



Agriculture & Horticulture  
DEVELOPMENT BOARD



# Grower Summary

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## HNS 186

Control of downy mildew on  
shrub and herbaceous plants

Final 2014

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HDC is a division of the Agriculture and Horticulture Development Board.

**Project Number:** HNS 186

**Project Title:** Control of downy mildew on shrub and herbaceous plants

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**Report:** Final Report 2014

**Publication Date:** April 2014

**Previous report/(s):** Annual Report 2013

**Start Date:** 01 April 2012

**End Date:** 31 March 2014

**Project Cost:** £58,500

## Headline

1. Thirteen products, including novel fungicides and biofungicides, a fungicide incorporated in the growing medium and a foliar fertiliser, reduced downy mildew on *Geum*; nine products reduced downy mildew in *Hebe*.
2. Eleven fungicide programmes designed to reduce resistance risk and provide season-long protection against downy mildew greatly reduced the disease on *Geum*.
3. New EAMUs are available permitting the use of Fenomenal, Percos and Previcur Energy as spray treatments for control of downy mildew on ornamentals on both protected and outdoor crops.
4. Fungicides and biofungicides used in this project were shown to be safe to 11 commonly grown herbaceous plant species when used at recommended rates, however repeat applications of Fubol Gold WG damaged a small-leaved variety of *Hebe*.

## Background and expected deliverables

Downy mildew diseases can seriously damage over a dozen nursery stock and herbaceous perennials including *Buddleia*, *Digitalis*, *Gaillardia*, *Labium*, *Hebe*, *Rose* and *Veronica*. Fungicides are the primary method of control for most growers. The availability of fungicides for use on ornamentals is currently declining due to changing legislation. Furthermore, there is a risk of some fungicides failing to control downy mildew diseases due to selection of fungicide-resistant strains; this has recently occurred with metalaxyl-M (e.g. Fubol Gold WG) failing to control impatiens downy mildew. The SCEPTRE HortLink project is evaluating a wide range of new fungicides and biofungicides for downy mildew control on edible crops. This project examined the most promising new products identified in the SCEPTRE HortLink project, and elsewhere, for control of downy mildews on two ornamental crops, and for their crop-safety to a range of ornamentals. Simple crop protection programmes, based where possible on products designed to reduce the risk of resistance build-up, were devised and tested. The HDC Factsheet on downy mildew diseases of hardy nursery stock and herbaceous plants was updated.

The overall aim of the project was to improve control of downy mildew diseases. Specific project objectives were:

1. To determine the effectiveness of selected novel fungicides and biofungicides;
2. To devise and determine the effectiveness of some simple alternating programmes;

3. To screen novel fungicides and biofungicides with good potential for control of downy mildew diseases for their safety to a range of susceptible ornamentals.

## **Summary of the project and main conclusions**

Three fully replicated experiments were carried out in 2012, five in 2013 and one in 2014, all on commercial nurseries. Objective 1 was examined in all experiments and specifically in experiments 1, 2 and 8; Objective 2 was examined in experiments 3, 4, 5 and 7. Objective 3 was examined in all experiments and specifically in experiment 6.

### ***Experiment 1 – Fungicides and biofungicides for control of Hebe downy mildew (Year 1)***

Nine conventional fungicides, two biofungicides and a foliar fertiliser were evaluated as high volume sprays and PlantTrust (fosetyl- aluminium) as a growing medium incorporation, for control of downy mildew (*Peronospora grisea*) on *Hebe x franciscana* 'Variegata' in a low multispan tunnel on a nursery in Norfolk. The conventional fungicides comprised Fenomenal (fosetyl-aluminium + fenamidone), Fubol Gold WG (mancozeb + metalaxyl-M), Infinito (fluopicolide + propamocarb hydrochloride), Paraat (dimethomorph), Percos (ametoctradin + dimethomorph), Pergado Uni (mandipropamid), Previcur Energy (fosetyl-aluminium + propamocarb hydrochloride), Signum (boscalid + pyraclostrobin) and one coded product (F62); the biofungicides were both coded products (F60 and F61); the foliar fertiliser was Hortiphyte (potassium phosphite). Fungicides and the foliar fertiliser were applied every 14 days and the biofungicides every seven days from 6 September to 20 December 2012. The PlantTrust was incorporated and plants potted three weeks after other treatments were established due to late delivery. No downy mildew occurred despite the introduction of *Hebe* plants affected by the disease into the tunnel. No crop damage or effect on plant quality was observed.

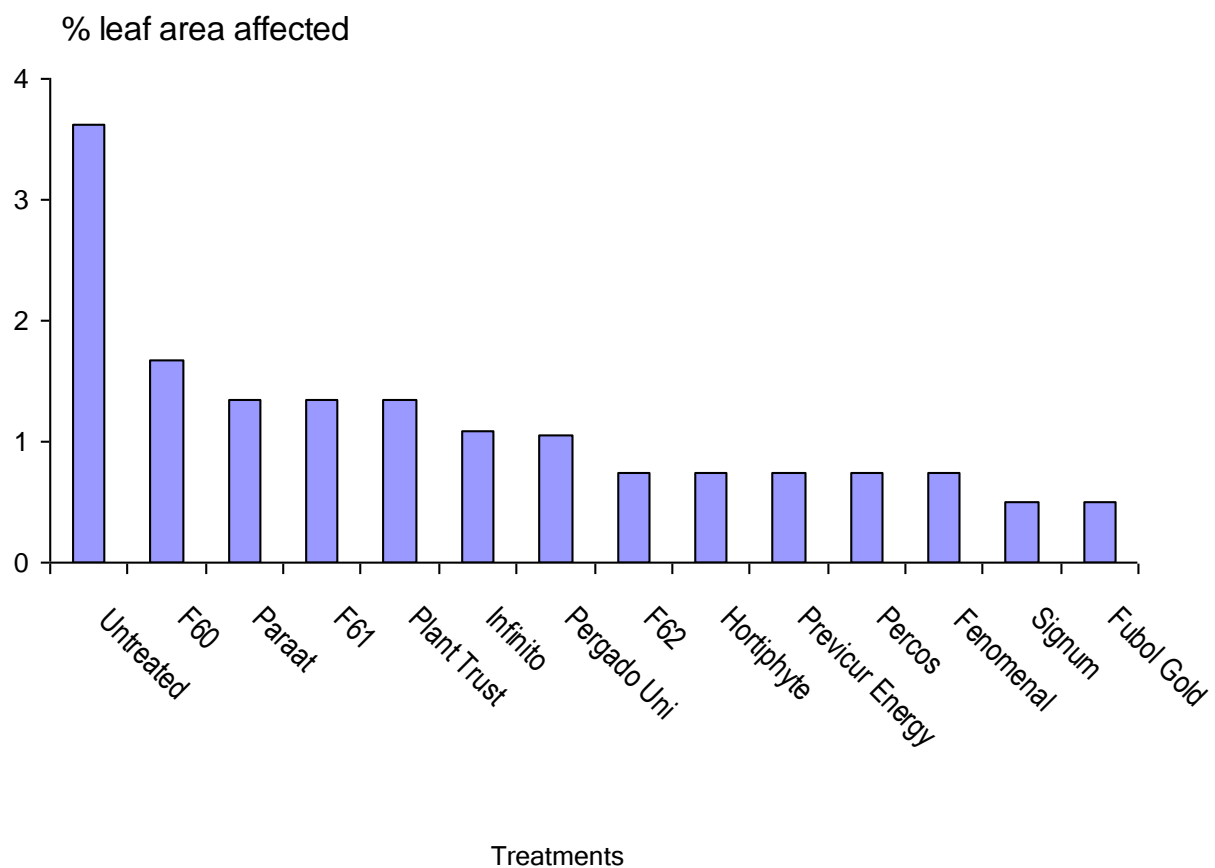
### ***Experiment 2 – Fungicides and biofungicides for control of Geum downy mildew (Year 1)***

The same treatments as used in Experiment 1 were examined for control of downy mildew (*Peronospora potentillae*) on *Geum* 'Mrs Bradshaw' on a nursery in Norfolk.

Plug plants were already infected by a low level of downy mildew at potting. The first two applications of all treatments were therefore applied at a seven day interval (6 and 13 September 2012) as is likely to be done in good commercial practice when downy mildew occurs, and thereafter at 14 (fungicide) or seven (biofungicide) day intervals. All treatments

reduced disease incidence and severity (Figure 1). Signum and Fubol Gold WG gave the best control, with Fenomenal, Percos, Previcur Energy, Hortiphyte and F62 almost as good. The two biofungicides (F60 and F61), Paraat and PlantTrust were slightly less effective than Fubol Gold WG and Signum in this experiment. Following cold weather in December and January, patches of leaf yellowing developed on 18-47% of plants that had been treated with Infinito, F61 and F62.

It should be noted that Hortiphyte has no approval as a plant protection product and that the work done here was not done for the purpose of supporting a plant protection product claim. Hortiphyte is permitted for use on crops as a foliar fertiliser and the work reported here describes the potential side effect of Hortiphyte nutritional treatments on downy mildew.



**Figure 1.** Effect of fungicides, biofungicides (F60 and F61) and a foliar fertiliser on *Geum* downy mildew, Norfolk – December 2012

### **Experiment 3 – Fungicide products and simple programmes for control of *Hebe downy mildew* (Year 1)**

Seven treatments were evaluated for control of downy mildew on *Hebe* 'Frozen Flame' from 29 August to 19 December 2012. The treatments comprised PlantTrust incorporation in the growing medium; Fenomenal applied as a monthly drench and as a spray; programmes of Fenomenal, Signum and Hortiphyte each alternating with Fubol Gold WG every 14 days, and Hortiphyte as a monthly foliar spray. Downy mildew was first observed in mid-September and increased in November. By 7 January 2013, downy mildew affected 14% leaf area on untreated plants. Disease severity appeared to be reduced by PlantTrust, by Fenomenal drenches and sprays, and by Hortiphyte sprays (Table 1). Fenomenal drench and spray treatments, applied at monthly intervals, were most effective and reduced the disease to around 1% leaf area affected. Treatment with Fubol Gold WG resulted in leaf tip pale discolouration, first visible one week after the third spray application (the maximum spray number); damage symptoms increased with a further spray (applied under an Experimental Permit) and some plants showed shoot tip dieback and plant collapse (Figure 2).

**Table 1.** Effect of fungicide programmes on *Hebe* downy mildew, Works – 2012

<b>Product(s)</b>	<b>Application method and interval (days)</b>	<b>Total no. applications</b>	<b>% leaf area affected (7 Jan 2012)</b>	<b>% plants marketable</b>
1. Untreated	-	0	14.3	75
2. PlantTrust	Incorporation	1	7.8	84
3. Fenomenal	Drench (28)	5	1.6	97
4. Fenomenal	Spray (28)	5	1.0	100
5. Fenomenal /Fubol Gold	Spray (14)	9	- <sup>a</sup>	0
6. Signum /Fubol Gold	Spray (14)	9	-	3
7. Hortiphyte /Fubol Gold	Spray (14)	9	-	25
8. Hortiphyte	Spray (14)	5	2.7	97

<sup>a</sup> Unable to assess downy mildew due to spray damage to plants; earlier observations indicated low disease levels; see Year 1 report.



**Figure 2.** Close up of *Hebe* 'Frozen Flame' leaf damage after four sprays with Fubol Gold WG at 1.9 g/L

***Experiment 4 – Evaluation of fungicide and biofungicide programmes for control of downy mildew on Hebe (Year 2)***

Nine alternating programmes using both fungicides and biofungicides were applied to *Hebe* plants cultivar *Hebe x franciscana* 'Variegata' on a commercial nursery in Norfolk (Table 2). To encourage infection two sets of plants previously infected with downy mildew were placed around the trial plots ('infecter' plants) which remained unsprayed; and trial plants were covered with plastic sheeting for a period of 96 hours after each spray to create leaf wetness. At week 42 infection had not occurred naturally and a spore solution was used to inoculate the infecter plants. Treatment applications were halted in week 46. No disease was visible at a final assessment in week 51.



**Table 2.** Fungicide, biofungicide and foliar fertiliser programmes applied to both *Hebe* and *Geum* plants – 2013

Treatment	Week number															
	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	
1. Untreated	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
<u>Current options for growers</u>																
2. PlantTrust (incorporation)	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
3. Current fungicides +foliar fertiliser	FG	-	Hor	-	Sig	-	FG	-	Hor	-	Sig	-	FG	-	Hor	
4. Foliar fertiliser only (low input programme)	Hor	-	Hor	-	Hor	-	Hor	-	Hor	-	Hor	-	Hor	-	Hor	
5. Two novel fungicides programme (outdoor crops only)	Inf	-	Per	-	Inf	-	Per	-	Inf	-	Per	-	Inf	-	Per	
6. Broad-spectrum programme (protected or outdoor)	Per	-	FG	-	Sig	-	Per	-	FG	-	Sig	-	Per	-	FG	
7. Nil until first symptoms (then T6)	-	-	-	-	-	-	-	Per	FG	-	Sig	-	Per	-	Sig	
<u>Potential new options for growers (tested under Experimental Permit)</u>																
8. Biological 1 (F60) until first symptoms	F60	F60	F60	F60	F60	F60	F60	Per	FG	-	Sig	-	Per	-	Sig	
9. Biological 2 (F61) until first symptoms	F61	F61	F61	F61	F61	F61	F61	Per	FG	-	Sig	-	Per	-	Sig	
10. Three fungicides programme (low resistance risk; O+P)	Per	-	FG	-	Fen	-	Per	-	FG	-	Fen	-	Per	-	FG	
11. New chemistry	F62	-	F62	-	F62	-	F62	-	F62	-	F62	-	F62	-	F62	
12. Broadening spectrum	Per+ F60	-	Inf+ F60	-	Per+ F60	-	Inf+ F60	-	Per+ F60	-	Inf+ F60	-	Per+ F60	-	Inf+ F60	

Current options comply with maximum spray number, application method and all other label statutory conditions. See Table 2 for rates of use.

FG – Fubol Gold WG; Sig – Signum; Fen – Fenomenal; Hor – Hortiphyte; Inf – Infinito; Per – Percos.

**Experiment 5 - Evaluation of fungicide and biofungicide programmes for control of downy mildew on Geum (Year 2)**

The same treatments as used in Experiment 4 (see Table 2) were examined for control of downy mildew on *Geum* 'Mrs Bradshaw' on a nursery in Norfolk. Introduction of 'infector' plants and periodic covering with plastic sheeting, as detailed for Experiment 4, was sufficient to introduce downy mildew. The final spray was applied at week 47.

Downy mildew severity (Table 3) was reduced by all treatments except T2 (PlantTrust). The most effective treatment was an alternating programme of Fubol Gold WG, Hortiphyte and Signum (T3), which resulted in no recorded downy mildew and high plant vigour. Treatment 6 (Percos/Fubol Gold WG/Signum) was also very good. Application of biological treatments (F60 and F61) until first symptoms was better than no treatment until first symptoms (T6).

**Table 3.** Effect of spray programmes of fungicides, biofungicides and a foliar fertilizer on *Geum* downy mildew – 2 December 2013 (10 days after final spray)

Treatment (spray sequence)	Total no. sprays	% plants affected	% leaf area affected	Plant vigour (0-5) 4 Jan
1. Untreated	-	66	23.1	3.6
2. PlantTrust	-	71	19.9	3.5
3. FG/Hor/Sig	8	<b>0</b>	<b>0.0</b>	<b>5.0</b>
4. Hortiphyte	8	<b>7</b>	<b>0.2</b>	<b>4.8</b>
5. Infinito/Percos	8	<b>7</b>	<b>0.1</b>	<b>4.5</b>
6. Per/FG/Sig	8	<b>2</b>	<b>0.0</b>	<b>5.0</b>
7. Nil until symptoms, then T6	5	46	<b>7.4</b>	3.3
8. F60 until symptoms, then T6	12	<b>12</b>	<b>0.0</b>	4.3
9. F61 until symptoms, then T6	12	<b>16</b>	<b>0.6</b>	4.3
10. Per/FG/Fen	8	<b>12</b>	<b>0.0</b>	<b>4.5</b>
11. F62	8	<b>8</b>	<b>0.0</b>	<b>4.5</b>
12. Per + F60/Inf + F60	8	<b>5</b>	<b>0.0</b>	<b>4.5</b>

Figures in bold are significantly different from the untreated.

FG – Fubol Gold WG; Hor – Hortiphyte; Sig – Signum; Per – Percos; Fen – Fenomenal; Inf – Infinito.

**Experiment 6 – Evaluation of novel fungicide and biofungicide products for phytotoxicity to herbaceous crop species commonly affected by downy mildew (Year 2)**

None of 10 fungicides or biofungicides, or a foliar fertiliser, each applied four times at the recommended rate, was observed to cause phytotoxicity on any plant species at any point in this trial. The products were Hortiphyte, Infinito, Fenomenal, Fubol Gold WG, Paraat, Percos, Previcur Energy, and three coded products (F60, F61, F62). There was incidental occurrence of powdery mildew on *Coreopsis* which was reduced by Fenomenal, Fubol Gold WG, a coded biofungicide (F61) and the foliar fertiliser Hortiphyte.

**Experiment 7 – Comparison of spray programmes to control downy mildew on Hebe (Year 2)**

Experiment 7 was done on a nursery in Worcestershire. An alternating fungicide spray programme was evaluated for control of downy mildew on *Hebe* ‘Heartbreaker’ in comparison with the nursery standard programme (Table 4). The crop was grown on a sand bed with sub-irrigation in a glasshouse. Liners produced on the nursery were potted into 2 L pots on 8 August; fungicide spray treatments commenced around one week later and continued until 21 November. On 30 November 2013, downy mildew affected 7.5% of plants in the grower standard programme and none treated with the new broad-spectrum programme.

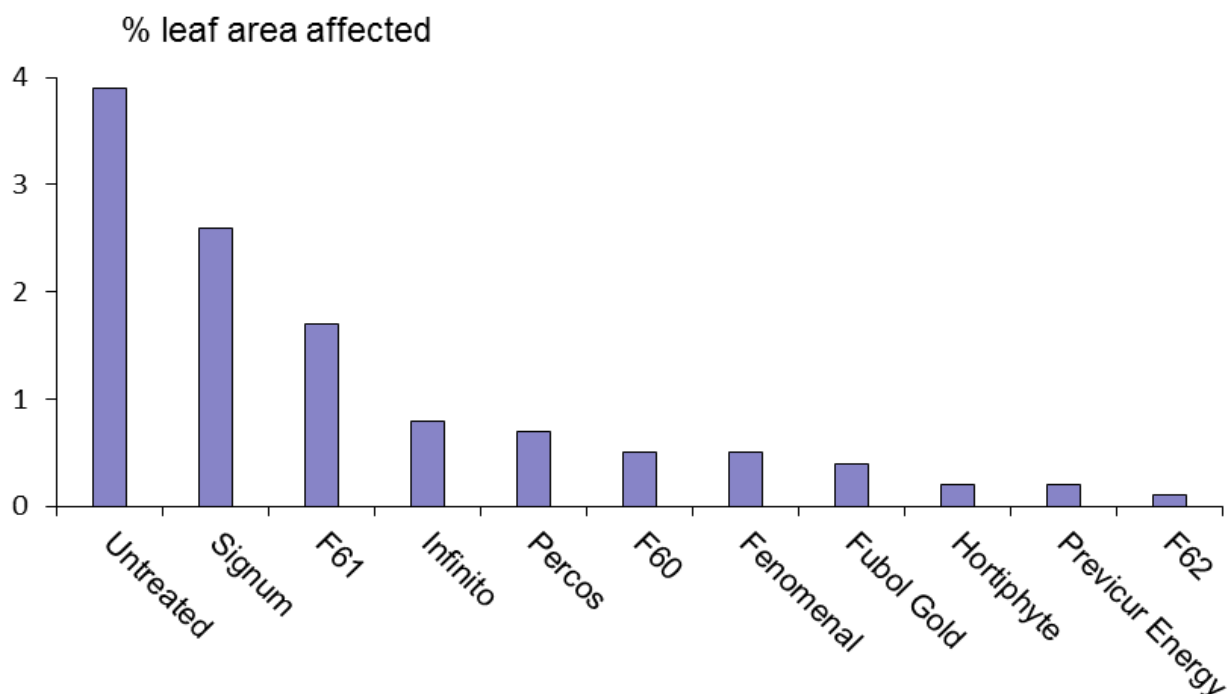
**Table 4.** Effect of two spray programmes on incidence of *Hebe* downy mildew – 30 November 2013

Treatment	Sprays applied (week no.)								% plants affected
	33	35	37	39	41	43	45	47	
1. New programme	Per	FG	Sig	Per	FG	Sig	Per	FG	0
2. Nursery programme	Cu	Sig	Ami	FG	Sys	FG	Pro	Cu	7.5

Ami – Amistar; Cu – Headland Copper; FG – Fubol Gold WG; Per – Percos; Pro – Proplant; Sig – Signum; Sys – Systhane 20EW

### **Experiment 8 – Comparison of products on Hebe (Year 2)**

The plants used in Experiment 4 were re-used in early 2014 to evaluate the efficacy of eight fungicides (applied twice at 14 day intervals) and two biofungicides (applied three times at seven day intervals) for control of *Hebe* downy mildew. A low level of downy mildew was first observed on 17 January 2014. Sprays were applied on 4, 11 and 18 February. At two weeks after the final spray, downy mildew severity was less than 0.5% on plants treated with Fubol Gold WG, Hortiphyte, F62 and Previcur Energy. Infinito, Percos, F60 (biofungicide), F61 (biofungicide) and Fenomenal were almost as good. Signum did not reduce disease (Figure 3).



**Figure 3.** Effect of fungicides, biofungicides (F60 and F61), and a foliar fertiliser (Hortiphyte) on *Hebe* downy mildew, Norfolk – 3 March 2014

**Table 5.** Summary of products evaluated as sprays for control of downy mildew, rate of use, and their approval status (February 2014) for use on ornamental crops

Product	Active ingredient(s) (fungicide group)	Rate of use	Approval		Max spray number
			Outdoor (O)	Protected (P)	
1. Fenomenal	fosetyl-Al (33) + fenamidone (11)	2.5 kg/ha	✓ 1990/13	✓ 1990/13	2
2. Fubol Gold WG	mancozeb (M3) + metalaxyl M (4)	1.9 kg/ha	✓ 0217/12	✓ 0217/12	3
3. Hortiphyte	potassium phosphite	2.5 L/ha	✓	✓	NS
4. Infinito	fluopicolide (43) + propamocarb (28)	1.6 L/ha	✓ 0952/13	-	4 if 1.6 L rate
5. Paraat	dimethomorph (40)	0.36 kg/ha	-	✓ 2585/11	2
6. Percos	ametoctradin (45) + dimethomorph (40)	0.8 L/ha	✓ 0819/13	✓ 0819/13	4
7. Pergado Uni	mandipropamid (40)	0.6 L/ha	✓ 1605/12	✓ 1605/12	4 (O) 1 (P)
8. PlantTrust	fosetyl-aluminium (33)	2.4 kg/m <sup>3</sup>	Label	Label	1
9. Previcur Energy	fosetyl-aluminium (33) + propamocarb (28)	2.5 L/ha	✓ 1845/13	✓ 1845/13	2
10. Signum	boscalid (7) + pyraclostrobin (11)	1.35 kg/ha	✓ 1842/09	✓ 1842/09	2
11. F60	Novel biological	-	NA	NA	-
12. F61	Novel biological	-	NA	NA	-
13. F62	Novel chemical	-	NA	NA	-

Spray applications were applied at 1000 L/ha. Fenomenal used as a drench was applied at 1.5 g/L, 200 ml/pot. NA – Not approved for use as a spray treatment; treatment applied under an Experimental Permit. NS – none stated.

Note that Fenomenal is also permitted for use on protected ornamentals as a drench with up to three applications per year at 50-150 g/100 L; Previcur Energy is also permitted for use on protected ornamentals as a drench with up to two applications at a maximum of 30 L/ha.

Use of Percos outdoors is restricted to the period June to September. Use on container plants standing on hard surfaces is prohibited.

Hortiphyte is permitted for use as a foliar fertiliser. It is not a plant protection product and makes no claims for disease control.

Before using a product for a plant protection purpose, always check that it is currently approved for the intended use and situation.

## Financial benefits

Downy mildew diseases can seriously damage some major shrub and herbaceous species. Losses in *Hebe* for example are estimated to exceed £200,000 annually. This project will benefit growers through identification of some new fungicides and biofungicides with activity against downy mildew and their potential for use on ornamentals. Development of sustainable programmes using fungicide and biofungicides that are crop-safe and effective will reduce losses and downgrading due to downy mildew in ornamental plants. Quantifying risks of phytotoxicity will ensure that both efficacy and safety can be evaluated.

## Action points for growers

- Consider use of the products detailed in Table 5 as protectant treatments for control of downy mildew on *Geum*, *Hebe* and other hardy nursery stock and herbaceous plants.
- Use two or more fungicides from different mode of action groups to reduce the risk of selecting resistant strains of downy mildew. Example programmes applied in alternation that gave good control of downy mildew in this project were:
  - Percos, Fubol Gold WG, Signum
  - Fubol Gold WG, Hortiphyte (foliar fertiliser), Signum
  - Percos, Infinito
  - Percos, Fenomenal, Fubol Gold WG
- An alternating spray programme of Percos, Fubol Gold WG and Signum should give some protection of some other diseases (e.g. powdery mildew, leaf spots) in addition to downy mildew.
- Test treat a small number of plants to check for phytotoxicity before using a fungicide widely on a new species or variety for the first time if not one of the species found to have no reactions in this study.
- Some novel fungicides and biofungicides (F60, F61, F62) with activity against downy mildew were identified in this project; HDC will issue publicity if and when these products are approved for use on ornamental crops.
- Note that Fenomenal and Previcur Energy have previously been permitted on ornamentals only as drench treatments; applications made during the course of this

project resulted in EAMU 1990/13 and EAMU 1845/13 authorising these products for use as foliar sprays.

- Note that use of Percos outdoors is restricted to applications between June and September and that use on hard surfaces is prohibited.
- Note that Hortiphyte applied as a foliar fertiliser can give useful incidental control of downy mildew on *Geum* and *Hebe*.
- Note that Fubol Gold WG may cause slight damage to some varieties of *Hebe* if the maximum number of permitted sprays (three) is used; and severe damage if this spray number is exceeded.
- Note that multiple applications of Infinito and cold (frosty) weather can result in leaf yellowing on *Geum*.