Project title:	Asparagus: evaluation of spray treatments for control of purple spot (*Stemphylium vesicarium*) in a field crop
Project number:	FV 341a
Project leader:	Tim O'Neill, ADAS
Report	Final Report, October 2012
Previous reports:	None
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Location of project:	Commercial farm, Warwickshire
Industry representative:	Mr Philip Langley, Shropshires, Sandfields Farms, Luddington, Stratford on Avon
Date project commenced:	1 July 2012
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DISCLAIMER

The results and conclusions in this report are based on an investigation conducted over a one-year period. The conditions under which the experiments were carried out and the results have been reported in detail and with accuracy. However, because of the biological nature of the work it must be borne in mind that different circumstances and conditions could produce different results. Therefore, care must be taken with interpretation of the results, especially if they are used as the basis for commercial product recommendations.

AUTHENTICATION

We declare that this work was done under our supervision according to the procedures described herein and that the report represents a true and accurate record of the results obtained.

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GROWER SUMMARY

Headline

- Olympus (azoxystrobin + chlorothalonil) and Switch (cyprodinil + fludioxonil) gave the best control of purple spot out of five fungicides tested.

Background and expected deliverables

Stemphylium purple spot (*S. vesicarium*) on asparagus ferns often results in premature defoliation and can significantly reduce yield in subsequent seasons. In work on container-grown asparagus inoculated with spores of *S. vesicarium,* single sprays of Amistar Top (azoxystrobin + difenoconazole), Olympus (azoxystrobin + chlorothalonil), Plover (difenoconazole), Signum (boscalid + pyraclostrobin) and Switch (cyprodinil + fludioxonil) appeared to reduce the disease. Various programmes using these products in different sequences in field trials gave significant reductions of purple spot (FV 341). However, there is no sound information on the relative efficacy of individual products in the field, or their efficacy when used at different levels of disease pressure. The aim of this project was to compare the efficacy of five fungicide products each applied at two spray timings ('early' and 'late' first spray) in controlling Stemphylium purple spot on ferns. Additionally, the efficacy of a four-spray programme of Serenade ASO, and an alternating four-spray programme of Signum and Plover were examined; all the products listed for testing are approved for use on asparagus.

The expected deliverables from this project are increased knowledge on the relative efficacy of five fungicides and a biofungicide for control of Stemphylium purple spot, including their performance at two levels of disease pressure.

Summary of the project and main conclusions

A replicated large plot field experiment was established in late June 2012 in a two-year down field of asparagus, variety Gijnlim, in Warwickshire. Five fungicides approved for use on asparagus (Table 1) were each applied as two-spray programmes (a) from first appearance of the disease ('early' treatment), and (b) when the disease was obvious ('late' treatment), resulting in 10 treatment comparisons. Additionally, Serenade ASO was examined as a four-spray programme and Signum and Plover were applied alternately in a four-spray programme. Sprays were applied as a fine mist at 300 L/ha. Wet weather throughout much of July and early August resulted in severe disease development.

At the start of the experiment Stemphylium purple spot was present only on the stem bases and at a low level (1.3% stem surface area). Early spray programmes of Olympus (azoxystrobin + chlorothalonil) and Switch (cyprodinil + fludioxonil), each applied on 27 June and 12 July, gave good control on the stem base and branches five days after the second spray. There was also a trend for reduced spotting on needles with these two products. Amistar Top (azoxystrobin + difenoconazole), Plover (difenoconazole), Signum (boscalid + pyraclostrobin), Serenade ASO (*Bacillus subtilis*) and the Signum/Plover programme had no effect at this stage (Table 2). On 25 July (2 weeks after the early sprays were completed), all of the early spray programmes and also the Signum/Plover alternating programme were giving control (between 35% and 75% reduction) of lower stem infection. There was a low level (1 - 3%) of needle spot in the fern canopy at the time with no difference between treatments.

At the start of the late treatment programmes on 20 July, Stemphylium spotting was obvious on lower stems (4.3% surface area), and was also now present on needles in the fern canopy (2.9%). One week after the end of these programmes (9 August) the disease affected 20% of needles in untreated plots. This was reduced to 10% or less by all of the late two-spray programmes. Stemphylium spotting increased greatly during 9-16 August to affect 59% of needles by 16 August. The disease was reduced by all of the late two-spray programmes and also the Signum/Plover four-spray programme; Olympus (18.8% needles affected) and Switch (12.9%) were again the most effective products. The Olympus early two-spray programme also remained effective (26%), now four weeks after the last spray application. The Serenade ASO four-spray programme did not reduce Stemphylium at any assessment.

Visual assessment of canopy greenness largely reflected control of Stemphylium on fern needles, with Olympus and Switch generally having the highest scores. At one month after the final spray application, the proportion of canopy still green was less than 30% in all treatments except for plots which had received two late sprays of Olympus (54% green). The proportion of stems dead at this time (18% in untreated plots), due to severe Stemphylium in the canopy, was reduced by Switch early sprays (7%), Olympus late sprays (3%) and the Signum/Plover four spray programme (7%).

Olympus and Signum gave the most persistent control (1 month) of severe foci when products were applied as early sprays; Olympus and Switch gave the more persistent control (2 weeks) when products were applied as late spray. The reduced persistence of disease control from the late spray programmes is likely due to the higher disease pressure and possibly also from reduced spray penetration. In a wet year such as 2012, it is likely that a programme of at least four spray applications will be required to maintain protection. The

above results suggest that for the most effective disease control in a wet year programmes include early sprays of Olympus and/or Signum and later sprays of Olympus and/or Switch.

Table 1. Details of fungicides and a biofungicide examined for control of Stemphylium purple spot on asparagus - 2012

Product	**Active ingredients (fungicide group)**	**Rate of use (L or kg/ha)**	**Maximum number sprays**	**Approval status (October 2012)**
Amistar Top	azoxystrobin (11) + difenoconazole (3)	1.0	2	EAMU 0831/07
Olympus	azoxystrobin (11) + chlorothalonil (M5)	2.5	2	Label
Plover	difenconazole (3)	0.5	2	EAMU 0158/05
Signum	boscalid (7) + pyraclostrobin (11)	1.5	2	EAMU 2105/10
Serenade ASO	*Bacillus subtilis* (44)	10.0	20	EAMU 0475/2012
Switch	cyprodinil (9) + fludioxonil (12)	1.0	3	EAMU 3173/10

EAMU – Extension of Authorisation for Minor Use. Treatments applied under an EAMU are used at grower's own risk.

Table 2. Effect of fungicide spray programmes on control of Stemphylium purple spot on asparagus, Warwickshire – 2012

Treatment	% area lower stem affected		% needle spot in upper canopy		% severe foci	% green canopy
	17 July	**25 July**	**9 Aug**	**16 Aug**	**16 Aug**	**4 Sep**
1. Untreated	4.3	5.1	20.0	59.4	69.3	20.2
Early two-spray programmes (applied 27 June and 12 July)						
2. Amistar Top	3.9	**3.3**	12.1	46.2	56.7	15.8
3. Olympus	**1.5**	**1.3**	**0.9**	**25.8**	**43.3**	19.6
4. Plover	4.0	**3.1**	15.0	56.7	70.0	19.6
5. Signum	3.3	**2.1**	**11.2**	49.6	**45.0**	22.1
6. Switch	**1.8**	**1.7**	**3.9**	50.4	58.3	15.8
Late two-spray programmes (applied 20 July and 3 August)						
7. Amistar Top	2.9	**3.4**	**8.1**	**38.3**	50.0	25.0
8. Olympus	4.8	4.3	**8.2**	**18.8**	**33.3**	**54.2**
9. Plover	**2.8**	**2.9**	**10.1**	**29.2**	55.0	22.9
10. Signum	3.8	**3.0**	**9.2**	**37.1**	53.3	25.4
11. Switch	4.3	3.9	**5.7**	**12.9**	**30.0**	26.7
Four-spray programmes (applied 27 June, 12 and 20 July, 3 August)						
12. Serenade ASO	4.7	3.9	10.8	49.2	63.3	23.9
13. Signum/Plover	3.0	**2.5**	13.3	**29.6**	51.7	21.7

Values significantly different ($p < 0.05$) from the untreated in the same column are shown in bold. Sprays were applied at 14 day intervals with final treatments on 12 July (early two-spray programme) and 3 August (late two-spray and four-spray programmes).

Financial benefits

Poor control of Stemphylium on asparagus fern in the summer and autumn can reduce transfer of carbohydrate to roots and reduce yield in subsequent seasons. In the USA it was demonstrated that untreated control plots yielded around 20% less than plots on which the disease was managed successfully the previous season using fungicides. Information on the effect of Stemphylium control on yield in the UK is not available Assuming an average yield of 1 tonne/ha and a farm gate price of £5,500/tonne, a yield loss of 20% represents £1,100/ha, considerably more than the cost of a four-spray fungicide programme. Implementation of the results of this project are therefore likely to result in significant savings in a season when the disease is damaging.

Action points for growers

- Start fungicide treatment for control of Stemphylium on ferns immediately the first symptoms occur (usually at the stem base) and preferably before it spreads to the needle canopy.
- Purple spot has a short disease cycle and fungicides should be applied regularly to maintain control, particularly when there is frequent rainfall in July – September.
- Suitable fungicides include Amistar Top, Olympus, Plover, Signum and Switch; in our work Olympus and Switch were the two most effective products overall.
- Where there is reduced opportunity for spray application, consider using Olympus or Signum if early season and Olympus or Switch if later in the season to provide more persistent protection against severe disease foci.
- An alternating spray programme of Olympus and Switch is at low risk of resistance development and, based on the results of this project, should give good control of Stemphylium purple spot. If the programme starts with Switch, there is the option to apply a total of five sprays to a crop, should weather conditions and disease levels indicate this is necessary.

Figure 1: Asparagus Stemphylium symptoms in fungicide experiment 2012. Purple spot on needles (top left), canopy browning and needle fall (top right), comparison of plots with different disease severity (bottom left) and stem base lesions (bottom right).

SCIENCE SECTION

Introduction

A range of fungicides with activity against Stemphylium are approved for use on asparagus: Amistar Top (azoxystrobin + difenoconazole), Olympus (azoxystrobin + chlorothalonil), Plover (difenoconazole), Signum (boscalid + pyraclostrobin) and Switch (cyprodinil + fludioxonil). There is opportunity to assess the performance of these products in a field trial. Due to the restriction of a maximum of two sprays per crop (except for Switch where three are permitted), a full season programme of 4-5 spays of individual products cannot be done without crop destruction. It is therefore planned that products are applied as two-spray programmes early in the season, and in separate treatments as two-spray programmes later in the season. This will provide opportunity to determine if products differ in the level of control they provide at different levels of disease pressure.

The biofungicide Serenade ASO (*Bacillus subtilis*) was recently approved (EAMU 0425/2012) for use on vegetables with up to 20 applications per crop and a zero harvest interval. The product is marketed primarily for control of grey mould (*Botrytis cinerea*), but there is evidence in the literature that some strains of *Bacillus subtilis* inhibit growth of *S. vesicarium.* Also, in FV 341 we found that Serenade ASO applied as a foliar spray to overwintering asparagus debris reduced spore release of *S. vesicarium* significantly, indicating activity against the pathogen. There is opportunity to determine if Serenade ASO provides any control of Stemphylium purple spot on asparagus fern when applied as a programme of foliar sprays during the period of fern growth.

Materials and methods

Site and crop details

An experiment was established in a 2-year down crop of asparagus, cv. Gijnlim, in Warwickshire. There was a history of Stemphylium purple spot in asparagus on this site. Harvest of spears was completed on 22 May and the experiment was laid down around 5 weeks later when fern was 1.5 – 2 m high. The crop was grown according to normal farm practice, in 1.83 m wide beds. A crop diary is given in Appendix 1.

Treatments

Twelve treatments were examined in comparison with an untreated control (Table 1). The two products chosen for the four-spray fungicide programme (T13) were Signum and Plover.

This was because they represent different fungicide groups and therefore reduce resistance risk when used in alternation; and because they performed well in FV 341: Signum prolonged green canopy retention while Plover appeared to have the better curative activity of the products tested. Products were used at their full commercial rate and in compliance with label restrictions on maximum spray number (Table 2). Sprays were applied using a calibrated CO_2 assisted knapsack sprayer with a fine nozzle (F1002) at 2.0 bar pressure using a 2 m boom. Sprays were applied at 300 L/ha over the top of the crop.

Table 1. Details of fungicide and biofungicide treatments – Warwickshire, 2012

Treatment	Spray timing 1 (27 June)	Spray timing 2 (12 July)	Spray timing 3 (20 July)	Spray timing 4 (3 August)
1. Untreated	-	-	-	-
2. Amistar Top - early	✓	✓	-	-
3. Olympus - early	✓	✓	-	-
4. Plover - early	✓	✓	-	-
5. Signum - early	✓	✓	-	-
6. Switch - early	✓	✓	-	-
7. Amistar Top - late	-	-	✓	✓
8. Olympus – late	-	-	✓	✓
9. Plover – late	-	-	✓	✓
10. Signum – late	-	-	✓	✓
11. Switch - late	-	-	✓	✓
12. Serenade ASO	✓	✓	✓	✓
13. Programme	Signum	Plover	Signum	Plover

Table 2. Details of products used

Product	Active ingredients	Rate of use (Kg or L/ha)	Max spray number
Amistar Top	azoxystrobin + difenoconazole (250+125 g/L)	1.0	2
Olympus	azoxystrobin + chlorothalonil (80+400 g/L)	2.5	2
Plover	difenconazole (250 g/L)	0.5	2
Signum	boscalid + pyraclostrobin (26.7+6.7% w/w)	1.5	2
Switch	cyprodinil + fludioxonil (37.5+25% w/w)	1.0	3
Serenade ASO	*Bacillus subtilus* (13.96 g/L)	10 L/ha	20

Experimental design and statistical analysis

The experiment was a factorial design with two factors (product and timing) at 5 and 2 levels respectively. Additionally there were two treatments applied as four-spray programmes. Treatments were arranged in randomised blocks with threefold replication and double replication (6 plots) of the untreated control. Each plot consisted of an 8 m length of three adjacent beds (total plot width c.5 m). Assessments were done in the central 6 m length of the middle bed. Results were examined by ANOVA.

Disease assessments

Assessments were made of various symptoms of Stemphylium purple spot according to the stage of disease development at the time of the assessment. Plots were examined at four points, one near each end and two in the middle, from one side of the middle bed. The symptoms assessed were:

- % stem surface area affected by Stemphylium spot, lower halves of stems
- % stem surface area affected by Stemphylium spot, upper halves of stems and branches
- % needles affected by Stemphylium spot, and associated browning in the fern canopy
- % needles on the floor
- % of the plot length affected by severe disease foci
- % canopy green
- Proportion of stem bases dead (final assessment only)

Results and discussion

<u>Early spray treatment programmes</u>

The first spray was applied on 27 June 2012 when Stemphylium spotting was present only on the lower halves of stems and affected around 1.3% surface area. There were no significant differences ($p > 0.05$) between treatments or blocks at this stage (see Appendix 2). On 17 July, five days after completion of the early two-spray programmes, the disease had increased to affect 4.4% surface area of lower stem halves on untreated plots, and had spread to affect also the upper stem halves and needles (Table 3). Stemphylium purple spot was significantly reduced on lower stem halves by the early two-spray programmes of Olympus and Switch ($p = 0.003$) and on upper stem halves by these fungicides and Signum

(p = 0.011). Also, there was a trend for reduced needle spotting with Olympus and Switch. Neither of the four-spray programmes reduced disease significantly (p >0.05) at this stage. Levels of Stemphylium spotting on the late two-spray programmes were very similar to the untreated control, as to be expected as these plots were still untreated.

By 25 July, 2 weeks after completion of the early spray programmes, these treatments were all giving control of lower stem infection (Table 3). Olympus (1.3% stem area affected) and Switch (1.7%) were most effective, closely followed by Signum (2.1%). Olympus was significantly more effective than Amistar Top (3.3%) (p = 0.006). A similar pattern of disease control was evident on the upper stems and in the needle canopy, although no treatments were significantly different from the untreated (p >0.05) (Tables 3 and 4).

There were no significant differences (p>0.05) between treatments in the level of Stemphylium spotting on the stem bases after 25 July, probably a reflection of reduced fungicide spray penetration to this area with increasing growth of the fern canopy.

By 9 August, four weeks after the end of the early spray programmes, Stemphylium spot and associated needle browning was very obvious in the centre of the fern canopy of untreated plots, and some other plots, affecting c. 20% of the total needle surface area. Only plots treated early with Olympus and Switch remained largely unaffected in the canopy. Spotting was more obvious within the canopy than on the outside, adjacent to the pathway between beds. Sporulation on *S. vesicarium* was confirmed by microscope examination on brown needles examined the following day. It is likely that there was prolonged wetness duration in the canopy that resulted in sporulation and rapid disease spread between needles. One week later (16 August), Stemphylium spotting had increased greatly to affect 60% of needles on untreated plants (Figure 1). Olympus still had a discernible and significant (p = 0.003) beneficial effect at this stage, reducing canopy infection to 25.8%. None of the other early two-spray fungicide programmes remained effective.

<u>Late spray treatment programmes and four-spray programmes</u>

The assessment on 25 July was 5 days after the start of the late spray programmes. Somewhat surprisingly given the short time for treatments to have an effect, the level of infection on lower stem halves was significantly reduced (p <0.05) by Amistar Top, Plover and Signum, compared with untreated plants.

At this stage, treatments 12 (Serenade ASO) and 13 (4-spray fungicide programme) had each received three sprays compared with two in treatments 2-6 (early treatment programmes) and one in treatments 7-11 (late treatment programmes). Three sprays of Serenade ASO did not reduce Stemphylium, whereas the Signum/Plover/Signum

programme significantly reduced ($p < 0.05$) spotting on lower stems by around 50%. Needle loss on 25 July, judged by quantity of needles on the ground, ranged from 1.3 to 3.0% and there were no significant differences between treatments.

By 9 August, one week after completion of the late spray programmes (and of the four-spray programmes), Stemphylium was reduced from 20% canopy infection on untreated plants to 10% or less by all of the late two-spray programmes. Switch was most effective, reducing infection to 5.7% (Table 4).

As noted above, the disease increased greatly on untreated plants over the following week to affect 60% of canopy needles. The disease was reduced by all of the late two-spray programmes and also by the Signum/Plover four-spray programme. Olympus (18.8% of needle area affected) and Switch (12.9%) were the most effective. Switch was significantly ($p = 0.003$) better than Amistar Top (38.3% infection). When the late spray programmes are compared with regard to canopy greenness at this time, Olympus (60%) and Switch (69%) were significantly ($p < 0.001$) better than Amistar Top (41%), Signum (45%) and Plover (40%) (Table 5).

An assessment of the proportion of fern canopy severely affected by Stemphylium purple spot (% plot with severe foci) on 16 August clearly showed Olympus and Switch as the two best treatments whether programmes started early or late (Table 5 and Figure 2).

Serenade ASO applied as a four-spray programme did not reduce Stemphylium infection on stems or fern canopy, the proportion of a plot with severe disease foci, nor increase canopy greenness. There was a trend for reduced infection on stems and fern canopy at assessments up until 9 August, shortly after the final spray application, but thereafter severe foci of infection and plot greenness were very similar to untreated plots.

Persistence of control

As expected, none of the early two-spray programmes gave control (i.e. reduction in % plot with severe foci or increase in % greenness) that persisted through to the final assessment on 4 September (Table 5). Olympus and Signum had the greatest persistence of the early sprays, giving significant control (35-38%) of severe foci one month after the second spray was applied. Of the late two-spray programmes, Olympus and Switch gave good control (52-57%) of severe foci that persisted two weeks after the final spray, but no longer (Table 5). Olympus applied as a late two-spray programme also increased retention of green foliage that persisted one month.

In practice, especially in a wet year such as 2012, it is likely that a programme of at least four sprays will be required. Although the late two-spray programmes resulted in lower

disease at the final assessment than the early two spray programmes, a late start means higher disease pressure and more problems with spray penetration.

The four-spray programme tested in this work was among the best treatments with regard to % stems dead and % needle spot in the upper needle canopy towards the end of the season (Tables 4 and 5), although it had less effect on % greenness than two late sprays of Olympus (Table 5). A four-spray programme alternating Olympus with Switch warrants investigation for control of Stemphylium under conditions of high disease pressure as experienced in 2012. An alternating programme of Olympus and Switch is theoretically at low risk of resistance development as both products contain active ingredients, and the four active ingredients are in different fungicide groups.

Overall comparison of products and timings

The overall effectiveness of different products and timings was examined by combining the results of the early and late treatment programmes in a factorial analysis (Table 6). The proportion of the fern canopy still fully green on 25 July was significantly increased ($p = 0.015$) by all fungicides except for Amistar Top. Not surprisingly at this assessment, the early programmes had least needle spot and browning in the canopy ($p = 0.033$).

At the assessment of 16 August, two weeks after the final spray application, infection in the fern canopy was reduced by all the fungicides. Olympus and Switch were most effective; Olympus was significantly better ($p = 0.047$) than Amistar Top, Plover and Signum. At this late assessment, both the early and the late fungicide treatments had reduced canopy infection compared with untreated plants, with the late-spray programmes (27.2% infection) being significantly better ($p=0.001$) than the early – spray programmes (45.8% infection). Similarly, the late spray programmes overall resulted in a higher level of canopy greenness than the early spray programmes (51% and 40% respectively).

By 4 September, severe foci of Stemphylium affected more than 75% of the canopy in all treatments except for the late Olympus sprays (67%) (Table 5). This high level of infection resulted in canopy greenness values of around 20-25% except for the late Olympus sprays where over 50% of the canopy remained green (Table 5). Whereas both Olympus and Switch resulted in greater retention of canopy greenness at 2 weeks after the final spray, only Olympus showed a beneficial effect at 4 weeks (Table 6). Overall, the late-spray programmes resulted in a significantly higher ($p <0.001$) greenness score (31%) than the early-spray programmes (19%) (Table 6).

Plant death appeared to be due mainly to premature and extensive leaf browning and leaf fall rather than girdling stem base lesions. Three of the fungicide programmes reduced (p =

0.03) the proportion of dead stems when assessed on 4 September (Table 3). These were Switch early-sprays (6.7%), Olympus late-sprays (3.4%) and the Signum/Plover four-spray programme (6.6%), compared with 18.3% in untreated plots. The somewhat surprising result of a beneficial effect from Switch early-sprays and not from the late-sprays is consistent with the relative control on upper and lower stems at earlier assessments. The four-spray Serenade ASO programme (9.3% stem dead) appeared only slightly less effective than the four-spray Signum/Plover programme (6.6%), and was almost statistically different from the untreated.

Comparison with earlier work

In earlier work (FV 341) there was an indication (not statistically significant at $p = 0.05$) that Plover was more effective than Amistar Top, Olympus, Signum and Switch in reducing Stemphlylium purple spot on asparagus when applied to plants 3 days after artificial inoculation with the fungus. In the current work, Olympus and Switch were consistently the best two treatments, significantly better than the other fungicides at several assessments. Although Plover significantly reduced purple spot symptoms with spray programmes starting at low and high disease pressure (nil and 3% canopy spotting), it was not significantly better ($p>0.05$) than any of the other fungicides at any of the assessments. It seems likely that with the higher disease pressure and the observed statistical difference between treatments, the current work more accurately estimates the inherent activity of Plover against Stemphylium purple spot compared with other fungicides.

The greater efficacy of Olympus (azoxystrobin and chlorothalonil) than Amistar Top (azoxystrobin + difenoconazole) is interesting as the quantity of azoxystrobin applied is similar at 250 g ai/ha (Amistar Top) and 200 g ai/ha (Olympus). Possibly chlorothalonil provides better protection than difenoconazole against *S. vesicarium*. Also, possibly the more persistent control (5 weeks) observed with Olympus than all the other products (Table 4) is due to a greater persistence/redistribution of chlorothalonil in wet weather, a feature claimed for the fungicide when used on potatoes to control blight (*Phytophthora infestans*).

In earlier work (FV 341), emphasis was placed on using Signum early and late in a spray programme in order to achieve effective control and maintain canopy greenness. The current work also demonstrates good control of Stemphylium purple spot with Signum when used early, but Olympus and Switch appear to be the better products for effective disease control when used later in a season, at high disease pressure.

No rust (*Puccinia asparagi*) or other fungal disease occurred in the experiment. No symptoms of crop damage were observed after any of the treatment applications.

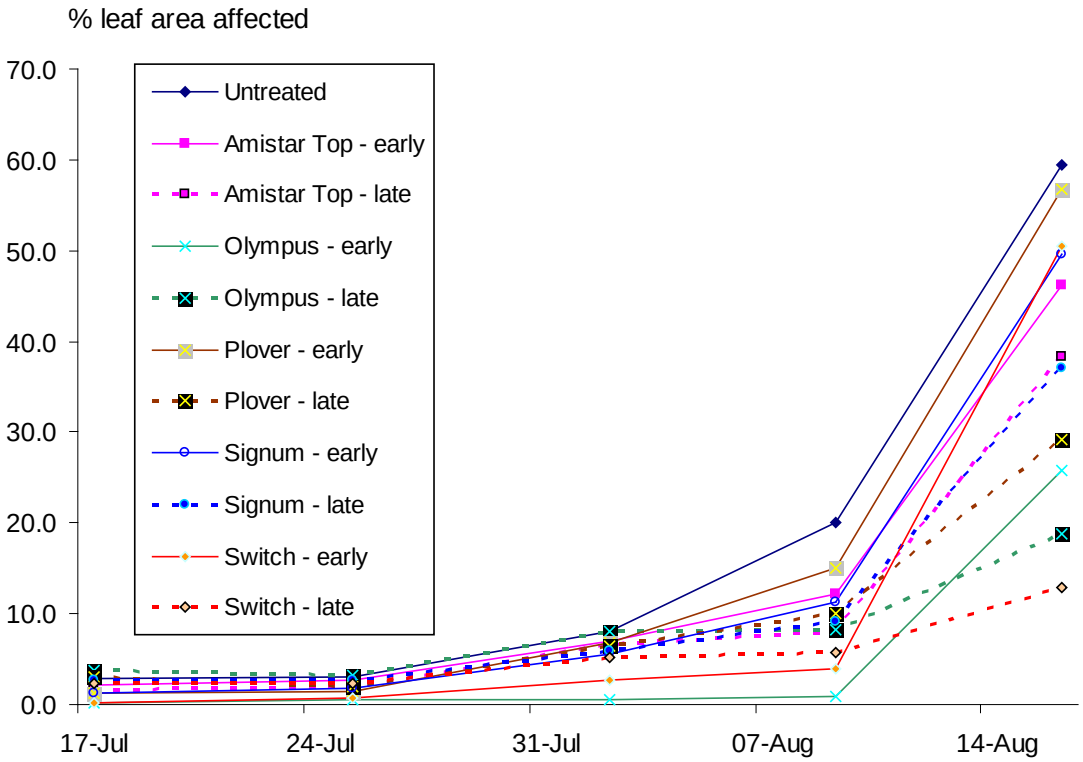

Figure 1. Effect of two sprays of different fungicides applied early (27 June and 12 July) or late (20 July and 3 August) on severity of Stemphylium needle browning on asparagus – Warwickshire, 2012

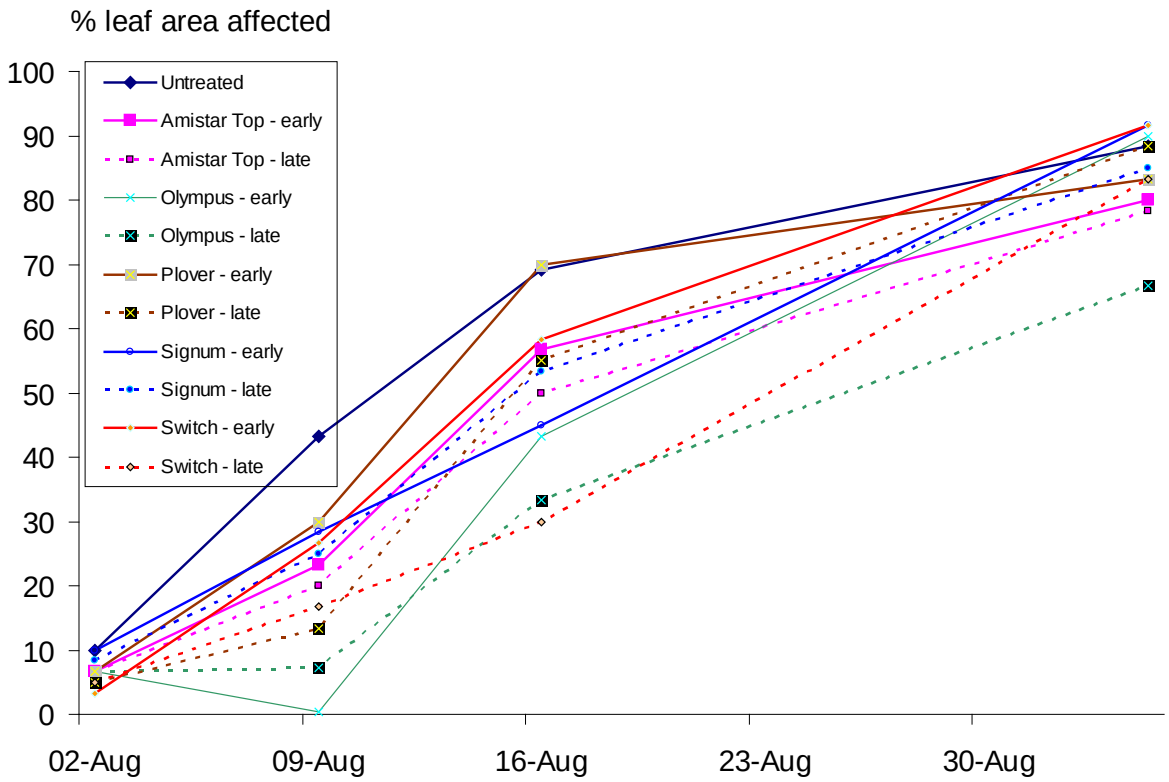

Figure 2. Effect of two sprays of different fungicides applied early (27 June and 12 July) or late (20 July and 3 August) on severe foci of Stemphylium in asparagus – Warwickshire, 2012

Table 3. Effect of various spray programmes on control of Stemphylium purple spot on asparagus, Warwickshire – 2012

Treatment	% area of lower stem affected					% area of upper stem affected					% stems dead
	17 July	25 July	2 Aug	9 Aug	16 Aug	17 July	25 July	2 Aug	9 Aug	16 Aug	4 Sep
1. Untreated	4.3	5.1	4.5	3.2	4.0	2.8	3.3	3.9	4.4	5.9	18.3
Early 2-spray programmes											
2. Amistar Top	3.9	**3.3**	3.3	3.3	4.7	1.6	1.4	2.0	4.6	5.1	19.0
3. Olympus	**1.5**	**1.3**	1.3	1.6	2.0	**0**	0.4	0.4	0.4	**2.5**	16.5
4. Plover	4.0	**3.1**	4.6	3.5	4.7	2.0	1.4	1.8	4.4	6.8	14.5
5. Signum	3.3	**2.1**	3.8	2.8	3.5	**1.3**	0.9	1.8	3.3	**4.0**	18.0
6. Switch	**1.8**	**1.7**	1.8	1.8	2.3	**0.2**	0.7	0.8	2.7	**2.8**	**6.7**
Late 2-spray programmes											
7. Amistar Top	2.9	**3.4**	4.7	3.9	4.9	1.6	2.0	2.3	4.2	4.7	12.0
8. Olympus	4.8	4.3	4.7	2.8	4.6	2.1	2.4	2.1	3.8	**3.5**	**3.4**
9. Plover	**2.8**	**2.9**	2.7	2.9	3.9	2.3	2.1	1.6	3.5	**4.0**	9.6
10. Signum	3.8	**3.0**	4.9	3.3	5.0	1.9	2.0	2.5	4.2	6.9	19.4
11. Switch	4.3	3.9	5.5	3.2	5.2	1.9	1.9	1.5	3.4	**3.5**	11.9
Four spray programmes											
12. Serenade ASO	4.7	3.9	2.8	2.9	3.8	2.6	2.2	1.7	4.0	5.2	9.3
13. Signum/Plover	3.0	**2.5**	2.8	2.0	4.1	**1.4**	2.2	4.4	3.5	5.6	**6.6**
Significance (27 df)	0.001	0.006	0.121	NS	NS	0.007	0.022	0.212	0.054	<0.001	0.03
LSD vs untreated	1.35	1.69	-	-	-	1.24	-	-	1.94	1.67	9.07
between treatments	1.57	1.95	-	-	-	1.45	-	-	2.24	1.93	10.47

Values significantly different (p <0.05) from the untreated in the same column are shown in bold.

Table 4. Effect of spray programmes on control of Stemphylium purple spot on asparagus, Warwickshire – 2012

Treatment	% needle spot upper canopy				
	17 July	**25 July**	**2 Aug**	**9 Aug**	**16 Aug**
1. Untreated	2.9	3.0	8.0	20.0	59.4
Early 2-spray programmes					
2. Amistar Top	2.1	2.6	**7.0**	12.1	46.2
3. Olympus	0.1	0.6	**0.5**	**0.9**	**25.8**
4. Plover	1.3	1.5	6.8	15.0	56.7
5. Signum	1.3	1.8	**5.5**	11.2	49.6
6. Switch	0.2	0.7	**2.7**	**3.9**	50.4
Late 2-spray programmes					
7. Amistar Top	1.7	1.9	6.6	**8.1**	**38.3**
8. Olympus	3.8	3.2	8.1	**8.2**	**18.8**
9. Plover	3.0	2.0	6.5	**10.1**	**29.2**
10. Signum	2.7	2.6	**5.9**	**9.2**	**37.1**
11. Switch	2.3	2.4	**5.2**	**5.7**	**12.9**
Four spray programmes					
12. Serenade ASO	2.7	2.0	6.4	10.8	49.2
13. Signum/Plover	2.8	1.6	6.9	13.3	**29.6**
Significance (27 df)	0.093	0.153	0.011	0.04	0.003
LSD vs untreated	-	-	1.58	9.47	21.09
between treatments	-	-	1.82	10.94	24.36

Values significantly different ($p < 0.05$) from the untreated in the same column are shown in bold.

Table 5. Effect of spray programmes on control of Stemphylium purple spot on asparagus, Warwickshire –2012

Treatment	% plot severe foci				% greenness			
	2 Aug	**9 Aug**	**16 Aug**	**4 Sep**	**2 Aug**	**9 Aug**	**16 Aug**	**4 Sep**
1. Untreated	10.0	43.3	69.2	88.3	89.2	69.4	34.2	20.2
Early 2-spray programmes								
2. Amistar Top	6.7	23.3	56.7	80.0	90.0	70.8	**45.0**	15.8
3. Olympus	6.7	**0.4**	**43.3**	90.0	92.5	**80.4**	43.3	19.6
4. Plover	6.7	30.0	70.0	83.3	88.8	71.3	41.7	19.6
5. Signum	10.0	28.3	**45.0**	91.7	89.6	69.2	35.0	22.1
6. Switch	3.3	26.7	58.3	91.7	94.2	**76.3**	36.2	15.8
Late 2-spray programmes								
7. Amistar Top	6.7	20.0	50.0	78.3	92.1	74.2	40.8	25.0
8. Olympus	6.7	**7.3**	**33.3**	66.7	90.8	**75.4**	**60.0**	**54.2**
9. Plover	5.0	**13.3**	55.0	88.3	92.5	**75.0**	39.6	22.9
10. Signum	8.3	25.0	53.3	85.0	89.2	74.2	**45.0**	25.4
11. Switch	5.0	**16.7**	**30.0**	83.3	91.3	**75.0**	**68.8**	26.7
Four spray programmes								
12. Serenade ASO	1.7	25.0	63.3	85.0	91.3	72.1	37.5	23.9
13. Signum/Plover	6.7	30.0	51.7	83.3	92.5	70.0	**44.2**	21.7
Significance (27 df)	0.916	0.062	0.012	0.053	NS	0.031	<0.001	<0.001
LSD vs untreated	-	22.10	19.49	-	-	5.59	9.77	9.22
LSD between treatments	-	25.52	22.50	-	-	6.45	11.28	10.65

Values significantly different (P <0.05) from the untreated in the same column are shown in bold.

Table 6. Overall effect of fungicide products and spray timings on control of Stemphylium purple spot of asparagus, Warwickshire – 2012

Factor	% needle spot and browning in canopy			% greenness		
	25 July	**9 Aug**	**16 Aug**	**25 July**	**16 Aug**	**4 Sep**
Fungicide						
Untreated	3.0	20.0	59.4	93.2	34.2	20.2
Amistar Top	2.2	10.1	**42.3**	94.3	42.9	20.4
Olympus	2.0	4.6	**22.3**	**95.7**	**51.7**	**36.9**
Plover	1.8	12.5	**42.9**	**94.5**	40.6	22.5
Signum	2.2	10.2	43.3	**94.5**	40.0	22.5
Switch	1.5	4.8	**31.7**	**96.0**	**52.5**	21.2
Significance (23 df)	NS	NS	0.047	0.015	0.010	<0.001
LSD	-	-	16.13	1.14	8.58	7.36
Timing						
Untreated	3.0	20.0	59.4	93.2	34.2	20.2
Early programmes	**1.5**	12.1	**45.8**	95.3	**40.3**	18.6
Late programmes	2.4	8.1	**27.2**	94.7	**50.8**	**30.8**
Significance (23 df)	0.033	NS	0.001	NS	<0.001	<0.001
LSD vs untreated	0.85	-	10.20	-	5.43	4.65
between treatments	1.13	-	13.50	-	7.18	6.15

Figures in bold are significantly different from the untreated in the same column.

Early and late spray programmes were completed on 12 July and 3 August respectively.

Conclusions

1. Stemphylium purple spot developed rapidly during July and August 2012, a period when there was heavy rain and frequent showers. The disease spread from the stem base (late June) to cause 20% needle browning on untreated plants by 9 August, and 60% by 16 August.

2. Spray application of fungicides at a low volume (300 L/ha) and high pressure (2.5 bar) over the top of 1.5 – 2 m tall asparagus ferns, before a full canopy of needles was present, was initially effective at reducing Stemphylium spotting at the stem

base. Treatment differences reduced and became non-significant as the season progressed, probably due to reduced spray penetration through the fern canopy.

3. Amistar Top (azoxystrobin + difenoconazole), Olympus (azoxystrobin + chlorothalonil), Plover (difenconazole), Signum (boscalid + pyraclostrobin) and Switch (cyprodinil + fludioxonil) all significantly ($p < 0.05$) reduced Stemphylium on stems and/or needles.
4. Olympus and Switch were significantly ($p < 0.05$) more effective than the other fungicides tested, at one or more assessments when applied at either low or high disease pressure (nil or 3% spotting in the fern canopy respectively at the start of spray treatments).
5. The proportion of dead stems in early September was significantly reduced ($p < 0.05$), from around 20% to less than 7%, by Switch (two early sprays), Olympus (two late sprays) and by a four-spray Signum/Plover alternating programme.
6. An Alternating spray programme of Olympus and Switch is at low risk of resistance development and based on the results of this project, should give good control of Stemphylium purple spot. If the programme starts with Switch, there is the option to apply a total of five sprays to a crop, should weather conditions and disease levels indicate this is necessary.
7. There was a trend for reduced Stemphylium following treatment with Serenade ASO (*Bacillus subtilis*) but the difference was not statistically significant ($p > 0.05$).

Technology transfer

Project update in ADAS Vegetable Notes and HDC weekly email, 2 August 2012.

Project update to Asparagus Growers Association, 5 September 2012.

<u>Article</u>

O'Neill TM (2012). Fungicide treatments for asparagus purple spot. *HDC News*. (submitted)

Appendix 1 Crop diary

Date	Action
27 June 2012	Trial marked out. Spray 1 applied. Ferns c. 1.5 - 2 m tall
	Baseline disease assessment in all plots
12 July 2012	Spray 2 applied (end of early treatment programmes)
17 July 2012	Full disease assessment
20 July 2012	Spray 3 applied (start of late treatment programmes)
25 July 2012	Full disease assessment
30 July 2012	Browning obvious within the needle canopy (c. 20% on untreated plants)
31 July 2012	Stemphylium sporulation confirmed on brown needles collected the previous day
2 Aug 2012	Full disease assessment
3 Aug 2012	Spray 4 applied (end of late treatment programmes)
9 Aug 2012	Full disease assessment
16 Aug 2012	Full disease assessment
4 Sep 2012	Assessment of disease foci and canopy greenness

Appendix 2 Additional disease assessment data

Treatment	Baseline disease	Greenness (%)
	% stem base area, 27 June	25 July
1. Untreated	1.4	93.2
Early 2-spray programmes		
2. Amistar Top	1.2	94.3
3. Olympus	1.8	**96.3**
4. Plover	1.5	**94.7**
5. Signum	1.3	**94.7**
6. Switch	1.6	**96.3**
Late 2-spray programmes		
7. Amistar Top	1.2	94.3
8. Olympus	1.2	**95.0**
9. Plover	1.2	94.3
10. Signum	1.2	94.3
11. Switch	1.1	**95.7**
Four spray programmes		
12. Serenade ASO	1.5	**95.3**
13. Signum/Plover	1.5	94.3
Significance (27 df)	0.566	0.008
LSD vs untreated	-	1.45
between treatments	-	1.67

Values in bold are significantly different from the untreated.