Grower Summary

HNS 146

Hebe: aspects of the biology and control of fusarium wilt

Final report 2009

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GROWER SUMMARY

Headline

Fusarium wilt of hebe in the UK is caused by *Fusarium oxysporum*; the disease can be managed by varietal choice, maintaining stock plants free of *F. oxysporum*, fungicide drenches to the growing medium and disinfection of re-used containers and standing beds.

Background and expected deliverables

In 2005, *Fusarium oxysporum* was consistently isolated from stained vascular tissue of container-grown hebe plants affected by wilt and dieback. A vascular wilt disease of hebe caused by *F. oxysporum* was first described in Europe in 2000 (in Italy) and it was considered that this might be the same problem. Hebe is a very popular garden plant and the occurrence of a new wilt disease could severely damage sales. By the start of this project, the problem had been recognised on one nursery, where it had been a continuing problem for several years. In 2005 it caused losses of over 15,000 plants.

The objectives of this project are:

1. To determine whether *F. oxysporum* is a cause of hebe wilt in the UK;
2. To investigate aspects of the disease biology and spread;
3. To devise an effective control strategy.

Summary of the project and main conclusions

Symptoms and cause of fusarium wilt in hebe

A *Fusarium* species consistently isolated from the vascular tissue of container-grown hebe plants exhibiting symptoms of a vascular wilt disease was identified as *F. oxysporum.* Identification of the species was confirmed by DNA sequencing at CSL.

Fusarium wilt of hebe caused by *Fusarium oxysporum* commonly appears as:

- wilting of one or more, but rarely all, shoot tips (Figure 1);
- loss of leaf colour;

- brown patches on leaves progressing to leaf, shoot and eventually plant death (Figure 1);
- dark brown staining of vascular tissue in the stem base and in affected shoots;
- occasionally, pale pink fungal pustules of *F. oxysporum* develop at the stem and/or on affected shoots.

Figure 1: Shoot-tip wilting (left) is an early symptom of fusarium wilt; leaf and shoot death (right) usually follow.

Occurrence of hebe fusarium wilt in the UK

Although reported to be widespread in the Netherlands, the disease was only identified on two UK nurseries. The UK Plant Health and Seeds Inspectorate (PHSI) determined that the fungus isolated (*F. oxysporum*) was a non-quarantine organism and therefore not subject to any statutory controls. ADAS horticulture consultants examined hebe plants on several other nurseries and garden centres during the project and found no evidence of fusarium wilt.

Infection and disease development

Micropropagated hebe plug plants, cv. Pink Pixie, were inoculated with spores of an *F. oxysporum* isolate obtained from wilted hebe. The fungus was applied as a root dip pre-potting. Symptoms of fusarium wilt developed after three weeks. *F. oxysporum* was consistently recovered from affected plants in pure culture. *F. oxysporum* was therefore confirmed as a cause of fusarium wilt of hebe in the UK according to Koch's postulates.

The incidence of infected plants increased with spore concentration. Root wounding (by cutting-off root tips) did not increase the incidence of infected plants. Other inoculation techniques were examined. Drenching potted plants around the stem base with *F. oxysporum* resulted in fusarium wilt symptoms, as did dip-inoculation of freshly cut shoot tips, but these methods of inoculation were generally less successful than the root-dip method.

Some plants that were still visibly healthy at 15 weeks after inoculation were found to have dark, stained vascular tissue at the stem base, and *F. oxysporum* was recovered from such tissue. These results indicate that the development of fusarium wilt can be relatively slow, taking more than 15 weeks.

Specificity of F. oxysporum in hebe

Young plug plants of hebe cvs Pink Pixie and Purple Pixie and stock cv. Carmen were each inoculated with two strains of *F. oxysporum* obtained from hebe plants affected by fusarium wilt, and a strain obtained from stock (*Matthiola incana*) plants affected by fusarium wilt. The plants were inoculated by dipping roots in a standardised spore concentration and then potted into new plastic plant pots and grown in a heated glasshouse. Both strains of *F. oxysporum* obtained from hebe only caused fusarium wilt symptoms in hebe, and the *F. oxysporum* strain obtained from stock only caused fusarium wilt symptoms in stock. These results suggest that the strain of *F. oxysporum* causing wilt in hebe plants in the UK is a host-specific pathogen. It is unlikely that the fungus will readily cause a vascular wilt in herbaceous or nursery stock species unrelated to hebe; it is also unlikely that *F. oxysporum* isolates causing vascular wilt diseases in other hosts, such as stock, will readily cause a vascular wilt in hebe. In this experiment the latent period between inoculation and symptom development was 9 weeks.

Effect of temperature and moisture on infection

Plug plants of hebe cv. Pascal were inoculated with *F. oxysporum* by dipping roots in a spore suspension for 15 minutes. Plants were potted in a peat-based medium and held for seven days in controlled environment cabinets maintained at 18 and 25°C

with the growing medium maintained damp or wet. Plants were then placed in a warm glasshouse for 7 weeks and watered as required. Symptoms of fusarium wilt first appeared 4 weeks after inoculation. At 8 weeks after inoculation there was a significantly greater incidence of infected plants following an initial incubation period at 25°C, compared with at 18ºC.

Distribution of F. oxysporum within plants

In order to provide information on the extent of systemic infection within plants, isolation for *F. oxysporum* was made from different parts of apparently healthy cuttings and pot-grown plants. The plants tested were obtained from a nursery with a history of the disease. *F. oxysporum* was recovered at a low incidence from the stem base of rooted cuttings cv. Purple Pixie (3/20) and Rosie (1/20). It was also recovered from the stem base of 9 cm potted plants (3/30 plants), and from roots (1/30 plants). When older plants in 3 L pots were tested, *Fusarium* sp. was recovered from 3/6 shoots on one branch and from none of 19 shoots on eight other branches.

These results indicate that cuttings taken from apparently healthy container-grown plants, used as stock plants, may be infected with *F. oxysporum*. The disease could therefore be maintained on a nursery through the propagation cycle.

Varietal susceptibility

Fusarium wilt was observed in the UK on cvs. Autumn Glory, Blue Star, Caledonia, First Light, Pascal, Pink Paradise, Pearl of Paradise, Pink Pixie, Purple Pixie, Purple Shamrock, Rosie, Sapphire, Silver Dollar and Sutherlandii. Pink Pixie and Purple Pixie were more commonly affected than other varieties. An inoculation experiment comparing the relative susceptibility of six varieties showed that cv. Pink Pixie (35% or plants affected) was significantly more susceptible than Caledonia (5%), Rosie (8%) and Pascal (18%) after 16 weeks; Purple Pixie (25%) and Pink Paradise (30%) were also highly susceptible.

Sources of F. oxysporum on a nursery

In October 2006, samples of sand from three sand beds and once-used hebe pots were collected from a nursery with a history of fusarium wilt and tested for contamination with *F. oxysporum* by a growing-on test. The sand was mixed with a peat-based growing medium and used to fill new plastic plant pots; the once-used pots were filled with new growing medium. Both sets of pots were potted with plants of hebe cv. Pink Pixie.

The first symptoms of fusarium wilt in any of the media amended with nursery sand were observed after six weeks; all of the inoculated control plants were showing symptoms at this time. After 18 weeks, 25% of plants grown in medium amended with sand from one of the nursery beds, and 15% of plants in the once-used pots, had developed symptoms of fusarium wilt. None of the uninoculated control plants, or the plants in two of the sand-amended media, developed symptoms. Examination of apparently healthy plants revealed additional, symptomless infection in plants grown in medium mixed with sand from one of the sand beds on the nursery.

Evaluation of fungicide and biological treatments

In 2007, the fungicides Amistar (azoxystrobin), Delsene 50 Flo (carbendazim), Scotts Octave (prochloraz) and an experimental material, and six biological treatments (matured pine bark incorporated into the growing medium, Trianum P drench, two experimental biocontrol agents, Mycoplex granules incorporated at potting and Turf Vigour Special applied as a drench) were evaluated for control of fusarium wilt in container-grown hebe in a replicated experiment in a heated glasshouse. Fusarium wilt was first observed 10 weeks after inoculation and at the end of the experiment 23% of untreated plants were wilted or dead. Scotts Octave significantly increased the number of surviving plants (i.e. not wilted or dead). None of the other treatments had a significant effect. Amistar drench treatment resulted in stunted growth.

In 2008, the fungicides Cercobin WG (thiophanate methyl) and Scotts Octave (prochloraz), an alternating programme of Cercobin WG and Octave, matured pine bark incorporated into the growing medium (30% v/v), and added lime (as ground chalk) incorporated into the growing medium, were evaluated for control of fusarium

wilt in container-grown hebe in a replicated experiment. The alternating fungicide programme was tested on plants in a peat-based growing medium and in the same medium amended with matured pine bark. Fusarium wilt was first observed after 2 weeks, and after 23 weeks 25% of plants in untreated plots were wilted or dead. The incidence of plants dead or showing symptoms of fusarium wilt was significantly reduced by Octave drenches and by the Cercobin WG/Octave programme applied to plants in the bark-amended growing medium (Figure 2). The latter treatment reduced the disease to 2.5% plants dead or wilted. Most other treatments (except for the added lime treatment) appeared to reduce the disease. None of the control uninoculated plants developed fusarium wilt. The added lime did not raise the pH which may explain the failure of this treatment to affect fusarium wilt.

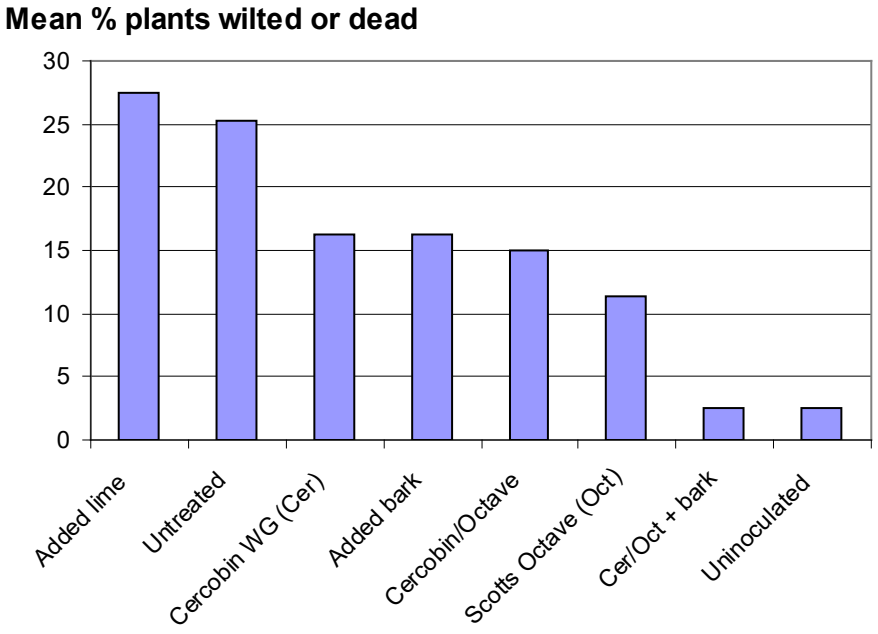

Figure 2: The effect of fungicides and growing medium amendments on fusarium wilt in hebe 23 weeks after inoculation – 2008

Spread of F. oxysporum in a sandbed

An experiment was devised to determine the effect of flood irrigation on the extent of movement of *F. oxysporum* through sand at levels sufficient to cause fusarium wilt in hebe cv. Pink Pixie. Miniature sandbeds were infested with *F. oxysporum* directly beneath, or approximately 3 cm to one side, of pots of hebe cv. Pink Pixie.

Additionally, sand in small open top plastic containers was infested with *F. oxysporum* and placed at the side of hebe plants on sandbeds; this treatment served to check for movement of *F. oxysporum* in ways other than through movement in water at flood-irrigation. After 27 weeks, fusarium wilt was confirmed at a very low incidence in plants where the causal fungus was placed on sand directly beneath pots or adjacent to pots. The disease was not confirmed in the uninoculated control. The plants had rooted considerably into the sandbeds and it is possible that infection of plants arose by root growth coming into contact with the inoculum rather than movement of inoculum through the sand in water. This experiment confirms that hebe fusarium wilt can arise from sandbeds infested with *F. oxysporum* but found no evidence to support the hypothesis that the fungus is readily spread through the sand by flood-irrigation.

Disinfection of sand

Three disinfectants (Jet 5 at 2%, Horticide at 0.08% and Unifect G at 4%) were tested for their ability to eliminate *F. oxysporum* from sand. Sand was infested by inoculation with a suspension of *F. oxysporum* spores 2 weeks before drench treatment with the disinfectants. After fumes had dissipated, sand was tested in the laboratory by plating onto agar to determine levels of *F. oxysporum* infestation. All three disinfectants significantly reduced levels of *F. oxysporum*. Unifect G at 4% was the most effective and no *F. oxysporum* was recovered from sand treated with this product. Treated sand was mixed with a peat-based growing medium and used to grow hebe plants for 12 weeks. Only a very low incidence of fusarium wilt occurred and there were no significant differences between plants grown in inoculated and uninoculated growing media.

Financial benefits

Losses due to fusarium wilt of hebe on one nursery were at least £30,000 in 2005 and further substantial losses occurred in 2006. As the project progressed, increased understanding of the disease was gained, and new control measures were devised and implemented. The disease occurred at a lower incidence in 2008, affecting <1% of plants.

This disease is new to the UK and appears at present to be restricted in occurrence. If it can be controlled in the near future, the potential financial benefit is huge because widespread fusarium wilt in garden centres or home gardens could severely damage the image of hebe and subsequent sales.

Action points for growers

Recognition

- Growers should familiarise themselves with the symptoms of hebe fusarium wilt (see Fig. 1)
- Many varieties of both large leaf and dwarf forms of hebe are susceptible to fusarium wilt. The varieties Pink Paradise, Pink Pixie and Purple Pixie are more susceptible than Caledonia or Rosie.
- Note that hebe fusarium wilt may be confused with downy mildew. If in doubt, contact a plant pathologist or submit a sample to a Plant Clinic.

Disinfection

- If hebe fusarium wilt is known or suspected on your nursery, disinfect sand beds, other standing areas, pots and containers before re-using them for hebe (see HDC Factsheet 15/05). Disinfectants with good activity against *F. oxysporum* in sand are Jet 5, Horticide and Unifect G following manufacturers recommended rates.
- It is important to disinfect standing areas thoroughly, not just wet the surface.
- Do not re-use pots from plants visibly affected by hebe fusarium wilt.

Stock plant health

- Check the health of stock plants before taking cuttings; be aware that in addition to visible symptoms, symptomless, systemic infection by *F. oxysporum* can occur within shoot tips. Check for vascular staining on a few plants per batch.

- Fusarium wilt of hebe is known to occur in mainland Europe; carefully examine a sample of any plants contract-grown in mainland Europe for your nursery and consider testing for fusarium wilt.

Growing environment

- Where feasible, maintain growing temperatures below 20°C; there is evidence that fusarium wilt is favoured by temperatures around 25°C.
- Amendment of Levington M3 growing medium with 40% (v/v) fine matured bark significantly reduced hebe fusarium wilt.

Fungicide treatment

- The fungicides Cercobin WG (SOLA 1382/08) and Scotts Octave (label approval) applied in an alternating programme, and Scotts Octave alone, significantly reduced incidence of hebe fusarium wilt when applied as drench treatments.
- In an experiment on hebe cv. Pink Pixie where plants were inoculated with *F. oxysporum* soon after potting, the use of a matured pine bark amendment combined with alternating drenches of Cercobin WG (1.4 g/L) and Scotts Octave (1.0 g/L) at 2-week intervals (4 drenches in total) gave the most effective control of the disease.