the most effective and also had a curative effect when applied 3 days post-infection. Since symptoms of Stemphylium can develop rapidly, the scope for curative activity may be limited and so maintenance of a protectant fungicide programme is advisable. In field studies, programmes commencing and ending with Signum were found to be more effective than similar programmes with Amistar; in addition late sprays of Signum (September) seemed to increase retention of green fern tissue.

Appropriate timing of fungicides for control of Stemphylium purple spot on asparagus fern will depend on risk in terms of disease pressure and weather conditions. The main period to protect the fern will be mid-June (or from end of harvest) to mid-September. Fern should be monitored regularly in order to detect early symptoms of the disease. If fern is at risk from Stemphylium attack (wet conditions forecasted, infected debris present, early symptoms observed on spears or young fern), fungicide applications may be warranted to minimise symptom development and to avoid yield losses in subsequent years. During prolonged warm, dry conditions, the number and frequency of fungicide applications may be reduced. In field studies (FV 341), under high disease pressure, five and six-spray fungicide programmes at 2-3 week intervals commencing in late June/early July and ending in early to mid-September reduced Stemphylium purple spot and increased root carbohydrate (CHO) levels at crown dormancy, compared with untreated crop areas.

Forecasting

Research in Michigan State, USA, France and the UK has shown that use of a simple model (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. In the TOMcast™ system, leaf wetness duration and the average temperature during wetness periods are used to derive Disease Severity Values (DSVs). DSVs are calculated every 24 hours and range from 0 to 4. DSVs accumulate until a threshold is reached, a spray is applied, and the DSV total is reset to 0.

Maximising the benefits of timing sprays according to the TOMcast™ model depend on the use of appropriate thresholds and suitable fungicide products. In HDC Project FV 341, fungicide programmes with 2-4 applications timed according to the TOMcast™ disease model reduced disease severity compared with an untreated control but were not as effective as routine programmes (5-6 sprays) in increasing root CHO levels at dormancy.

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. 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 involves 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 findings from HDC Project FV 341 is provided in 'Fungicide programme guidelines'.

Resistance management

Fungicide programmes should be planned to minimise the risk of fungicide resistance. For example, azoxystrobin and pyraclostrobin (strobilurins) are members of the QoI fungicide group for which resistance is reported for various fungal species. Disease control may be reduced if strains of pathogens less sensitive to strobilurins develop. To avoid the likelihood of resistance developing, application of products containing strobilurins should be made with due regard to current FRAG-UK guidelines for QoI compounds (www.pesticides.gov.uk). Label recommendations suggest that strobilurins are used in mixtures with a fungicide from a different cross-resistance group, as part of a programme, and that the number of strobilurin applications does not exceed 50% of the total fungicide applications.

Fungicide programme guidelines

The following example sequence of fungicides is effective for control of Stemphylium purple spot on asparagus: 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).

Fungicide programme guidelines for management of Stemphylium purple spot on asparagus

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 days 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 days 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 days 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 days after any previous spray)

Note

Omission of a fungicide product does not necessarily mean that it is not approved and available for use. No endorsement of named products is intended nor is any criticism implied of other alternative, but unnamed, products.

Regular changes occur in the approval status of pesticides, arising from changes in pesticide legislation or for other reasons. For the most up to date information, please check with your professional supplier, BASIS registered adviser or with the help-line at the Chemicals Regulation Directorate (CRD) (Tel 01904 455775; www.pesticides.gov.uk; Email: pesticides@hse.gsi.gov.uk).

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