Grower Summary

HNS 180

Development of fungicide treatments for sustainable control of powdery mildew on rose and herbaceous crops

Final 2012

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

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Project Number:	HNS 180
Project Title:	Development of fungicide treatments for sustainable control of powdery mildew on rose and herbaceous crops
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Headline

- Ten fungicides covering a wide range of active ingredients gave good control of powdery mildew on aquilegia, aster, phlox or rose.
- Effective products were Cyflamid (cyflufenamid), Flexity (metrafenone), Fortress (quinoxyfen), Nativo 75WG (tebuconazole + trifloxystrobin), potassium bicarbonate + Silwet L-77 (wetter), Signum (boscalid + pyraclostrobin), Switch (cyprodinil + fludioxonil), Systhane 20EW (myclobutanil) and Thiovit Jet (sulphur) + Silwet L-77 (wetter).
- The biofungicde Serenade ASO (*Bacillus subtilis*) gave some control.
- Seven fungicide programmes, designed to be at low risk of selecting resistant strains and comply with maximum spray number limits, gave good season-long control of powdery mildew on aquilegia and phlox.

Background and expected deliverables

Powdery mildews of rose and herbaceous perennials are widespread, common and potentially very damaging diseases. Whilst fungicides still remain the primary method of control the efficacy and crop safety of individual fungicides against powdery mildew diseases on different crops is likely to vary.

Work in project HNS 156 identified new fungicides with good activity against powdery mildew on seedling crops of *Crataegus* species (*Podosphaera clandestina*) and *Quercus* species (*Erysiphe alphitoides*) and devised long-term programmes for their use.

The overall aim of this project was to devise fungicide programmes based on currently available products, used within their spray number limit, that provide sustainable, season-long control of powdery mildew on *Rosa* species and some susceptible herbaceous crop species.

Summary of the project and main conclusions

Evaluation of fungicides for control of rose powdery mildew

Twelve fungicide or biofungicide treatments were compared for control of powdery mildew on container-grown rose cv. Ruby Wishes in a shade tunnel on a nursery in Norfolk. High volume sprays were applied between April and July 2010 at approximately 14 day intervals.

Powdery mildew was first observed shortly after the third spray application, and increased to affect 23% of leaflets and 2.2% of the leaf area on untreated plants by the end of the experiment. Disease severity was significantly reduced by all treatments with no clear difference between them: Kindred (meptyldinocap), Nativo 75WG, Nimrod (bupirimate),

potassium bicarbonate + Silwet L-77, potassium bicarbonate + Serenade ASO, Serenade ASO, Signum, Switch, Systhane 20EW and three coded experimental products.

The incidence of affected leaflets at the end of the trial was reduced by all treatments except for Serenade ASO and potassium bicarbonate + Serenade ASO; possibly Serenade ASO would have given better control if applied every 7 days. None of the treatments caused crop damage or left an obvious spray deposit.

Evaluation of fungicides for control of powdery mildew on aquilegia and phlox

Eleven fungicide treatments were compared for the control of powdery mildew (*Erysiphe aquilegiae* and *Podosphaera fusca*) on container-grown Aquilegia cv. Red Hobbit and Phlox cv. Blue Paradise on a nursery in Norfolk. Five high volume sprays were applied at approximately 14 day intervals between July and September 2010. Powdery mildew was first observed, on both crops, one week after the third spray.

On aquilegia powdery mildew increased to affect 40% of untreated plants and all treatments reduced disease incidence to 15% or less. No powdery mildew was found on plants treated with Cyflamid, Nativo 75WG, Signum or Thiovit Jet + Silwet L-77. Disease severity was low and there were no clear differences between treatments.

On phlox powdery mildew was severe and by 7 October 2010 affected 70% of the leaf area of untreated plants. The best treatments were Cyflamid, Nativo 75WG, potassium bicarbonate + Silwet L-77, Signum and Thiovit Jet + Silwet L-77, all of which reduced the disease to less than 7% leaf area affected. The biofungicide Serenade ASO reduced mildew severity by 50% and the treatment may have been more effective if applied weekly. Potassium bicarbonate was significantly more effective when used with the silicon based wetter Silwet L-77 (1% leaf area affected) than with Serenade ASO (8%).

No leaf scorch or other obvious adverse effects were observed immediately after treatments. However, after five sprays had been applied, the mean height of phlox plants treated with Fortress, Nativo 75WG and both of the potassium bicarbonate treatments was lower (25-26 cm) compared with the untreated (29 cm). Thiovit Jet + Silwet L-77 left an obvious pale brown spray deposit on both aquilegia and phlox.

Evaluation of fungicides for control of established powdery mildew on aster

Nine fungicide treatments were compared for control of established powdery mildew (*Golvinomyces cichoracearum*) on container-grown aster (*Aster novi-belgii*) cv. Purple Dome at ADAS Boxworth. Each treatment was applied twice as high volume sprays at a 7 day interval in October 2010. Seven days after the second treatment the leaf area affected by powdery mildew was greatest on untreated plants (37%) and was significantly reduced by all treatments (Cyflamid, Flexity, Fortress, Nativo 75WG, potassium bicarbonate + Silwet L-77,

Systhane 20EW, Signum, Swift SC and Switch). Potassium bicarbonate + Silwet L-77 was the most effective, reducing powdery mildew to 11% leaf area affected. In spring 2011, a low incidence of powdery mildew occurred on new growth of plants untreated in autumn 2010, and no powdery mildew on any of the plants treated with fungicide the previous autumn.

Evaluation of fungicide programmes

Seven fungicide programmes designed to be at low risk of selecting resistant strains of mildew were devised and tested on outdoor container crops of aquilegia and phlox during summer 2011. Each programme consisted of alternate sprays of two or three products until the maximum spray number for a product was reached, when it was continued with Thiovit Jet + Silwet L-77 or Systhane 20EW, which have no restriction on spray number (Table 1). The same seven programmes were tested on rose with additional programmes of Systhane 20EW + potassium bicarbonate alternating with Nimrod and one using the EMR powdery mildew predictions model (see HNS 165). All of the programmes are suitable for use on both outdoor and protected crops except for those containing either Cyflamid or Nativo 75WG (outdoor crops only).

On aquilegia, powdery mildew first occurred on 3 August and increased to affect 43% leaf area of untreated plants at 7 days after the final spray. All of the programmes reduced the disease to 5% or less and none caused any obvious crop damage (Table 1).

On phlox, powdery mildew affected over 70% of upper and lower leaf surfaces of untreated plants at the end of the trial. Six of the programmes gave excellent control reducing the disease to 3% leaf area affected or less; the Serenade ASO/potassium bicarbonate programme was slightly less effective, with around 20% on the lower leaf surface (Table 1).

On rose, the level of powdery mildew infection was slight, affecting only 3% leaf area of untreated plants at the end of the trial. None of the fungicide programmes reduced disease incidence or severity. Two programmes (Signum/Cyflamid/Nativo 75WG and Serenade ASO/potassium bicarbonate + Silwet L-77) increased the proportion of plants with a high plant quality score, possibly due to control of powdery mildew.

Table 1: Efficacy of fungicide programmes against powdery mildew on aquilegia and phlox – 2011

Programme	Suitable for		Spray treatment and application week:								% leaf area affected 1 week after final spray		
	Outdoor crops	Protected crops	Week 25	Week 27	Week 29	Week 31	Week 32	Week 33	Week 34	Week 35	Aquilegia	Phlox	
												Upper surface	Lower surface
1. Untreated	-	-	-	-	-	-	-	-	-	-	45	70	81
2. Preventative	✓	✓	Thiovit[a]	Signum	Thiovit	Signum	-	Thiovit	-	Thiovit	2	<1	6
3. Preventative	✓	✓	Switch + $KHCO_3$	Signum	Switch + $KHCO_3$	Signum	-	Switch + $KHCO_3$	-	Systhane + $KHCO_3$	1	1	6
4. Preventative	✓	✓	Systhane + $KHCO_3$	Signum	Systhane + $KHCO_3$	Signum	-	Systhane + $KHCO_3$	-	Systhane + $KHCO_3$	1	2	4
5. Preventative	✓	✓	Fortress	Signum	Fortress	Signum	-	Systhane + $KHCO_3$	-	Systhane + $KHCO_3$	3	1	5
6. 'High disease risk'	✓		Signum	Cyflamid	Nativo	Signum	-	Cyflamid	-	Nativo	1	2	6
7. 'Biological'	✓	✓	Serenade	Serenade	Serenade	$KHCO_3$[b]	-	$KHCO_3$	-	$KHCO_3$	6	5	23
8. From first symptoms	✓		-	-	-	Signum[b]	Cyflamid	-	Nativo	-	4	2	8

[a]A silicon based wetter (Silwet L-77) was added to Thiovit Jet and potassium bicarbonate ($KHCO_3$) at 0.025%.

[b]Change of product (treatment 7) and start of spray programme (treatment 8) were made in response to first occurrence of powdery mildew in the crop.

Persistence of protectant sprays

An experiment was devised to compare the persistence of protection against powdery mildew provided by a single spray of different fungicides. Aster plants were sprayed with nine fungicides (Cyflamid, Flexity, Fortress, Nativo 75WG, Serenade ASO, Signum, Switch, Systhane 20EW and Thiovit Jet + Silwet L-77) at 1, 7 and 14 days before inoculation with spores of powdery mildew (*Golvinomyces cichoracearum*). Mildew developed on all treatments sprayed 14 days before inoculation, on two treatments (Cyflamid and Thiovit Jet + Silwet L-77) sprayed 7 days before inoculation and on no treatments where fungicides were sprayed 1 day before inoculation. Persistence of protection was greatest on plants treated with Systhane 20EW, Serenade ASO and Thiovit Jet + Silwet L-77 (all less than 5% leaf area affected when treated 14 days before infection) and least on plants treated with Flexity (20%).

Summary of product efficacy

The relative efficacy of products examined is summarised in Table 2. Details of products used and their approval status are given in Table 3.

Table 2. Summary of fungicide and biofungicide efficacy against powdery mildew diseases on aquilegia, phlox and rose – 2010

Product	Fungicide group codes	Level of powdery mildew control[a] on:		
		Aquilegia	Phlox	Rose
Cyflamid	U6	*****	*****	-
Flexity	U8	****	*****	-
Fortress	13	****	*****	-
Kindred	29	-	-	****
Nativo 75WG	3+11	*****	*****	*****
Nimrod		-	-	*****
Potassium bicarbonate + Silwet L-77	NC	*****	*****	*****
Potassium bicarbonate + Serenade ASO	NC	*****	**	***
Serenade ASO	NC	*****	**	****
Signum	7+11	*****	*****	*****
Switch	9+12	***	****	****
Systhane 20EW	3	*****	****	*****
Thiovit Jet + Silwet L-77	M2	*****	*****	-

Product	Fungicide group codes	Level of powdery mildew control[a] on:		
		Aquilegia	Phlox	Rose
Disease level on untreated		40% plants affected (all at low level)	70% leaf area affected	21% leaflets affected (all at low level)

[a] Disease reduced by: *, 1-20%; **, 21-40%, ***, 41-60%, ****, 61-80%; *******,** 81-100%, - not tested.

Products were applied as protectant sprays approximately every 14 days.

Fungicide group codes are taken from the Fungicide Resistance Action Committee code list. Numbers and letters are used to distinguish fungicide groups according to their cross-resistance behaviour; products with the same number are at high risk of cross-resistance. U =unknown mode of action; m=multisite inhibitor (low risk of resistance); NC = not classified.

Table 3. Details of fungicide and biofungicide products used in this work and their approval status (March 2012)

Product	Active ingredient(s)	Rate used on outdoor crops	Approval status on ornamentals:		Maximum number sprays or total dose
			Outdoor	Protected	
Cyflamid	cyflufenamid (50 g/L)	0.5 L/ha	SOLA 0512/07	Not approved	2
Flexity	metrafenone (300 g/L)	0.5 L/ha	SOLA 2850/08	Not approved	1 L/ha
Fortress	Quinoxyfen (500 g/L)	0.25 L/ha	SOLA 2852/08	SOLA 2852/08	0.5 L/ha
Nativo 75WG	tebuconazole + trifloxystrobin (50:25% w/w)	0.4 g/L	LTAEU	Not approved	2
Nimrod	bupirimate (250 g/L)	0.38 ml/L	Label (rose) and LTAEU	Label (rose) and LTAEU	none
Potassium bicarbonate + Silwet L-77	$KHCO_3$ + wetter	5 -10 g/L + 0.025%	Commodity substance	Commodity substance	60 kg/ha
Serenade ASO	*Bacillus subtilis* (13.96 g/L)	10 ml/L	EAMU 0475/12	EAMU 0475/12	20
Signum	boscalid + pyraclostrobin (26.7:6.1% w/w)	1.35 g/L	SOLA 1842/09	SOLA 1842/09	2
Swift SC	trifloxystrobin (500 g/L)	0.5 ml/L	2882/08	Not approved	2
Switch	cyprodinil + fludioxonil (37.5:5.25% w/w)	0.8 -1 g/L	Label (1 kg/ha)	Label (0.8 kg/ha)	3

Product	Active ingredient(s)	Rate used on outdoor crops	Approval status on ornamentals:		Maximum number sprays or total dose
			Outdoor	Protected	
Systhane 20EW	myclobutanil (200 g/L)	0.3 ml/L	Label	Label	None stated
Thiovit Jet + Silwet L-77	sulphur + Wetter (80% w/w)	10 kg/ha + 0.025%	LTAEU	LTAEU	None stated

Treatments rates are based on a spray volume of 1,000 L/ha. Products used in mixtures were applied at the full rate.

LTAEU - Long Term Arrangements for Extension of Use. Nimrod is currently permitted on ornamentals other than rose under the LTAEU.

Where a product is used under the LTAEU, a SOLA or an EAMU, growers should read and observe all the restrictions; use under a SOLA, EAMU or the LTAEU is at the grower's own risk.

Financial benefits

Each year powdery mildews affect many species of hardy nursery stock and herbaceous perennials. The diseases they cause may be slight or, in some situations, if left untreated, may cause severe economic losses. They impair photosynthesis, stunt growth and can cause premature leaf fall. They generally do not kill their hosts but extensive white fungal growth on leaf, stem and flower surfaces make plants unsightly, and thus either unsaleable or of reduced quality. Severe damage can cause death of leaves and shoots. Although numerous fungicides are available for powdery mildew control, weekly applications may be needed to maintain adequate control. The potential financial benefits to growers from this project are more reliable control of powdery mildew with reduced risk of fungicide resistance, and reduced losses and down-grading of crops due to powdery mildew.

Assuming a value for rose production in the UK of £24m (DEFRA 2011), losses directly attributed to powdery mildew are estimated at 5%. If these losses could be reduced by 50% due to improved control programmes using a range of fungicide at similar cost there would be a saving of £600,000 per annum for the rose industry. Assuming a value of container nursery stock production in the UK of £286m (DEFRA 2011) of which 15% is herbaceous stock this would give a value of £43m for container grown herbaceous stock. In addition field grown herbaceous nursery stock is valued at £14m giving a total value of herbaceous production of £57m. It is estimated that 15% of production genera are susceptible to powdery mildew and losses amount to 15% of these genera due to quality down grading and missed sales opportunities. If losses could be reduced by 50% due to improved control programmes using a range of fungicide at similar cost there would be a saving of £640,000

per annum for the herbaceous plant industry. Total benefits from this project are therefore estimated at £1.24m per annum.

http://www.defra.gov.uk/statistics/files/defra-stats-foodfarm-landuselivestock-hottstats-bhs2011-110721.pdf

Action points for growers

- Use fungicides from a range of different fungicide groups when devising a spray programme for control of powdery mildew (see Table 2); this is important because powdery mildew pathogens are 'high risk' with regard to resistance management.
- Seek to include in the spray programme one or more fungicides which are at low risk of selecting resistant strains; such products include potassium bicarbonate and Thiovit Jet.
- Consider use of Nativo 75WG, Nimrod, Potassium bicarbonate + Silwet L-77, Signum, Switch, Systhane 20EW and the biofungicide Serenade ASO, in spray programmes for control of powdery mildew on outdoor rose.
- Consider use of: Cyflamid, Flexity, Fortress, Nativo 75WG, potassium bicarbonate + Silwet L-77, Signum, Switch, Systhane 20EW, Thiovit Jet + Silwet L-77 and the biofungicide Serenade ASO in spray programmes for powdery mildew on outdoor crops of aquilegia and phlox.
- When using potassium bicarbonate to control powdery mildew, mixing it with a silicon based wetter is likely to improve control.
- The biofungicide Serenade ASO applied every 14 days can give some control of powdery mildew, though generally it is less effective than conventional mildew fungicides applied at the same spray interval; use Serenade ASO at a shorter spray interval to increase the chance of better control.
- Note that Fortress at 0.25 L/ha, Nativo 75WG at 0.4 kg/ha and potassium bicarbonate at 10 g/L may reduce plant height. Do not use these products on very young plants or in succession where crop height is critical.
- A range of simple fungicide programmes, consisting of two or three products applied in alternation can be used to provide effective control of powdery mildew on aquilegia and phlox with reduced risk of selecting resistant strains (see Table 1).
- Consider using Systhane 20EW, Serenade ASO and Thiovit Jet + Silwet L-77 on aster where the interval to the next spray may be more than 14 days.

- Do not rely on potassium bicarbonate + Silwet L-77 to provide adequate control in crops (e.g. phlox) where powdery mildew may occur on the lower leaf surface.
- Consider using Systhane 20EW in mixture with potassium bicarbonate to increase the level of control, especially where the disease is visible in a crop.