

SCEPTREPLUS

Final Trial Report

Trial code:	SP 32
Title:	Control of fungal disease in ornamental plants
Crop	Group: Ornamental plants – Nine species
Target	<i>Botrytis cinerea</i>
Lead researcher:	Dave Kaye
Organisation:	RSK ADAS
Period:	1 st October 2018 – 31 st December 2018
Report date:	31 st March 2019
Report author:	Dave Kaye
ORETO Number: (certificate should be attached)	409

I the undersigned, hereby declare that the work was performed according to the procedures herein described and that this report is an accurate and faithful record of the results obtained.

Date: 9th May 2019

Authors signature:



Trial Summary

Introduction

A wide range of ornamental plants are commercially grown in the UK, encompassing a variety of plant species. Fungal pathogens threaten the health and marketability of these plants, with Botrytis (*Botrytis cinerea*) one of the most common diseases requiring treatment. Current controls are becoming increasingly limited, with few new active substances and products available, and others withdrawn or failing to gain re-registration. Consequently, new products to treat Botrytis disease need to be identified.

Ornamental plants are sold based on aesthetics and quality, and any phytotoxicity reduces plant marketability. Fern species are particularly prone to suffer these affects, with few crop-safe fungicide options available. For example, Rovral WG (iprodione) was one of a few products used for control of Botrytis without phytotoxicity issues on ornamentals, but was withdrawn from use in the UK in June 2018.

Methods

Trials were run at a commercial nursery in Herefordshire, England. Nine commonly grown hardy nursery stock species were included, selection was based on their relative susceptibilities to Botrytis infection. These included two ferns—Polystichum and Dryopteris—as well as Ajuga, Heuchera, Primula, Sedum, Verbascum, Vinca, English Lavender and Rudbeckia. Treatments including an untreated control, industry standard and nine test products were evaluated for Botrytis control; six conventional fungicides and three biofungicide treatments, all applied as foliar sprays. Treatments were applied alone as a four spray programme, at a 10 day interval on 13th November, 23rd November, 4th December, and 14th December respectively. All treatments were applied using a 0.5 m boom with an Oxford Precision Sprayer knapsack at 500 L ha⁻¹ water volume. The industry standard, Signum, was applied at commercial label rate for use on ornamental crops. The test products were applied at rates recommended by the individual product manufacturer (see application details section).

An individual trial was established for each species, due to the requirement for specific husbandry inputs. A randomised block design was used with four replicates of ten treatments, including an untreated control (water), totaling 40 plots per species. Each plot comprised five plug plants (5 cm wide, 4-15 cm high, dependent on individual species), planted in individual 10 cm liner pots. Plots were assessed for Botrytis severity only, by recording the percentage of leaf area with Botrytis browning. This was done on six occasions: at the start of the trial, immediately before each treatment and two weeks following the final treatment application. Phytotoxicity was assessed 10 days after each treatment application and immediately before the next treatment and two weeks after the final treatment application.

All the trials with the different plant species were artificially inoculated with Botrytis (isolated from English Lavender, cultured in the laboratory, then applied at a concentration of 10⁴ spores ml⁻¹) 24 hours prior to the first treatment application (November 12th).

Results

Disease: Despite placement of the trials under cool and damp conditions, and an evening watering schedule, Botrytis symptoms developed slowly, with the disease developing in just five of the nine species (Ajuga, Heuchera, Primula, Rudbeckia and Sedum). An increased concentration of Botrytis spores applied during artificial inoculation may have increased the incidence and severity of Botrytis, however the trial was placed amongst several other commercial crops and significant disease development would have put these at risk.

Due to limited Botrytis infection, and low levels of subsequent symptom development (<3% leaf area affected in untreated plots), the results were limited to two plant species which exhibited greater than 10% botrytis severity by the final assessment. Botrytis is able to infect

both mature and senescent material and during the final assessments, levels of natural senescence were greatest on Sedum, which resulted in the greatest Botrytis severity scores. Statistically significant differences in Botrytis severity were seen in Sedum and Heuchera at two assessment dates (Tables 1 and 2). Data from the other plant species has not been presented here as no botrytis developed.

Table 1. Effect of biological and chemical fungicides on mean Botrytis severity (%) in Sedum at each assessment date, 2018.

	Sedum - Average % Botrytis severity				
Date	13-Nov	23-Nov	03-Dec	13-Dec	27-Dec
Day	0	10	20	31	45
Treatment					
Untreated	0.00	0.00	10.10	62.35	Fully died back
Signum	0.00	0.00	16.95	57.25	Fully died back
AHDB9891	0.00	0.00	12.25	52.90	Fully died back
AHDB9873	0.00	0.00	12.30	73.65	Fully died back
AHDB9926	0.00	0.00	5.15	27.25	Fully died back
AHDB9872	0.00	0.00	3.15	14.95	Fully died back
AHDB9885	0.00	0.00	8.90	54.00	Fully died back
AHDB9927	0.00	0.00	8.25	49.25	Fully died back
AHDB9913	0.00	0.00	3.25	39.35	Fully died back
AHDB9871	0.00	0.00	21.25	77.85	Fully died back
	Not significantly different from the untreated control (p>0.05).				
	Significantly different from the untreated control (p≤0.05).				

For Sedum, AHDB9926, AHDB9872 and AHDB9913 treated plants showed significantly reduced Botrytis disease severity compared with both the untreated control, and the industry standard, Signum, at Assessment 4 (13th December). By the final assessment, all living plant tissue had senesced and was not assessed.

Table 2. Effect of biological and chemical fungicides on mean Botrytis severity (%) in Heuchera at each assessment date, 2018.

	Heuchera - Average % Botrytis severity				
Date	13-Nov	23-Nov	03-Dec	13-Dec	27-Dec
Day	0	10	20	31	45
Treatment					
Untreated	0.00	0.00	5.75	4.05	10.50
Signum	0.00	0.00	7.50	3.70	7.25
AHDB9891	0.00	0.00	4.55	3.65	4.65
AHDB9873	0.00	0.00	6.00	5.05	5.00
AHDB9926	0.00	0.00	4.45	3.70	2.75
AHDB9872	0.00	0.00	3.65	2.70	2.75
AHDB9885	0.00	0.00	4.45	4.10	4.30
AHDB9927	0.00	0.00	5.85	3.75	4.80
AHDB9913	0.00	0.00	6.25	3.25	3.15
AHDB9871	0.00	0.00	5.15	4.65	5.60

	Not significantly different from the untreated control ($p>0.05$).
	Significantly different from the untreated control ($p\leq 0.05$).

For Heuchera, all treatments significantly reduced the severity of Botrytis compared with the untreated control, except for the industry standard, Signum.

Botrytis incidence was also evaluated with no treatment significantly reducing botrytis infection compared to the untreated control in any species, at any assessment date.

Crop safety: Low levels of phytotoxic symptoms were seen on Polystichum and Dryopteris alone—the two fern species, across all test products. Damage was limited to the young unfurling fronds which were stunted, and suffered slight yellowing. Phytotoxicity was first observed in some treatments before the second treatment application, with all treatments showing some symptoms by the final assessment date (Tables 3 and 4). Symptoms remained minor and never progressed to unacceptable levels, even after four applications had been applied. These effects were short-lived, with the young fronds growing away from this damage as they matured. The levels of phytotoxicity were not of commercial concern, and all affected plants were of marketable quality.

Table 3. Average phytotoxicity effect of the biological and chemical fungicides tested on Polystichum at each assessment date, 2018.

	Polystichum - Average phytotoxicity score				
Date	13-Nov	23-Nov	03-Dec	13-Dec	27-Dec
Day	0	10	20	31	45
Treatment					
Untreated	10	10	10	10	10
Signum	10	10	9	9	10
AHDB9891	10	10	9	9	9
AHDB9873	10	10	9	9	9
AHDB9926	10	10	9	9	9
AHDB9872	10	10	9	9	9
AHDB9885	10	10	9	9	9
AHDB9927	10	10	9	9	9
AHDB9913	10	10	9	9	9
AHDB9871	10	10	9	9	9

10 = No damage, 0 = dead, 8 = acceptable damage, i.e. unlikely to impact marketability and is acceptable to the grower.

Table 4. Average phytotoxicity effect of the biological and chemical fungicides tested on Dryopteris at each assessment date, 2018.

	Dryopteris - Average phytotoxicity score				
Date	13-Nov	23-Nov	03-Dec	13-Dec	27-Dec
Day	0	10	20	31	45
Treatment					
Untreated	10	10	10	10	10
Signum	10	10	10	10	9
AHDB9891	10	10	10	9	9
AHDB9873	10	10	10	9	9
AHDB9926	10	9	10	10	9

AHDB9872	10	10	10	9	9
AHDB9885	10	10	9	9	9
AHDB9927	10	10	10	9	9
AHDB9913	10	10	10	9	9
AHDB9871	10	10	10	10	9

10 = No damage, 0 = dead, 8 = acceptable damage, i.e. unlikely to impact marketability and is acceptable to the grower.

Conclusions

- Botrytis developed, following inoculation prior to the first fungicide application, in five of the nine test plant species, but it was at a low level (<3%) for all plant species except Heuchera and Sedum which had severity of 10% and 62% respectively by the end of the trial.
- Three succinate dehydrogenase inhibitors (SDHI) products, AHDB9926, AHDB9872 and AHDB9913 reduced the severity of Botrytis in Sedum at the penultimate assessment. The industry standard Signum did not reduce disease significantly.
- All products significantly reduced the severity of Botrytis in Heuchera by the final assessment including the industry standard Signum.
- No phytotoxic damage developed on Ajuga, English Lavender, Heuchera, Primula, Rudbeckia, Sedum or Vinca following application of any of the treatments.
- Low levels of phytotoxic damage developed in the two fern species, Dryopteris and Polystichum, following treatment application. However, damage from all treatments was minor, and comparable to that caused by the industry standard, Signum. All affected plants were of marketable quality.

Conclusions: All test products were shown to reduce Botrytis severity in at least one test plant species. Phytotoxic effects were seen in the two fern species, but not to a level of commercial concern.

Objectives

1. To screen new fungicides and biofungicides for Botrytis control efficacy in a range of ornamental species.
2. To screen new fungicides and biofungicides in a range of ornamental species, including those known to be vulnerable to phytotoxic damage.

Trial conduct

UK regulatory guidelines were followed but EPPO guidelines took precedence. The following EPPO guidelines were followed:

Relevant EPPO guideline(s)		Variation from EPPO
EPPO PP1/54(3)	Botrytis spp. on vegetables	Yes – see below
EPPO PP1/135(4)	Phytotoxicity assessment	None
EPPO PP1/152(4)	Guideline on design and analysis of efficacy evaluation trials	None
EPPO PP1/221(1)	Foliar disease of non-woody ornamentals	Yes – see below
EPPO PP1/225(2)	Minimum effective dose	None
EPPO PP1/181(4)	Conduct and reporting of efficacy evaluation trials including good experimental practice	None
EPPO PP1/224(2)	Principles of efficacy evaluation for minor uses	None

Deviations from EPPO guidance:

1. EPPO PP1/221(1), EPPO PP1/54(3) – Plot size was reduced to five plants due to space constraints, plot size remained sufficient for robust statistical analysis, (confirmed by the ADAS statistician).

Test site

Item	Details
Location address	Polytunnel Wyevale Nurseries, Wyevale Way, Hereford HR4 7AY
Crop and variety	Ajuga – ‘Chocolate Chip’ Dryopteris – <i>Dryopteris erythrosa</i> Heuchera – ‘Liquorice’ Primula – <i>Primula beesiana</i> Polystichum – <i>Polystichum rigens</i> Sedum – ‘Bertram Anderson’ Verbascum – ‘Flush of White’ Vinca – ‘Bowles Purple’ English Lavender - <i>Lavandula angustifolia</i> Rudbeckia – <i>Rudbeckia deamii</i>
Soil or substrate type	Compost
Agronomic practice	See Appendix A
Prior history of site	See Appendix A

Trial design

Item	Details
Trial design:	Randomised block
Number of replicates:	4
Row spacing:	12 cm
Plot size: (w x l)	20 cm x 30 cm
Plot size: (m ²)	0.06 m ²
Number of plants per plot:	5
Leaf Wall Area calculations	N/A

Treatment details

AHDB Code	Active substance	Product name/ manufacturers code	Formulation batch number	Content of active substance in product	Formulation type
N/A	Water	Untreated control	-	-	-
N/A	Boscalid & pyraclostrobin	Signum	12-P00528	26.7 g L ⁻¹ & 6.7 g L ⁻¹	Water dispersible granule
AHDB9891	N/D	N/D	N/D	N/D	N/D
AHDB9873	N/D	N/D	N/D	N/D	N/D
AHDB9926	N/D	N/D	N/D	N/D	N/D
AHDB9872	N/D	N/D	N/D	N/D	N/D
AHDB9885	N/D	N/D	N/D	N/D	N/D
AHDB9927	N/D	N/D	N/D	N/D	N/D
AHDB9913	N/D	N/D	N/D	N/D	N/D
AHDB9871	N/D	N/D	N/D	N/D	N/D

No adjuvants were included at any treatment application.

Commercial trial: Methods, assessments and records

Trials were sited at a commercial nursery in Herefordshire, England. Nine commonly grown hardy nursery stock species were included, selected based on their relative susceptibilities to Botrytis infection. These included two ferns—Polystichum and Dryopteris—as well as Ajuga, Heuchera, Primula, Sedum, Verbascum, Vinca, English Lavender and Rudbeckia. All plants were sourced wholesale from two commercial growers and at arrival were 5 cm x 8-10 cm in size. Due to the specific crop husbandry inputs required for each plant species, nine individual trials were established. All test products were applied alone as a four spray repeated programme, at a 10 day interval (A - D), as foliar sprays at the maximum rate recommended by product manufacturers. Applying products singly, rather than within mixed programmes, was used in order to establish each product's efficacy, but also to directly attribute any phytotoxic affects which developed to individual products. All treatments were applied using a 0.5 m boom with an Oxford Precision Sprayer knapsack at 500 L ha⁻¹ water volume, using 03F110 nozzles.

The trial took place from early November to late December 2018, to maximise any natural disease pressure and opportunity for Botrytis infection to occur. Following arrival, on 31st October 2018, trial plants were potted up into 10 cm liner pots by staff at the host nursery. All aspects of plant husbandry were performed by the host nursery, following standard commercial practices. However, staff were requested to water the trial plants by hand in the evening, during times where watering was necessary, to try and provide conditions suitable for Botrytis infection.

Inoculation with Botrytis: Mature English Lavender plants were sourced from infected lavender plants from a commercial garden centre in October, and watered and stored in large sealable plastic bags at ambient temperatures. Botrytis that subsequently developed was isolated and grown on potato dextrose agar (PDA) in the laboratory at ADAS Boxworth. Plates were grown for 14 days in an incubator (19°C, 12:12 light:dark cycle) until grey

sporulation developed. A spore suspension (1×10^4 spores ml^{-1}) was then produced and applied to each trial plot (5 plants) on 12th November using a new hand held pump sprayer. Each plot received four full pumps, 20 cm above soil level, equating to 1.2 ml, giving a calculated 1.2×10^4 spores per plot. Inoculation was done in the afternoon in the trial polytunnel, under cool/cloudy and still conditions. The growing-media was damp before inoculation and the floor surrounding the trial, including between individual blocks, was wetted up to increase relative humidity.

Experimental design: A randomised block design was used with four replicates of ten treatments, including an untreated control (water), totaling 40 plots per species. Each plot comprised five plug plants, planted in individual 10 cm liner pots. Plots were assessed for Botrytis severity on five occasions, recording the percentage of leaf area with Botrytis browning. Phytotoxicity was assessed 10 days after each treatment was applied and two weeks after the final treatment application.

No pesticides other than the test products were applied, except for a Nimrod (bupirimate) overspray on 28th November, to treat powdery mildew. Bupirimate is specifically for powdery mildew treatment, and its use would not be expected to have had a detrimental impact on the results gathered. No phytotoxicity issues were recorded on any species following the Nimrod overspray.

Application schedule

Treatment number	Treatment: product name or AHDB code	Rate of active substance (ml or g a.s./ha)	Rate of product (l or kg/ha)	Application code
1	Control (water)	-	-	A-D
2	Signum	36.045 & 9.045	1.35	A-D
3	AHDB9891	625	2.50	A-D
4	AHDB9873	396	0.90	A-D
5	AHDB9926	360	1.00	A-D
6	AHDB9872	2500	5.00	A-D
7	AHDB9885	Not stated	4.00	A-D
8	AHDB9927	2000	4.00	A-D
9	AHDB9913	360	1.20	A-D
10	AHDB9871	4.14	0.30	A-D

Application details

	Application A	Application B	Application C	Application D
Application date	13/11/2018	23/11/2018	04/12/2018 ¹	14/12/2018
Time of day	13:50 – 15:20	14:15 – 15:25	14:35 – 15:16	15:09 – 16:14
Crop height (cm)				
Ajuga	04	4	4	4
Dryopteris	15	15	15	15
Heuchera	10	10	10	10
Primula	4	4	4	4
Polystichum	15	15	15	15
Sedum	5	5	5	5
Vinca	7	7	7	7
English Lavender	7	7	7	7
Rudbeckia	5	5	5	5
Crop coverage (%)				
Ajuga	30	30	30	30
Dryopteris	75	75	75	75
Heuchera	70	70	70	70
Primula	50	50	45	35
Polystichum	90	90	90	90
Sedum	30	25	20	10
Vinca	50	50	55	55
English Lavender	35	35	35	35
Rudbeckia	50	50	50	50
Application Method	Spray	Spray	Spray	Spray
Application Placement	Foliar	Foliar	Foliar	Foliar
Application equipment	Oxford Precision Sprayer (Knapsack)	Oxford Precision Sprayer (Knapsack)	Oxford Precision Sprayer (Knapsack)	Oxford Precision Sprayer (Knapsack)
Nozzle pressure	2	2	2	2
Nozzle type	03F110	03F110	03F110	03F110
Nozzle size	Flat fan	Flat fan	Flat fan	Flat fan
Application water volume/ha	500	500	500	500
Temperature of air - shade (°C)	12.6 - 13.6	7.5 - 7.9	5.0	4.1 - 4.2
Relative humidity (%)	74.1 - 82.0	89.4 - 89.5	90.8 – 91.0	92.3 – 92.4
Wind speed range (m/s)	0	0	0	0
Dew presence (Y/N)	N	N	N	N
Temperature of soil - 2-5 cm (°C)²	Not recorded	Not recorded	Not recorded	Not recorded
Wetness of soil - 2-5 cm	Damp	Damp	Damp	Damp
Cloud cover (%)	N/A	N/A	N/A	N/A

¹Application C was delayed by one day, to 11 days, due to issues with the spray lance. No plots received any treatment on this date and the trial was successfully treated on December 4th.

²Plants were grown in growing-media in 10 cm liner pots in a protected environment (polytunnel). Soil temperature was not recorded.

Untreated levels of pathogens at application and through the assessment period

Common name	Scientific Name	EPPO Code	Species	Infestation level pre-application, untreated disease severity (average %)	Infestation level at start of assessment period, untreated disease severity (average %) ¹	Infestation level at end of assessment period, untreated disease severity (average %)
Botrytis	<i>Botrytis cinerea</i>	BOTRCI	Ajuga	0.00	0.00	1.40
Botrytis	<i>Botrytis cinerea</i>	BOTRCI	Polystichum	0.00	0.00	0.00
Botrytis	<i>Botrytis cinerea</i>	BOTRCI	Dryopteris	0.00	0.00	0.00
Botrytis	<i>Botrytis cinerea</i>	BOTRCI	Heuchera	0.15	0.15	10.50
Botrytis	<i>Botrytis cinerea</i>	BOTRCI	Primula	0.00	0.00	1.15
Botrytis	<i>Botrytis cinerea</i>	BOTRCI	Sedum	0.00	0.00	62.35 ²
Powdery Mildew ³	Podosphaera species	ERYSP	Sedum	3.30	3.30	0.00
Botrytis	<i>Botrytis cinerea</i>	BOTRCI	Vinca	0.00	0.00	0.00
Botrytis	<i>Botrytis cinerea</i>	BOTRCI	English Lavender	0.00	0.00	0.00
Botrytis	<i>Botrytis cinerea</i>	BOTRCI	Rudbeckia	0.00	0.00	2.90

¹The first full assessment took place immediately prior to the first application.

²All Sedum plants had fully senesced by the final assessment, and no data was recorded. This value represents the infestation level at the penultimate assessment on 13th December.

³Botrytis is the primary target of this study, not powdery mildew. A curative overspray of Nimrod (bupirimate), a systemic, specific fungicide for powdery mildew was applied on 28th November to both cure current infection, and prevent further infection occurring.

No pests/pest damage were recorded on any plants at any assessment date.

Assessment details

All plants per plot were assessed for plant vigour before treatments were applied (13th November). At this date, before each subsequent treatment application, and 14 days following the final treatment, all plants were assessed for Botrytis severity and phytotoxic damage. Disease severity was scored as a percentage of total plant area affected.

Evaluation date	Evaluation timing (DA)*	Crop Growth Stage (BBCH)	Evaluation type (plant vigour, efficacy, phytotoxicity)	Assessment e.g. plant vigour, disease incidence and severity, phytotoxicity
13/11/2018	0	See application details	Plant vigour & pathogen presence	Plant vigour (1-5), 1 = very poor, 5 = excellent. Disease incidence, 0 or 1. Disease severity, percent of disease coverage of each plant/plot.
23/11/2018	10	See application details	Efficacy & phytotoxicity	Disease incidence, 0 or 1. Disease severity, percent of disease coverage of each plant/plot. Phytotoxicity (scale 0-10, 10 = no effects, 0 = dead).
03/12/2018	20	See application details	Efficacy & phytotoxicity	Disease incidence, 0 or 1. Disease severity, percent of disease coverage of each plant/plot. Phytotoxicity (scale 0-10, 10 = no effects, 0 = dead).
13/12/2018	31	See application details	Efficacy & phytotoxicity	Disease incidence, 0 or 1. Disease severity, percent of disease coverage of each plant/plot. Phytotoxicity (scale 0-10, 10 = no effects, 0 = dead).
27/12/2018	45	See application details	Efficacy & phytotoxicity	Disease incidence, 0 or 1. Disease severity, percent of disease coverage of each plant/plot. Phytotoxicity (scale 0-10, 10 = no effects, 0 = dead).

* DA – days after first spray application.

Statistical analysis

The trial was analysed by Chris Dyer (ADAS statistician) as a randomised block design with four replicates of 10 treatments using ANOVA (Genstat). The results for each species were analysed separately and no data transformation was required.

Results

Phytotoxicity

No phytotoxicity was recorded in the Ajuga, English Lavender, Heuchera, Rudbeckia, Sedum or Vinca following application of any of the treatments, at any assessment date. Slight yellowing and stunting occurred on the newly emerging fronds of the two fern species, Polystichum and Dryopteris, at the third and all subsequent assessments. This damage was found in plants treated with all test products, and the commercial standard Signum. Damage was minor and not of commercial significance, and the affected plants grew away from it well. No physical residues of the products were visible on the plants after treatment application.

Table 5. Average phytotoxicity effect of the biological and chemical fungicides tested on Polystichum at each assessment date, 2018.

	Polystichum - Average phytotoxicity score				
Date	13-Nov	23-Nov	03-Dec	13-Dec	27-Dec
Day	0	10	20	31	45
Treatment					
Untreated	10	10	10	10	10
Signum	10	10	9	9	10
AHDB9891	10	10	9	9	9
AHDB9873	10	10	9	9	9
AHDB9926	10	10	9	9	9
AHDB9872	10	10	9	9	9
AHDB9885	10	10	9	9	9
AHDB9927	10	10	9	9	9
AHDB9913	10	10	9	9	9
AHDB9871	10	10	9	9	9

10 = No damage, 0 = dead, 8 = acceptable damage, i.e. unlikely to impact marketability and is acceptable to the grower.

Table 6. Average phytotoxicity effect of the biological and chemical fungicides tested on Dryopteris at each assessment date, 2018.

	Dryopteris - Average phytotoxicity score				
Date	13-Nov	23-Nov	03-Dec	13-Dec	27-Dec
Day	0	10	20	31	45
Treatment					
Untreated	10	10	10	10	10
Signum	10	10	10	10	9
AHDB9891	10	10	10	9	9
AHDB9873	10	10	10	9	9
AHDB9926	10	10	10	10	9
AHDB9872	10	10	10	9	9
AHDB9885	10	10	9	9	9
AHDB9927	10	10	10	9	9
AHDB9913	10	10	10	9	9

AHDB9871	10	10	10	10	9
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10 = No damage, 0 = dead, 8 = acceptable damage, i.e. unlikely to impact marketability and is acceptable to the grower.

Product efficacy against Botrytis

The quality of all plants for each of the test species was uniform at the start of the trial, with all plants recorded as having high vigour. No Botrytis developed in four of the nine test species included in the work. Where Botrytis did develop, severity levels remained low in the untreated plots for three species by the final assessment; Ajuga (1.35%), Primula (1.15%) and Rudbeckia (2.90%). In these cases, disease levels were too low for meaningful statistical analysis to be performed. However, Botrytis developed to greater severity levels in both Heuchera (10.50%) and Sedum (52.90%) by the final assessments. No statistically significant differences in disease incidence were found between treated plots and the untreated control for any species at any assessment date ($p > 0.05$).

All treatments, apart from the industry standard Signum, were effective in significantly reducing Botrytis severity ($p = 0.043$) in Heuchera at 45 DA, (Table 7, Figure 1). Three of the products—AHDB9926, AHDB9872 and AHDB9913—also reduced Botrytis severity in Sedum at 30 DA, ($p < 0.001$, Table 8, Figure 2).

Table 7. Effect of biological and chemical fungicides on mean Botrytis severity (% plant area affected) in Heuchera at all assessment dates.

	Heuchera - Average % Botrytis severity				
Date	13-Nov*	23-Nov*	03-Dec	13-Dec	27-Dec
Treatment					
Untreated	0.00	0.00	5.75	4.05	10.50
Signum	0.00	0.00	7.50	3.70	7.25
AHDB9891	0.00	0.00	4.55	3.65	4.65
AHDB9873	0.00	0.00	6.00	5.05	5.00
AHDB9926	0.00	0.00	4.45	3.70	2.75
AHDB9872	0.00	0.00	3.65	2.70	2.75
AHDB9885	0.00	0.00	4.45	4.10	4.30
AHDB9927	0.00	0.00	5.85	3.75	4.80
AHDB9913	0.00	0.00	6.25	3.25	3.15
AHDB9871	0.00	0.00	5.15	4.65	5.60
p value	N/A	N/A	0.933	0.946	0.043
l.s.d.	N/A	N/A	5.286	3.224	4.472
	Not significantly different from the untreated control ($p > 0.05$).				
	Significantly different from the untreated control ($p \leq 0.05$).				

*Statistical analysis unnecessary at dates where no disease was present.

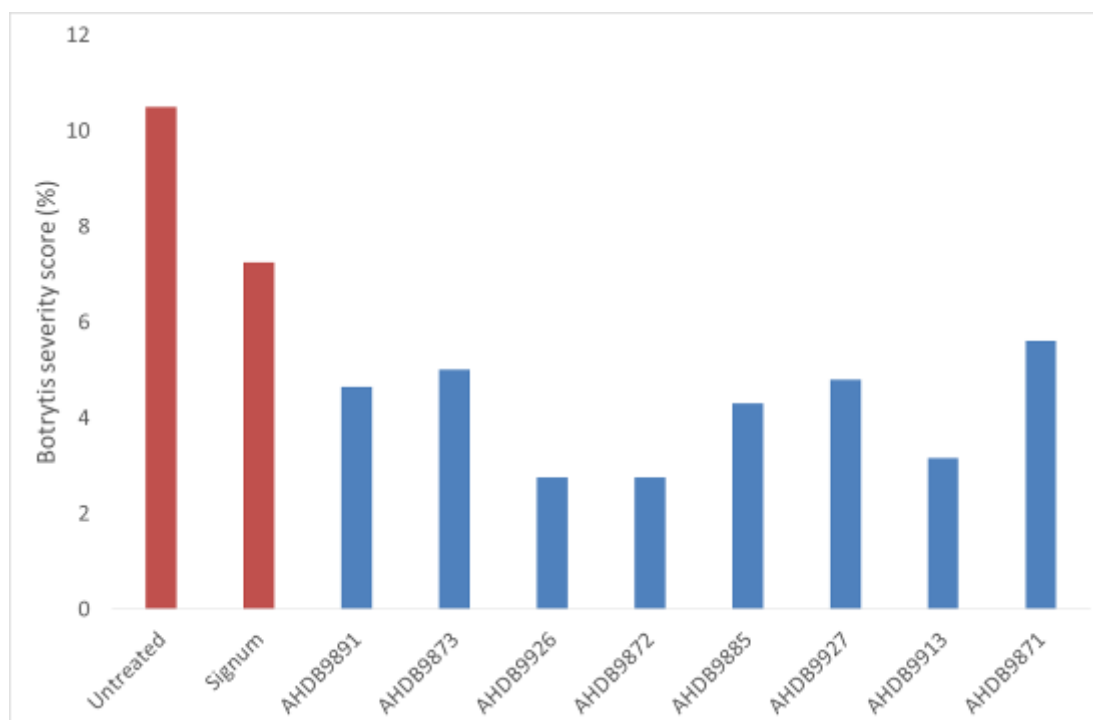


Figure 1. Effect of fungicides on mean Botrytis severity (% plant area affected) in Heuchera, 45 days after the first treatment application (27th Dec). Blue data bars represent data which is significantly lower than the untreated control, $p=0.043$.

Table 8. Effect of fungicides on mean Botrytis severity (% plant area affected) in Sedum at all assessment dates.

Date	Sedum - Average % Botrytis severity				
	13-Nov*	23-Nov*	03-Dec	13-Dec	27-Dec
Treatment					
Untreated	0.00	0.00	10.10	62.35	Fully died back
Signum	0.00	0.00	16.95	57.25	Fully died back
AHDB9891	0.00	0.00	12.25	52.90	Fully died back
AHDB9873	0.00	0.00	12.30	73.65	Fully died back
AHDB9926	0.00	0.00	5.15	27.25	Fully died back

AHDB9872	0.00	0.00	3.15	14.95	Fully died back
AHDB9885	0.00	0.00	8.90	54.00	Fully died back
AHDB9927	0.00	0.00	8.25	49.25	Fully died back
AHDB9913	0.00	0.00	3.25	39.35	Fully died back
AHDB9871	0.00	0.00	21.25	77.85	Fully died back
p value	N/A	N/A	0.053	<0.001	N/A
l.s.d.	N/A	N/A	11.35	18.83	N/A
	Not significantly different from the untreated control (p>0.05).				
	Significantly different from the untreated control (p≤0.05).				

*Statistical analysis unnecessary at dates where no disease was present

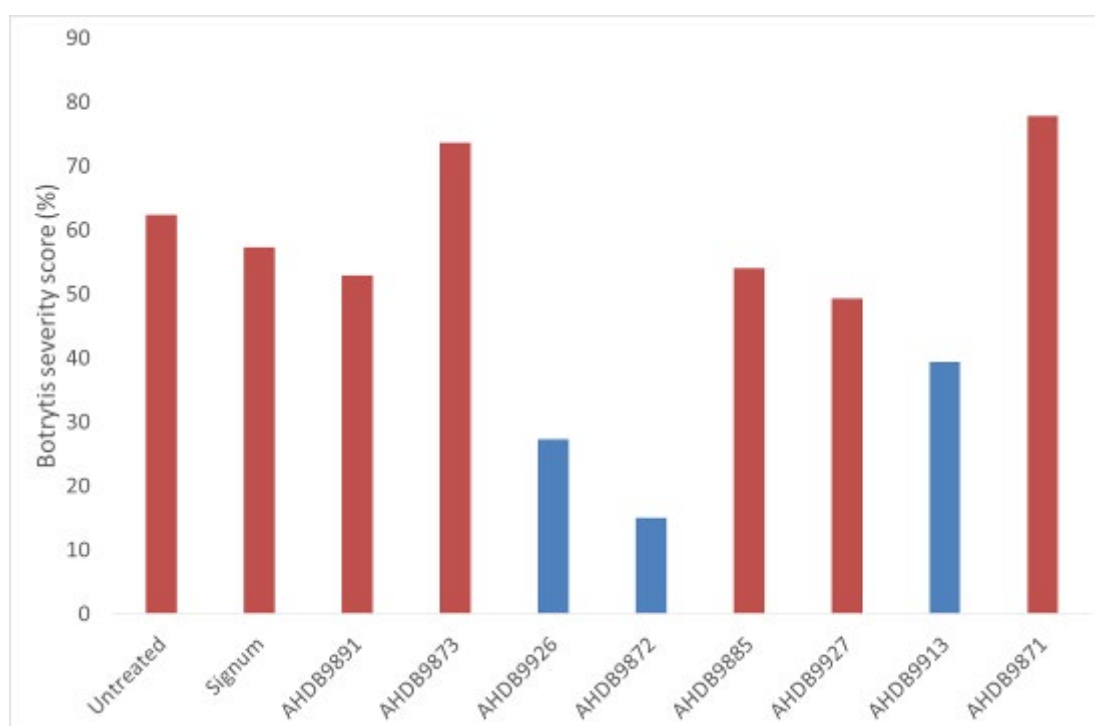


Figure 2. Effect of fungicides on mean Botrytis severity (% plant area affected) in Sedum, 30 days after the first treatment application (13th Dec). Blue data bars represent data which is significantly lower than the untreated control, p<0.001).

All the Sedum plants, regardless of treatment, had naturally senesced by the final assessment and no assessment of disease could be performed.

Discussion

The trials were artificially inoculated with a moderate level of Botrytis with the aim of ensuring that uniform levels of botrytis developed, but without creating too high a disease pressure that would potentially prevent any disease control and differences between treatments being observed. This level of inoculation also ensured that neighbouring, non-trial commercial plants were not put at unnecessary risk. The trial was carried out at a time of year when were conducive to the occurrence of Botrytis infection, but conditions were insufficient for significant botrytis infection to develop across all species.

Despite inoculation, Botrytis established and developed in just five of the nine ornamental plant species, with severity levels high enough for statistical analysis in only two species,

Heuchera and Sedum. By the final assessment, all test treatments—including the biological treatments—significantly reduced the severity of Botrytis infection in Heuchera, compared with the untreated control with the exception of the industry standard, Signum.

Three treatments, AHDB9926, AHDB9872 and AHDB9913, all significantly reduced the severity of Botrytis at the penultimate assessment in Sedum. These three products also performed the best in Heuchera, and all belong to the SDHI group of fungicides (FRAC group 7). All Sedum plants, regardless of species, had completely senesced by the final assessment and hence disease assessments were not possible.

Rovral WG (iprodione) was commonly used for control of Botrytis, as well as several other fungal pathogens. A benefit of Rovral WG was that it was crop safe on several sensitive crops, including ferns, but this fungicide was withdrawn from use in June 2018. All treatments tested in this work caused slight phytotoxic symptoms in the two fern species alone, but this was comparable to the industry standard, Signum and the ferns grew out of the damage by the final assessment. Growers who visited the trial three days following the third treatment application were not concerned by the level of phytotoxic damage present, stating that it was commercially acceptable and would not impact on marketability. All test products were used at maximum manufacturer's rates and repeated at relatively short intervals for conventional chemistry based products – every 10 days. The two biological products were also applied at this time interval, however many biologicals can be applied following as little as three day intervals.

Conclusions

- Botrytis developed in five of nine test plant species, with only Heuchera and Sedum showing severity levels above 10% by the trial's conclusion.
- All products tested significantly reduced the severity of Botrytis in Heuchera by the final assessment when applied four times, at 10 day intervals.
- Three SDHI products, AHDB9926, AHDB9872 and AHDB9913 significantly reduced the severity of Botrytis in Sedum at the penultimate assessment when applied four times, at 10 day intervals.
- No product reduced disease incidence, in any species, at any assessment.
- No phytotoxic damage developed on the Ajuga, English Lavender, Heuchera, Primula, Rudbeckia, Sedum or Vinca as a consequence of any product application.
- Low levels of phytotoxicity damage developed in the two fern species, Dryopteris or Polystichum, following any treatment application. Damage from all treatments was minor, and comparable to that caused by the industry standard, Signum. All affected plants were of marketable quality.

Acknowledgements

We would like to thank Steve Reed and all the staff at Wyevale Nurseries Ltd. for hosting and maintaining the trial. We would also like to thank Chris Dyer for performing the statistical analysis, and AHDB Horticulture and participating crop protection companies for advice on product selection and use, and for supporting the SCEPTREplus program.

Appendix

a) Trial images.



Botrytis on English Lavender isolated for trial inoculation.



Trial layout of the nine test ornamental plant species.



Dryopteris treated with AHDB9913 at the final assessment (27/12/2019).



Botrytis on Heuchera at the final assessment (27/12/2019).

b) Crop diary.

Species list

Species	Cultivar	Planting date
Ajuga	Chocolate Chip	31/10/2018
Dryopteris	<i>Dryopteris erythrosora</i>	31/10/2018
English Lavender	Melisa Lilac	31/10/2018
Heuchera	Liquorice	31/10/2018
Polystichum	Scarlet Starlit	31/10/2018
Primula	<i>Primula beesiana</i>	31/10/2018
Rudbeckia	<i>Rudbeckia fulgida</i> var. <i>deamii</i>	31/10/2018
Sedum	Bertram Anderson	31/10/2018
Vinca	Bowles Purple	31/10/2018

Previous cropping: Various commercial ornamental crop species.

Cultivations, fertilisers, etc: The trial was watered by hand as necessary. All watering was performed in the evening. No fertiliser was applied.

Pesticides:

Date	Product	Rate	Unit
26/11/2018	Nimrod (bupirimate)	1.0	L ha ⁻¹

c) Trial diary.

Date	Event
31/10/2018	Plant plugs potted up by nursery staff for all species.
09/11/2018	Trial set-up.
12/11/2018	Trial inoculated with Botrytis.
13/11/2018	Application A. Plant vigour and full disease assessment.
23/11/2018	Application B. Full disease and phytotoxicity assessment.
26/11/2018	Nimrod overspray for powdery mildew.
03/12/2018	Full disease and phytotoxicity assessment.
04/12/2018	Application C.
06/12/2018	Trial open day.
13/12/2018	Application D. Full disease and phytotoxicity assessment.
27/12/2018	Full disease and phytotoxicity assessment.

d) Raw data from assessments.

Botrytis incidence

Ajuga:

	DA:	0	10	20	31	45
	Date:	13/11/2018	23/11/2018	03/12/2018	13/12/2018	27/12/2018
Plot	Treatment	Botrytis incidence (%)				
1	1	0.0	0.0	20.0	0.0	0.0
2	4	0.0	0.0	0.0	0.0	0.0
3	3	0.0	0.0	20.0	0.0	20.0
4	8	0.0	0.0	20.0	20.0	0.0

5	2	0.0	0.0	20.0	20.0	0.0
6	10	0.0	0.0	0.0	0.0	20.0
7	6	0.0	0.0	0.0	0.0	20.0
8	5	0.0	0.0	20.0	20.0	20.0
9	7	0.0	0.0	40.0	0.0	80.0
10	9	0.0	0.0	20.0	0.0	40.0
11	6	0.0	0.0	0.0	0.0	20.0
12	4	0.0	0.0	0.0	0.0	0.0
13	5	0.0	0.0	0.0	0.0	0.0
14	3	0.0	0.0	0.0	0.0	20.0
15	1	0.0	0.0	20.0	40.0	20.0
16	7	0.0	0.0	0.0	0.0	0.0
17	8	0.0	0.0	40.0	0.0	60.0
18	10	0.0	0.0	20.0	20.0	80.0
19	9	0.0	0.0	0.0	20.0	40.0
20	2	0.0	0.0	40.0	40.0	60.0
21	7	0.0	0.0	40.0	0.0	20.0
22	8	0.0	0.0	20.0	0.0	0.0
23	4	0.0	0.0	20.0	20.0	80.0
24	1	0.0	0.0	40.0	0.0	40.0
25	10	0.0	0.0	0.0	20.0	60.0
26	3	0.0	0.0	0.0	40.0	60.0
27	5	0.0	0.0	80.0	0.0	100.0
28	2	0.0	0.0	100.0	0.0	100.0
29	9	0.0	0.0	60.0	40.0	80.0
30	6	0.0	0.0	60.0	0.0	60.0
31	1	0.0	0.0	80.0	0.0	80.0
32	8	0.0	0.0	60.0	20.0	80.0
33	3	0.0	0.0	20.0	0.0	20.0
34	7	0.0	0.0	40.0	0.0	60.0
35	5	0.0	0.0	60.0	40.0	20.0
36	10	0.0	0.0	40.0	20.0	100.0
37	6	0.0	0.0	60.0	20.0	0.0
38	9	0.0	0.0	80.0	0.0	80.0
39	2	0.0	0.0	60.0	0.0	100.0
40	4	0.0	0.0	40.0	0.0	20.0

Dryopteris: No Botrytis developed in treated or untreated plants by the conclusion of the trial.

English Lavender: No Botrytis developed in treated or untreated plants by the conclusion of the trial.

Heuchera:

	DA:	0	10	20	31	45
	Date:	13/11/2018	23/11/2018	03/12/2018	13/12/2018	27/12/2018
Plot	Treatment	Botrytis incidence (%)				
1	4	0.0	0.0	60.0	80.0	80.0
2	8	0.0	0.0	20.0	60.0	20.0
3	6	0.0	0.0	60.0	60.0	20.0
4	7	0.0	0.0	80.0	100.0	60.0
5	3	0.0	0.0	60.0	60.0	20.0
6	5	0.0	0.0	80.0	60.0	20.0
7	10	0.0	0.0	80.0	80.0	60.0
8	9	0.0	0.0	100.0	60.0	40.0
9	2	0.0	0.0	100.0	100.0	60.0
10	1	0.0	0.0	80.0	60.0	60.0
11	3	0.0	0.0	40.0	40.0	20.0
12	7	0.0	0.0	60.0	60.0	20.0
13	1	0.0	0.0	100.0	100.0	80.0
14	5	0.0	0.0	60.0	60.0	40.0
15	4	0.0	0.0	60.0	60.0	60.0
16	9	0.0	0.0	100.0	80.0	60.0
17	10	0.0	0.0	60.0	60.0	40.0
18	8	0.0	0.0	60.0	60.0	40.0
19	2	0.0	0.0	100.0	80.0	40.0
20	6	0.0	0.0	80.0	80.0	60.0
21	5	0.0	0.0	20.0	20.0	20.0
22	4	0.0	0.0	100.0	80.0	20.0
23	10	0.0	0.0	100.0	80.0	80.0
24	6	0.0	0.0	60.0	100.0	20.0
25	9	0.0	0.0	40.0	60.0	40.0
26	2	0.0	0.0	80.0	80.0	80.0
27	1	0.0	0.0	100.0	80.0	80.0
28	3	0.0	0.0	80.0	100.0	100.0
29	7	0.0	0.0	100.0	100.0	80.0
30	8	0.0	0.0	100.0	100.0	80.0
31	6	0.0	0.0	80.0	80.0	60.0
32	7	0.0	0.0	100.0	60.0	20.0
33	3	0.0	0.0	80.0	80.0	60.0
34	9	0.0	0.0	80.0	80.0	40.0
35	8	0.0	0.0	80.0	80.0	80.0
36	4	0.0	0.0	80.0	100.0	80.0

37	1	0.0	0.0	80.0	60.0	100.0
38	5	0.0	0.0	100.0	100.0	60.0
39	10	0.0	0.0	80.0	80.0	40.0
40	2	0.0	0.0	60.0	40.0	60.0

Polystichum: No Botrytis developed in treated or untreated plants by the conclusion of the trial.

Primula:

		DA:	0	10	20	31	45
		Date:	13/11/2018	23/11/2018	03/12/2018	13/12/2018	27/12/2018
Plot	Treatment	Botrytis incidence (%)					
1	1	0.0	0.0	0.0	0.0	40.0	
2	2	0.0	0.0	0.0	0.0	0.0	
3	5	0.0	0.0	0.0	0.0	20.0	
4	6	0.0	0.0	0.0	0.0	0.0	
5	3	0.0	0.0	0.0	40.0	20.0	
6	10	0.0	0.0	0.0	0.0	0.0	
7	8	0.0	0.0	0.0	20.0	40.0	
8	7	0.0	0.0	0.0	20.0	40.0	
9	4	0.0	0.0	0.0	0.0	20.0	
10	9	0.0	0.0	0.0	20.0	20.0	
11	6	0.0	0.0	0.0	0.0	0.0	
12	5	0.0	0.0	0.0	0.0	20.0	
13	4	0.0	0.0	0.0	40.0	20.0	
14	9	0.0	0.0	0.0	20.0	0.0	
15	3	0.0	0.0	0.0	0.0	20.0	
16	8	0.0	0.0	0.0	0.0	20.0	
17	2	0.0	0.0	0.0	0.0	60.0	
18	1	0.0	0.0	0.0	20.0	60.0	
19	10	0.0	0.0	0.0	20.0	20.0	
20	7	0.0	0.0	0.0	0.0	0.0	
21	8	0.0	0.0	0.0	20.0	20.0	
22	3	0.0	0.0	0.0	0.0	0.0	
23	5	0.0	0.0	0.0	0.0	0.0	
24	9	0.0	0.0	0.0	20.0	20.0	
25	4	0.0	0.0	0.0	0.0	0.0	
26	6	0.0	0.0	0.0	0.0	0.0	
27	2	0.0	0.0	0.0	0.0	0.0	
28	10	0.0	0.0	0.0	0.0	0.0	
29	7	0.0	0.0	0.0	0.0	20.0	
30	1	0.0	0.0	0.0	0.0	0.0	
31	8	0.0	0.0	0.0	0.0	40.0	
32	3	0.0	0.0	0.0	0.0	0.0	

33	10	0.0	0.0	0.0	0.0	0.0
34	7	0.0	0.0	0.0	0.0	20.0
35	5	0.0	0.0	0.0	0.0	0.0
36	1	0.0	0.0	0.0	0.0	0.0
37	4	0.0	0.0	0.0	0.0	0.0
38	2	0.0	0.0	0.0	0.0	40.0
39	6	0.0	0.0	0.0	0.0	0.0
40	9	0.0	0.0	0.0	0.0	0.0

Rudbeckia:

		DA:	0	10	20	31	45
		Date:	13/11/2018	23/11/2018	03/12/2018	13/12/2018	27/12/2018
Plot	Treatment	Botrytis incidence (%)					
1	7	0.0	0.0	20.0	0.0	0.0	
2	2	0.0	0.0	0.0	0.0	0.0	
3	5	0.0	0.0	20.0	0.0	0.0	
4	9	0.0	0.0	0.0	20.0	0.0	
5	8	0.0	0.0	20.0	20.0	20.0	
6	1	0.0	0.0	0.0	0.0	20.0	
7	6	0.0	0.0	0.0	0.0	0.0	
8	3	0.0	0.0	20.0	20.0	20.0	
9	4	0.0	0.0	0.0	0.0	0.0	
10	10	0.0	0.0	20.0	0.0	20.0	
11	6	0.0	0.0	0.0	0.0	0.0	
12	9	0.0	0.0	0.0	0.0	20.0	
13	2	0.0	0.0	0.0	0.0	0.0	
14	1	0.0	0.0	0.0	0.0	40.0	
15	5	0.0	0.0	40.0	40.0	40.0	
16	3	0.0	0.0	0.0	0.0	0.0	
17	7	0.0	0.0	40.0	0.0	0.0	
18	8	0.0	0.0	20.0	20.0	20.0	
19	4	0.0	0.0	20.0	20.0	20.0	
20	10	0.0	0.0	20.0	40.0	40.0	
21	1	0.0	0.0	0.0	0.0	0.0	
22	7	0.0	0.0	40.0	0.0	0.0	
23	6	0.0	0.0	20.0	20.0	20.0	
24	2	0.0	0.0	20.0	0.0	20.0	
25	5	0.0	0.0	0.0	20.0	20.0	
26	4	0.0	0.0	0.0	40.0	40.0	
27	9	0.0	0.0	0.0	0.0	0.0	
28	10	0.0	0.0	0.0	0.0	0.0	
29	3	0.0	0.0	40.0	40.0	40.0	
30	8	0.0	0.0	0.0	0.0	0.0	
31	10	0.0	0.0	0.0	0.0	0.0	

32	7	0.0	0.0	0.0	20.0	20.0
33	9	0.0	0.0	20.0	0.0	0.0
34	6	0.0	0.0	20.0	0.0	20.0
35	2	0.0	0.0	20.0	40.0	60.0
36	4	0.0	0.0	20.0	20.0	60.0
37	3	0.0	0.0	0.0	20.0	20.0
38	5	0.0	0.0	0.0	0.0	20.0
39	1	0.0	0.0	0.0	0.0	40.0
40	8	0.0	0.0	20.0	0.0	20.0

Sedum:

	DA:	0	10	20	31	45
	Date:	13/11/2018	23/11/2018	03/12/2018	13/12/2018	27/12/2018
Plot	Treatment	Botrytis incidence (%)				
1	8	0.0	0.0	20.0	60.0	Fully senesced
2	4	0.0	0.0	80.0	100.0	Fully senesced
3	5	0.0	0.0	40.0	80.0	Fully senesced
4	1	0.0	0.0	40.0	100.0	Fully senesced
5	3	0.0	0.0	20.0	100.0	Fully senesced
6	2	0.0	0.0	20.0	80.0	Fully senesced
7	9	0.0	0.0	40.0	100.0	Fully senesced
8	7	0.0	0.0	60.0	80.0	Fully senesced
9	6	0.0	0.0	0.0	40.0	Fully senesced
10	10	0.0	0.0	80.0	100.0	Fully senesced
11	1	0.0	0.0	80.0	100.0	Fully senesced
12	3	0.0	0.0	20.0	100.0	Fully senesced
13	9	0.0	0.0	0.0	60.0	Fully senesced
14	7	0.0	0.0	0.0	100.0	Fully senesced
15	8	0.0	0.0	20.0	100.0	Fully senesced
16	2	0.0	0.0	60.0	100.0	Fully senesced
17	4	0.0	0.0	40.0	100.0	Fully senesced
18	10	0.0	0.0	80.0	100.0	Fully senesced
19	5	0.0	0.0	20.0	60.0	Fully senesced
20	6	0.0	0.0	40.0	80.0	Fully senesced
21	9	0.0	0.0	20.0	100.0	Fully senesced
22	10	0.0	0.0	100.0	100.0	Fully senesced
23	4	0.0	0.0	60.0	100.0	Fully senesced
24	2	0.0	0.0	80.0	100.0	Fully senesced
25	5	0.0	0.0	20.0	100.0	Fully senesced
26	3	0.0	0.0	60.0	100.0	Fully senesced
27	7	0.0	0.0	60.0	100.0	Fully senesced
28	1	0.0	0.0	60.0	100.0	Fully senesced
29	8	0.0	0.0	60.0	100.0	Fully senesced
30	6	0.0	0.0	20.0	100.0	Fully senesced

31	4	0.0	0.0	40.0	100.0	Fully senesced
32	1	0.0	0.0	80.0	100.0	Fully senesced
33	7	0.0	0.0	20.0	100.0	Fully senesced
34	9	0.0	0.0	0.0	100.0	Fully senesced
35	8	0.0	0.0	60.0	100.0	Fully senesced
36	10	0.0	0.0	60.0	100.0	Fully senesced
37	3	0.0	0.0	40.0	80.0	Fully senesced
38	2	0.0	0.0	80.0	100.0	Fully senesced
39	6	0.0	0.0	40.0	100.0	Fully senesced
40	5	0.0	0.0	40.0	100.0	Fully senesced

Vinca: No Botrytis developed in treated or untreated plants by the conclusion of the trial.

Botrytis severity

Ajuga:

	DA:	0	10	20	31	45
	Date:	13/11/2018	23/11/2018	03/12/2018	13/12/2018	27/12/2018
Plot	Treatment	Botrytis severity (%)				
1	1	0.0	0.0	0.2	0.0	0.0
2	4	0.0	0.0	0.0	0.0	0.0
3	3	0.0	0.0	2.0	0.0	0.6
4	8	0.0	0.0	0.6	2.0	0.0
5	2	0.0	0.0	0.2	2.0	0.0
6	10	0.0	0.0	0.0	0.0	0.4
7	6	0.0	0.0	0.0	0.0	0.2
8	5	0.0	0.0	1.0	4.0	0.4
9	7	0.0	0.0	1.4	0.0	1.4
10	9	0.0	0.0	1.0	0.0	1.2
11	6	0.0	0.0	0.0	0.0	0.2
12	4	0.0	0.0	0.0	0.0	0.0
13	5	0.0	0.0	0.0	0.0	0.0
14	3	0.0	0.0	0.0	0.0	0.6
15	1	0.0	0.0	0.6	2.0	0.2
16	7	0.0	0.0	0.0	0.0	0.0
17	8	0.0	0.0	8.6	0.0	2.0
18	10	0.0	0.0	2.0	3.0	2.2
19	9	0.0	0.0	0.0	4.0	0.4
20	2	0.0	0.0	2.6	0.4	1.6
21	7	0.0	0.0	1.4	0.0	0.4
22	8	0.0	0.0	0.6	0.0	0.0
23	4	0.0	0.0	0.2	0.6	3.4
24	1	0.0	0.0	0.6	0.0	2.0
25	10	0.0	0.0	0.0	3.0	1.6

26	3	0.0	0.0	0.0	4.8	1.0
27	5	0.0	0.0	1.0	0.0	3.4
28	2	0.0	0.0	4.4	0.0	14.2
29	9	0.0	0.0	2.4	10.6	4.4
30	6	0.0	0.0	0.8	0.0	1.8
31	1	0.0	0.0	2.4	0.0	3.2
32	8	0.0	0.0	2.2	0.2	4.8
33	3	0.0	0.0	0.2	0.0	0.2
34	7	0.0	0.0	3.0	0.0	1.6
35	5	0.0	0.0	1.4	4.2	1.0
36	10	0.0	0.0	4.6	0.2	30.0
37	6	0.0	0.0	0.8	0.8	0.0
38	9	0.0	0.0	2.0	0.0	3.0
39	2	0.0	0.0	5.0	0.0	44.0
40	4	0.0	0.0	6.2	0.0	2.0

Dryopteris: No Botrytis developed in treated or untreated plants by the conclusion of the trial.

English Lavender: No Botrytis developed in treated or untreated plants by the conclusion of the trial.

Heuchera:

	DA:	0	10	20	31	45
	Date:	13/11/2018	23/11/2018	03/12/2018	13/12/2018	27/12/2018
Plot	Treatment	Botrytis severity (%)				
1	4	0.0	0.0	3.4	4.2	7.6
2	8	0.0	0.0	2.0	2.6	3.0
3	6	0.0	0.0	3.0	1.2	1.0
4	7	0.0	0.0	4.6	6.2	6.6
5	3	0.0	0.0	2.6	3.8	1.0
6	5	0.0	0.0	3.0	1.8	1.0
7	10	0.0	0.0	3.2	5.4	9.0
8	9	0.0	0.0	2.6	3.4	3.6
9	2	0.0	0.0	12.4	6.0	7.0
10	1	0.0	0.0	3.0	3.2	8.0
11	3	0.0	0.0	2.2	1.0	1.0
12	7	0.0	0.0	3.0	1.6	0.6
13	1	0.0	0.0	8.0	7.2	16.0
14	5	0.0	0.0	5.4	4.8	2.0
15	4	0.0	0.0	2.6	3.6	6.0
16	9	0.0	0.0	13.2	5.6	3.0
17	10	0.0	0.0	8.6	6.4	4.4
18	8	0.0	0.0	2.4	1.8	2.2

19	2	0.0	0.0	9.6	4.6	7.0
20	6	0.0	0.0	2.8	2.6	3.0
21	5	0.0	0.0	0.6	1.0	2.0
22	4	0.0	0.0	5.0	5.0	1.0
23	10	0.0	0.0	6.2	4.6	4.0
24	6	0.0	0.0	3.6	2.6	2.0
25	9	0.0	0.0	0.8	1.4	3.0
26	2	0.0	0.0	6.2	2.6	9.0
27	1	0.0	0.0	6.4	2.4	7.0
28	3	0.0	0.0	6.6	5.6	11.0
29	7	0.0	0.0	5.0	5.4	9.0
30	8	0.0	0.0	12.0	8.2	9.0
31	6	0.0	0.0	5.2	4.4	5.0
32	7	0.0	0.0	5.2	3.2	1.0
33	3	0.0	0.0	6.8	4.2	5.6
34	9	0.0	0.0	8.4	2.6	3.0
35	8	0.0	0.0	7.0	2.4	5.0
36	4	0.0	0.0	13.0	7.4	5.4
37	1	0.0	0.0	5.6	3.4	11.0
38	5	0.0	0.0	8.8	7.2	6.0
39	10	0.0	0.0	2.6	2.2	5.0
40	2	0.0	0.0	1.8	1.6	6.0

Polystichum: No Botrytis developed in treated or untreated plants by the conclusion of the trial.

Primula:

	DA:	0	10	20	31	45
	Date:	13/11/2018	23/11/2018	03/12/2018	13/12/2018	27/12/2018
Plot	Treatment	Botrytis severity (%)				
1	1	0.0	0.0	0.0	0.0	1.0
2	2	0.0	0.0	0.0	0.0	0.0
3	5	0.0	0.0	0.0	0.0	0.4
4	6	0.0	0.0	0.0	0.0	0.0
5	3	0.0	0.0	0.0	0.6	0.4
6	10	0.0	0.0	0.0	0.0	0.0
7	8	0.0	0.0	0.0	1.0	1.6
8	7	0.0	0.0	0.0	1.4	1.8
9	4	0.0	0.0	0.0	0.0	0.6
10	9	0.0	0.0	0.0	0.2	0.2
11	6	0.0	0.0	0.0	0.0	0.0
12	5	0.0	0.0	0.0	0.0	0.2
13	4	0.0	0.0	0.0	3.0	1.6
14	9	0.0	0.0	0.0	0.2	0.0

15	3	0.0	0.0	0.0	0.0	0.6
16	8	0.0	0.0	0.0	0.0	0.8
17	2	0.0	0.0	0.0	0.0	3.6
18	1	0.0	0.0	0.0	0.2	3.6
19	10	0.0	0.0	0.0	2.0	4.0
20	7	0.0	0.0	0.0	0.0	0.0
21	8	0.0	0.0	0.0	0.6	0.6
22	3	0.0	0.0	0.0	0.0	0.0
23	5	0.0	0.0	0.0	0.0	0.0
24	9	0.0	0.0	0.0	0.6	2.0
25	4	0.0	0.0	0.0	0.0	0.0
26	6	0.0	0.0	0.0	0.0	0.0
27	2	0.0	0.0	0.0	0.0	0.0
28	10	0.0	0.0	0.0	0.0	0.0
29	7	0.0	0.0	0.0	0.0	2.0
30	1	0.0	0.0	0.0	0.0	0.0
31	8	0.0	0.0	0.0	0.0	1.0
32	3	0.0	0.0	0.0	0.0	0.0
33	10	0.0	0.0	0.0	0.0	0.0
34	7	0.0	0.0	0.0	0.0	1.0
35	5	0.0	0.0	0.0	0.0	0.0
36	1	0.0	0.0	0.0	0.0	0.0
37	4	0.0	0.0	0.0	0.0	0.0
38	2	0.0	0.0	0.0	0.0	1.6
39	6	0.0	0.0	0.0	0.0	0.0
40	9	0.0	0.0	0.0	0.0	0.0

Rudbeckia:

	DA:	0	10	20	31	45
	Date:	13/11/2018	23/11/2018	03/12/2018	13/12/2018	27/12/2018
Plot	Treatment	Botrytis severity (%)				
1	7	0.0	0.0	0.6	0.0	0.0
2	2	0.0	0.0	0.0	0.0	0.0
3	5	0.0	0.0	3.0	0.0	0.0
4	9	0.0	0.0	0.0	2.0	0.0
5	8	0.0	0.0	5.0	2.0	2.0
6	1	0.0	0.0	0.0	0.0	7.0
7	6	0.0	0.0	0.0	0.0	0.0
8	3	0.0	0.0	1.4	4.0	4.0
9	4	0.0	0.0	0.0	0.0	0.0
10	10	0.0	0.0	0.6	0.0	2.0
11	6	0.0	0.0	0.0	0.0	0.0
12	9	0.0	0.0	0.0	0.0	0.4
13	2	0.0	0.0	0.0	0.0	0.0

14	1	0.0	0.0	0.0	0.0	3.0
15	5	0.0	0.0	2.0	2.0	2.0
16	3	0.0	0.0	0.0	0.0	0.0
17	7	0.0	0.0	3.0	0.0	0.0
18	8	0.0	0.0	2.0	3.0	3.0
19	4	0.0	0.0	1.0	4.0	6.0
20	10	0.0	0.0	1.0	0.4	2.0
21	1	0.0	0.0	0.0	0.0	0.0
22	7	0.0	0.0	3.4	0.0	0.0
23	6	0.0	0.0	3.4	0.6	0.6
24	2	0.0	0.0	1.0	0.0	2.0
25	5	0.0	0.0	0.0	3.0	3.0
26	4	0.0	0.0	0.0	4.8	7.0
27	9	0.0	0.0	0.0	0.0	0.0
28	10	0.0	0.0	0.0	0.0	0.0
29	3	0.0	0.0	13.0	10.6	16.6
30	8	0.0	0.0	0.0	0.0	0.0
31	10	0.0	0.0	0.0	0.0	0.0
32	7	0.0	0.0	0.0	0.2	1.6
33	9	0.0	0.0	4.0	0.0	0.0
34	6	0.0	0.0	6.6	0.0	1.0
35	2	0.0	0.0	3.0	4.2	8.0
36	4	0.0	0.0	5.0	0.2	4.0
37	3	0.0	0.0	0.0	0.8	0.8
38	5	0.0	0.0	0.0	0.0	1.0
39	1	0.0	0.0	0.0	0.0	1.6
40	8	0.0	0.0	1.0	0.0	2.0

Sedum:

		DA:	0	10	20	31	45
		Date:	13/11/2018	23/11/2018	03/12/2018	13/12/2018	27/12/2018
Plot	Treatment	Botrytis severity (%)					
1	8	0.0	0.0	0.2	22.0	Fully senesced	
2	4	0.0	0.0	12.4	80.6	Fully senesced	
3	5	0.0	0.0	7.0	21.0	Fully senesced	
4	1	0.0	0.0	7.0	59.0	Fully senesced	
5	3	0.0	0.0	1.0	74.6	Fully senesced	
6	2	0.0	0.0	6.0	57.0	Fully senesced	
7	9	0.0	0.0	11.0	55.6	Fully senesced	
8	7	0.0	0.0	12.0	56.0	Fully senesced	
9	6	0.0	0.0	0.0	5.4	Fully senesced	
10	10	0.0	0.0	11.0	74.4	Fully senesced	
11	1	0.0	0.0	16.0	49.0	Fully senesced	
12	3	0.0	0.0	4.0	48.0	Fully senesced	

13	9	0.0	0.0	0.0	39.0	Fully senesced
14	7	0.0	0.0	0.0	48.0	Fully senesced
15	8	0.0	0.0	12.0	70.0	Fully senesced
16	2	0.0	0.0	13.0	62.0	Fully senesced
17	4	0.0	0.0	7.4	76.6	Fully senesced
18	10	0.0	0.0	18.0	90.0	Fully senesced
19	5	0.0	0.0	1.0	20.0	Fully senesced
20	6	0.0	0.0	5.0	22.0	Fully senesced
21	9	0.0	0.0	2.0	30.8	Fully senesced
22	10	0.0	0.0	29.0	94.0	Fully senesced
23	4	0.0	0.0	14.0	77.0	Fully senesced
24	2	0.0	0.0	40.0	54.0	Fully senesced
25	5	0.0	0.0	0.6	45.0	Fully senesced
26	3	0.0	0.0	26.0	49.0	Fully senesced
27	7	0.0	0.0	23.0	63.0	Fully senesced
28	1	0.0	0.0	9.0	88.0	Fully senesced
29	8	0.0	0.0	8.4	56.0	Fully senesced
30	6	0.0	0.0	0.8	8.4	Fully senesced
31	4	0.0	0.0	15.4	60.4	Fully senesced
32	1	0.0	0.0	8.4	53.4	Fully senesced
33	7	0.0	0.0	0.6	49.0	Fully senesced
34	9	0.0	0.0	0.0	32.0	Fully senesced
35	8	0.0	0.0	12.4	49.0	Fully senesced
36	10	0.0	0.0	27.0	53.0	Fully senesced
37	3	0.0	0.0	18.0	40.0	Fully senesced
38	2	0.0	0.0	8.8	56.0	Fully senesced
39	6	0.0	0.0	6.8	24.0	Fully senesced
40	5	0.0	0.0	12.0	23.0	Fully senesced

Vinca: No Botrytis developed in treated or untreated plants by the conclusion of the trial.

e) Trial design.

		AJUGA									
BLOCK 1		1	4	3	8	2	10	6	5	7	9
	PLOT	1	2	3	4	5	6	7	8	9	10
BLOCK 2		6	4	5	3	1	7	8	10	9	2
	PLOT	11	12	13	14	15	16	17	18	19	20
BLOCK 3		7	8	4	1	10	3	5	2	9	6
	PLOT	21	22	23	24	25	26	27	28	29	30
BLOCK 4		1	8	3	7	5	10	6	9	2	4
	PLOT	31	32	33	34	35	36	37	38	39	40

		SEDUM									
BLOCK 1		8	4	5	1	3	2	9	7	6	10
	PLOT	1	2	3	4	5	6	7	8	9	10
BLOCK 2		1	3	9	7	8	2	4	10	5	6
	PLOT	11	12	13	14	15	16	17	18	19	20
BLOCK 3		9	10	4	2	5	3	7	1	8	6
	PLOT	21	22	23	24	25	26	27	28	29	30
BLOCK 4		4	1	7	9	8	10	3	2	6	5
	PLOT	31	32	33	34	35	36	37	38	39	40

		POLYSTICHUM									
BLOCK 1		10	9	4	8	1	2	5	7	6	3
	PLOT	1	2	3	4	5	6	7	8	9	10
BLOCK 2		9	6	2	5	7	3	1	4	10	8
	PLOT	11	12	13	14	15	16	17	18	19	20
BLOCK 3		5	4	1	7	3	9	6	8	2	10
	PLOT	21	22	23	24	25	26	27	28	29	30
BLOCK 4		6	4	10	2	3	8	5	7	1	9
	PLOT	31	32	33	34	35	36	37	38	39	40

		DRYOPTERIS									
BLOCK 1		10	2	3	9	7	1	5	6	4	8
	PLOT	1	2	3	4	5	6	7	8	9	10
BLOCK 2		4	5	9	8	6	2	10	7	3	1
	PLOT	11	12	13	14	15	16	17	18	19	20
BLOCK 3		10	3	9	1	6	5	4	7	2	8
	PLOT	21	22	23	24	25	26	27	28	29	30
BLOCK 4		9	5	10	7	6	1	8	3	2	4
	PLOT	31	32	33	34	35	36	37	38	39	40

		VINCA									
BLOCK 1		8	6	10	1	7	4	9	2	5	3
	PLOT	1	2	3	4	5	6	7	8	9	10
BLOCK 2		8	10	6	1	5	7	3	9	2	4
	PLOT	11	12	13	14	15	16	17	18	19	20
BLOCK 3		1	4	3	6	10	2	5	7	9	8
	PLOT	21	22	23	24	25	26	27	28	29	30
BLOCK 4		2	6	4	10	5	9	3	7	1	8
	PLOT	31	32	33	34	35	36	37	38	39	40

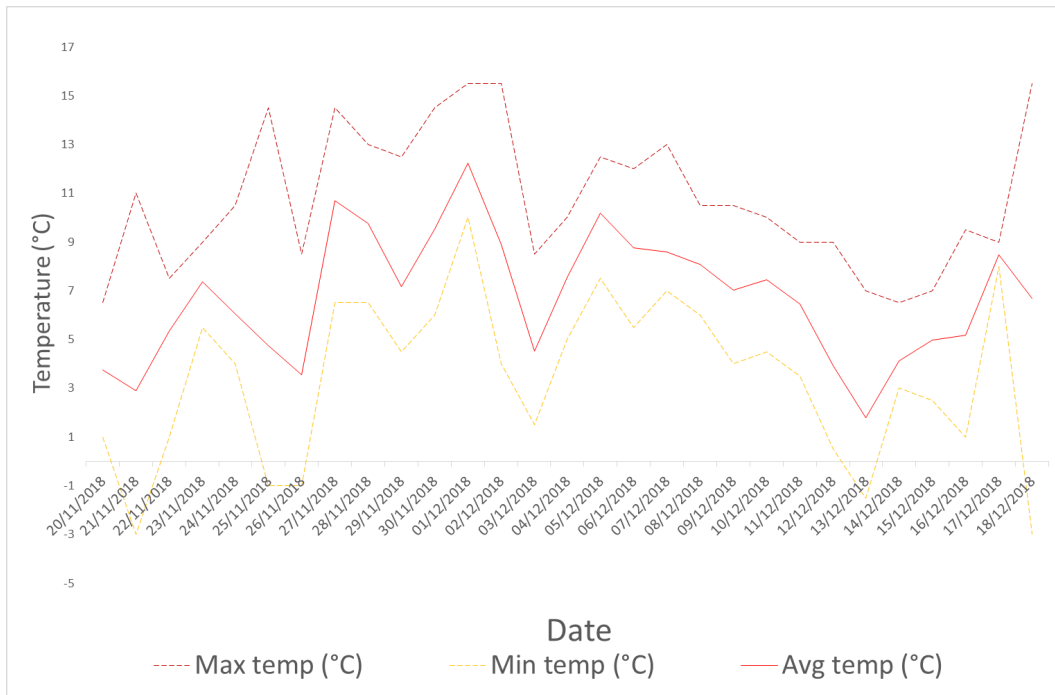
		HEUCHERA									
BLOCK 1		4	8	6	7	3	5	10	9	2	1
	PLOT	1	2	3	4	5	6	7	8	9	10
BLOCK 2		3	7	1	5	4	9	10	8	2	6
	PLOT	11	12	13	14	15	16	17	18	19	20
BLOCK 3		5	4	10	6	9	2	1	3	7	8
	PLOT	21	22	23	24	25	26	27	28	29	30
BLOCK 4		6	7	3	9	8	4	1	5	10	2
	PLOT	31	32	33	34	35	36	37	38	39	40

		ENGLISH LAVENDER									
BLOCK 1		6	5	9	4	8	1	7	2	10	3
	PLOT	1	2	3	4	5	6	7	8	9	10
BLOCK 2		7	3	1	4	8	10	6	5	2	9
	PLOT	11	12	13	14	15	16	17	18	19	20
BLOCK 3		4	8	5	3	2	10	7	1	6	9
	PLOT	21	22	23	24	25	26	27	28	29	30
BLOCK 4		10	2	4	8	9	7	3	1	6	5
	PLOT	31	32	33	34	35	36	37	38	39	40

		PRIMULA									
BLOCK 1		1	2	5	6	3	10	8	7	4	9
	PLOT	1	2	3	4	5	6	7	8	9	10
BLOCK 2		6	5	4	9	3	8	2	1	10	7
	PLOT	11	12	13	14	15	16	17	18	19	20
BLOCK 3		8	3	5	9	4	6	2	10	7	1
	PLOT	21	22	23	24	25	26	27	28	29	30
BLOCK 4		8	3	10	7	5	1	4	2	6	9
	PLOT	31	32	33	34	35	36	37	38	39	40

		RUDBECKIA									
BLOCK 1		7	2	5	9	8	1	6	3	4	10
	PLOT	1	2	3	4	5	6	7	8	9	10
BLOCK 2		6	9	2	1	5	3	7	8	4	10
	PLOT	11	12	13	14	15	16	17	18	19	20
BLOCK 3		1	7	6	2	5	4	9	10	3	8
	PLOT	21	22	23	24	25	26	27	28	29	30
BLOCK 4		10	7	9	6	2	4	3	5	1	8
	PLOT	31	32	33	34	35	36	37	38	39	40

f) Environmental data for the ornamentals trial.



g) ORETO certification.

