Grower Summary

SF 062

The epidemiology and control of strawberry powdery mildew under protection

Final 2006

Disclaimer

AHDB, operating through its HDC division seeks to ensure that the information contained within this document is accurate at the time of printing. No warranty is given in respect thereof and, to the maximum extent permitted by law the Agriculture and Horticulture Development Board accepts no liability for loss, damage or injury howsoever caused (including that caused by negligence) or suffered directly or indirectly in relation to information and opinions contained in or omitted from this document.

The results and conclusions in this report may be based on an investigation conducted over one year. Therefore, care must be taken with the interpretation of the results.

Use of pesticides

Only officially approved pesticides may be used in the UK. Approvals are normally granted only in relation to individual products and for specified uses. It is an offence to use non-approved products or to use approved products in a manner that does not comply with the statutory conditions of use, except where the crop or situation is the subject of an off-label extension of use.

Before using all pesticides check the approval status and conditions of use.

Read the label before use: use pesticides safely.

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

Project Number:	SF 062
Project Title:	The epidemiology and control of strawberry powdery mildew under protection
Project Leaders:	Dr Steven Parker Central Science Laboratory Sand Hutton York YO41 1LZ Dr Avice Hall Bioscience, CP Snow Building University of Hertfordshire College Lane Hatfield Hertfordshire AL10 9AB
Industry Representative:	Harriet Duncalfe
Report:	Final 2008
Publication Date:	21st August 2014
Previous report/(s):	Annual report 2004 Annual report 2005
Start Date:	1st June 2003
End Date:	30th November 2006
HDC Cost (Total cost):	£120,176.80

Further information

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

HDC, AHDB
Stoneleigh Park
Kenilworth
Warwickshire
CV8 2TL

Tel – 0247 669 2051

GROWER SUMMARY

Headline

- A better understanding of when powdery mildew attacks strawberries has been developed and progress is being made to develop a predictive model and improved control strategies.

Background and expected deliverables

Strawberry powdery mildew is a significant threat to the economic sustainability of crops grown under protection. The industry is dependent on a few cultivars, which are mostly very susceptible to the disease. Good control of powdery mildew can be achieved using fungicides, but production protocols are placing increasingly stringent limits on the products used, harvest intervals and allowable chemical residues. In addition, growers rely on a relatively limited armoury of fungicide active ingredients, placing enormous selection pressure on the pathogen population.

This is expected to improve the understanding of strawberry powdery mildew and use this to develop control strategies, which will integrate cultural and chemical control methods to reduce disease to tolerable levels.

The work is expected to:

- Assess the efficacy of fungicides currently approved on strawberry under protection, for controlling powdery mildew.
- Design chemical control schedules that are both effective and reduce selection pressure for fungicide insensitivity in the pathogen population.
- Identify agronomic management practices that can reduce disease pressure.

- Identify environmental conditions that favour the spread and development of disease, which might be used as the basis for risk warnings.

Summary of the project and main conclusions

Preliminary Review of the Literature

Powdery mildew on strawberries was reported at the start of the last century. The causal pathogen has been identified as *Sphaerotheca humuli* (DC.) Burr, the cause of hop powdery mildew, and *Sphaerotheca macularis*. Some authors have suggested that the two species might be the same. However, recent taxonomic studies have shown that the correct name of the fungus causing strawberry powdery mildew is *Podosphaera aphanis,* which is not the cause of hop powdery mildew.

Despite the taxonomic confusion about the identity of the pathogen, details of its life-cycle can be derived from previous work. Of particular interest are optimum growth conditions and the upper and lower environmental boundaries in which the pathogen can survive. Laboratory experiments have been used to estimate the time for completion of important life-cycle phases. These estimates provide a useful basis for planning the investigation of disease progress in the field experiments within the current project.

Inoculum and primary disease spread

In order to establish a new infection and develop visible symptoms, the pathogen requires 144 hours of suitable environmental conditions (*i.e.,* temperature and humidity). In most situations it is likely that infected, but visually asymptomatic plants are present when tunnels are covered at the start of each cropping season. These plants act as the primary inoculum source for infection of the crop.

In the experimental work, disease developed throughout two plots of newly planted strawberry plants, which were examined frequently following establishment. Disease symptoms were not clustered at the ends of the plots, but were distributed randomly throughout the plots. This result supported work undertaken in the previous season, which suggested that infection of newly planted crops is introduced via the planting stocks. Compared with established crops, disease symptoms took longer to develop within newly planted crops. It may be that the pathogen over-winters as either cleistothecia or conidia in new plantings, whereas in established crops infection may also over-winter as mycelium, possibly within leaf buds. New inoculum can be generated more rapidly from the later source of primary infection.

Cultivar resistance to strawberry powdery mildew

Seven cultivars, untreated by fungicides, were compared for the development of strawberry powdery mildew. All of them developed symptoms of the disease, however Everest and Florence had less than 5% of their leaf surface covered with red blotches. The dose of fungicide necessary to control an epidemic is a function of the amount of disease that would develop if the epidemic was left untreated (*cf* disease pressure). Therefore reduction in disease pressure from using more resistant cultivars offer opportunities to reduce the amount of fungicide applied, especially when the environment is suboptimal for disease development.

Chemical control

Regular applications of potassium bicarbonate can reduce powdery mildew levels substantially. The magnitude of control is approximately equivalent to a single application of Systhane (myclobutanil) at the maximum permitted dose. Systhane is currently an effective mainstay in programmes targeted to control powdery mildew in strawberries. Potassium bicarbonate could therefore provide a useful tool for growers aiming to widen the range of modes of action used to combat disease – reducing selection pressure for fungicide insensitivity. It might also be deployed near harvest to decrease the likelihood of fungicide residues on the fruit. A formulation of plant nutrients with potassium bicarbonate did not provide any additional control above that achieved by the straight product.

Excellent disease control was provided by Fortress (quinoxyfen), which has not previously been used by UK growers to control strawberry powdery mildew. This protectant fungicide reduced the severity of powdery mildew below the levels achieved with the benchmark products Systhane and Corbel (fenpropimorph). Apart from the requirement to quantify the protectant efficacy of the product more completely, this should include adherence to anti-resistance strategies to protect the long-term performance of the product.

Plant Stimulants

Weekly treatments with 'plant stimulants' did not provide any reduction in the severity of strawberry powdery mildew. On the basis of these experiments, growers should not use these products as an alternative to fungicides with known activity against the pathogen. Benefits to general plant vigour from using the products were not measured by these experiments.

Dipping plants to control initial disease development

Infection may already be present in plants used to establish new crops. Due to the canopy structure of strawberry crops, it is difficult to ensure complete coverage of the plants when fungicidal products are applied. As a consequence the applied dose may be much greater than the effective dose, *i.e.* the amount reaching the intended targets. Experiments showed that, in a high-pressure mildew environment, it was possible to delay the onset of strawberry powdery mildew symptoms by at least 7 days when the plants were dipped in a chemical control product before planting. This delay was evident for plants dipped in Systhane (myclobutanil) compared to those that were not dipped or that were dipped in water or bicarbonate. However, there are currently no products approved by The Pesticide Safety Directorate (PSD) for dipping of strawberry plants to control powdery mildew.

Inoculum levels linked to cupping and red blotches

Infection by strawberry powdery mildew causes a progression of symptoms (leaf cupping, presence of mycelium on leaves, red blotching of leaves and finally mycelium on the fruit). Presence of mycelium is the only symptom that can be linked, with any certainty by visual assessment, to powdery mildew. This work has shown that compared with apparently healthy leaves (*i.e.* uncupped and green*),* there were significantly more mycelial colonies present on leaves that were cupped or with red blotching. In addition, significantly more mycelium was found on the lower leaf surface than on the upper leaf surface. This suggests that treatment of powdery mildew should be initiated when leaf-cupping is observed and that further treatment may remain necessary even when red blotching is the only evident symptom. Since most of the inoculum is generated on the lower leaf surfaces, it is important to achieve good spray coverage of this portion of the canopy when applying fungicides.

Prediction of high risk periods

The prediction system developed by this work and outlined in the previous annual report (SF 62, 2005) has been further refined, so that it can better predict high risk periods. When data describing disease development (collected as part of the epidemiological studies) was compared with outputs by the prediction system, the high risk periods identified coincided with the onset of the measured epidemics. The prediction system requires some additional testing against experimental data and subsequently must be field-tested rigorously, in partnership with crop managers.

Financial benefits

In the short-term:

- The work will lead to the design of improved fungicide programmes that will improve control of powdery mildew and increase the picked yields.
- The use of the commodity substance potassium bicarbonate can provide similar levels of powdery mildew to conventional fungicides. Reliance on this will help to reduce the risk of pesticide residues occurring, thus increasing customer confidence and subsequent fruit sales.

In the medium-term:

- More responsible use of fungicides as a result of this work will reduce the development of fungicide resistance to commercially available fungicides, hence maintaining viable control options.
- The work will improve the targeting of fungicides and improve control.

Action points for growers

- Growers should avoid repeated applications of fungicides with the same Mode of Action. Consecutive and frequent applications of products from the same MOA group increase the likelihood that the pathogen will develop fungicide insensitivity. Information about The mode of actions of fungicides approved for use on strawberries are available in a table in the HDC Factsheet 17/08 Control of strawberry powdery mildew under protection.
- Growers should consider using applications of potassium bicarbonate within 3 days of covering tunnels (or removing fleece) to suppress disease spread. An early application of Fortress (Quinoxyfen) applied after the bicarbonate will provide further protection.
- New plantings may have low incidence of infection without any visible symptoms. Early application of potassium bicarbonate might provide cost effective management of this potential inoculum source.
- Inoculum is associated with the cupping and red blotch symptoms. Growers should aim to treat powdery mildew when these symptoms are present even if mycelium is not visible.
- Treatment should start when leaf-cupping is observed. Further treatment may be necessary, even when red blotching is the only evident symptom.
- Aim to achieve good spray coverage of the lower leaf surfaces.

- Where economically viable (and acceptable to retailers), growers should consider planting moderately resistant cultivars as part of an integrated disease management programme.