Horticultural
Development
Company

Grower summary

SF 74

Integrated pest and disease management for high quality protected raspberry production (LINK)

Annual Report 2008

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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.

Further information

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

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Headline

- Further progress has been made in 2007 to develop improved integrated pest and disease management systems to reduce the incidence of pesticide residues occurring in raspberries.

Background and expected deliverables

Raspberries are very susceptible to *Botrytis*, powdery mildew, raspberry beetle, raspberry cane midge and aphids. Pesticides are currently relied on for control and are applied close to harvest. Intensive use of pesticides, including the organo-phosphate (OP) chlorpyrifos, which is used to control raspberry beetle and cane midge, is undesirable and unsustainable. Raspberry aphids, and the viruses they spread, are becoming more important. Indeed some aphid populations have overcome the natural plant resistance.

Botrytis is the major cause of post-harvest fruit rotting and causes serious yield losses. Poor shelf-life reduces repeat buying. Retail surveillance has demonstrated that more than 50% of UK produced fruit contains fungicide residues and 22% contains chlorpyrifos residues. The major multiple retail customers are challenging raspberry producers to significantly reduce this incidence of residues.

The future registration of chlorpyrifos on raspberry beyond 2008 is in doubt. Screening trials by East Malling Research have so far failed to identify any alternative insecticides with significant activity for cane midge control, though many different materials of a wide range of types have been tested. Loss of chlorpyrifos would have serious adverse consequences for the UK raspberry industry as there is no alternative control measure for the midge.

Raspberries suffer from rain damage and, to meet the requirements of major multiple retailers, the crop now has to be grown under protection. Recent observations indicate that this increases the risk of powdery mildew infection in protected crops. Plant protection methods have not been adapted for this new growing environment, which provides opportunities to reduce reliance on pesticides.

The strong market demand to reduce, or ideally to eliminate the occurrence of residues prompted this 5-year HortLINK project which officially started in April 2006, following considerable initial work in 2005. It aims to develop sustainable methods of integrated management of *Botrytis*, powdery mildew, raspberry beetle, raspberry cane midge (with associated disorder 'midge blight') and aphids on protected raspberry crops. Such methods would not rely on sprays of fungicides and insecticides during flowering or fruit development so that quality fruit can be produced with minimal risk of occurrence of detectable pesticide residues at harvest.

Summary of the project and main conclusions

Progress on each objective of the project is summarised below

Botrytis

Cane infection

Inoculation experiments showed for a second year that cane age rather than leaf age significantly influences infection of primocane leaves; leaf infection was only possible on relatively old canes. Three infection routes to cane infection were identified:

i) via petioles of attached leaves.
ii) at leaf scar wound sites on the cane.
iii) direct infection of internode areas, especially on relatively old canes (after fruiting).

Both inoculation studies and crop observations indicate the latter is the major infection route. Botrytis lesions and sclerotia on primocanes were rarely found before October and usually not until late winter.

Fruit infection

Commercial tunnel grown crops were monitored in Cambridge and Kent. Before or during the flowering period, *B. cinerea* spores were only found at low levels on lesions on floricanes (fruiting canes) or on sporulating sclerotia. No other sources of spores were identified. Sporulation was more evident after fruiting, on over-ripe fruit and occasional weeds. Despite the sparsity of *B. cinerea* sources in tunnels during flowering, inoculum of *B. cinerea* was detected in the air on many days during this period. The incidence of flower infection at one of the two sites was accurately predicted (0.7 correlation) by a regression model using daytime temperature and inoculum of *B. cinerea* in the air. Incubation tests to relate the

mean quantity of *B. cinerea* DNA in fruit with the incidence of fruit developing botrytis rot were inconclusive.

Control by canopy manipulation

Removal of primocanes and leaves in a dense tunnel crop of cv. Glen Ample reduced humidity around the canes and subsequent leaf and cane botrytis infection. However, it had no significant effect on fruit botrytis infection. Primocane thinning in a less dense crop had no effect on humidity or disease incidence.

Control with fungicides and natural products

The incidence of latent *Botrytis* in fruit from an outdoor crop of cv. Glen Ample was significantly reduced (by up to 58%), by three sprays of Teldor during flowering; sprays of Hortiphyte Plus had little or no effect. However, use of Teldor increased the incidence of *Penicillium* and *Mucor* fruit rot in post-harvest tests, compared with untreated plants.

Management of fruit botrytis by cooling

A high incidence of raspberry fruit (>50%) were infected by latent *B. cinerea* at harvest, including those from covered crops. Development of infection to create visible damage within 9 days of harvest was largely prevented (over 98%) in fruits that were stored cold (4.5°C) for 4 days immediately after harvest, or stored cold for 2 days then cool (12°C) for 2 days. Fruit stored at ambient after harvest (even those from fungicide-treated covered crops), suffered over 50% rots within 7 days. Rapid cooling and effective cool-chain management may be sufficient to prevent botrytis fruit rot without the need for fungicide sprays during flowering. After storage for four days at 4.5°C, over 98% fruits from an unsprayed covered crop were still visibly healthy after a further 3 days at ambient temperature.

Powdery mildew

Host specificity

A DNA analysis of eight isolates of powdery mildew from raspberry and 27 from strawberry suggest that raspberry and strawberry isolates of *Podosphaera aphanis* are two distinct groups. Cross-inoculation studies were inconclusive due to the failure of raspberry isolates to infect raspberry; a strawberry isolate infected strawberry and not raspberry.

Raspberry beetle

Semiochemical-based monitoring and trapping systems for managing raspberry beetle

- The new sachet slow release system was more effective in the field than the previous vial system for attracting raspberry beetles and lasted 4 weeks. Compound B was more attractive than A under field conditions (confirming previous SCRI studies).

- The surface area of the white cross vanes is positively associated with increased raspberry beetle catches under field conditions at SCRI.

- In Kent, lattice deployment was more effective at one site than perimeter trapping, whilst at the second site they were equally effective.

- In Eastern Scotland, lattice deployment was more effective than perimeter trapping in the pre-flowering period at one site, whilst at the second site both deployment systems were similarly effective.

- Beetle catches in traps were higher before crop flowering (up to green fruit stage) in Eastern Scotland but this effect was less obvious in Kent.

- Both fruit damage and the numbers of raspberry beetle eggs found in flowers were very low at all sites (Kent and Eastern Scotland) monitored in 2007. Although pesticide-treated areas were not monitored in 2007, it is likely that sprayed areas were also not economically damaged by this pest. Climate (relatively cool, wet summer) is likely to have affected pest numbers.

- Although some beneficial non-target organisms (e.g. honey and bumble bees) were trapped, especially after flowering, the numbers caught were likely to be low as a proportion of local populations and therefore unlikely to affect local pollination success. Modifications to the trap are being considered to further reduce this risk.

Raspberry cane midge

Semiochemical-based systems of managing cane midge

Lure and trap optimisation:
The height of trap deployment was shown to have a strong affect on the numbers of midges caught in sex pheromone traps. Traps at ground level caught approximately three times as many midges as traps at 0.5 m above the ground and approximately six times as many as at a height of 1m. Only small numbers of midges were caught at greater heights. A standard height of trap deployment of 0.5 m is recommended for pest monitoring purposes. Work on female traps is pending identification of behaviourally-active cane wound attractants. This is in progress but has been delayed due to very low pest numbers in 2007.

Identifying host plant wound attractant of females:

- Methods have been developed to monitor *in situ* production of wound volatiles released from artificially split canes. Several plant compounds have been selected for further studies.

- Due to low incidence of raspberry cane midge in 2007, insufficient numbers were collected to establish a laboratory population for behavioural studies. EMR and ADAS will assist SCRI in 2008 to obtain suitable numbers for bioassays and GC-EAG at SCRI and NRI.

Control by disruption, mass trapping or lure and kill:
A large scale field experiment comparing prototype lure and trap for raspberry cane midge is pending successful completion of the above stages (reliant on sufficient pest numbers to test identified plant wound chemicals).

Aphids

Raspberry aphid controlled by late season sprays of aphicides

A large scale replicated field experiment compared the efficacy of single sprays of Calypso on 7 and 21 September, 5 19 October and 6 November 2006 for control of large raspberry aphid. Each Calypso treatment reduced numbers of eggs in winter and numbers of aphids in spring. However, the 19 October timing clearly gave the best results reducing aphid numbers by >95%.

Financial benefits

In 2003, 8,000 tonnes of raspberries, worth £28.4M were produced from 1,260 ha grown in Britain. A further 4,800t, worth £18.2M, were imported. The UK fresh market is under-supplied outside of the main season. New varieties are now being utilised to spread the season and it is expected that production will increase substantially, perhaps by three-fold. Surveillance of pesticide residues in soft fruit identifies raspberries as having a high occurrence of detectable residues. For example, the 2003 ACP survey found 50% of imported raspberries and 75% of home-grown raspberries had detectable residues. This greatly damages the consumer acceptability of raspberries and their image as a healthy food.

Control of powdery mildew and *Botrytis* in raspberry crops is already difficult. Anecdotal evidence suggests that 25-30% of bud loss is due to *Botrytis* and, as a result, the UK crop is not producing optimum yields. There is a limited range of pesticides that can be used and other means of crop protection (e.g. biological control) are not available. The knowledge and techniques developed in this project will define an integrated pest and disease management (IPDM) system for growing raspberries in protected environments. This will reduce or remove the incidence of detectable residues in fresh raspberries and give UK raspberry growers a competitive advantage.

Annual value in area of impact

Botrytis, powdery mildew, cane midge and raspberry beetle are problems wherever and however raspberry is grown in the UK. ADAS estimate that, at any one time, 60% of raspberry plantations are infected by these pests and diseases. Assuming 25% of the crop is forgone as a result of these infestations, this is equivalent to 2,000 tonnes of raspberries, worth £7M.

Expected annual added value

We make the following assumptions that arise from a successful project:

1. Losses in the current crop will be reduced by 10%, yielding an additional £2M of UK sales.
2. Enhanced competitiveness of UK raspberry growing will reduce imports by 50%, yielding an additional £10M of sales.
3. Increased consumer confidence in raspberries will grow the overall market by 20%, yielding a further £5M of sales.

A successful outcome to this project could potentially reduce losses in the current crop by 10%, yielding an additional £2M of UK sales. This will also enhance the competitiveness of

UK raspberry growing. It could increase consumer confidence in raspberries. If the overall market grew by 20%, a further £5M of sales would result.

Grower capital investment and cost recovery

It is not anticipated that this project will result in additional capital investments for growers. Pesticides typically cost £690/ha per annum. It is unlikely that costs of crop protection will be reduced and they may even increase if biological control systems are used extensively. However, this increase would be small in relation to the value of the crop.

Action points for growers

- Cane density critically influences the risk of cane Botrytis, a high density of canes making crops prone to the disease. Ensure that an open canopy structure with adequate numbers of canes for optimal yield is maintained by thorough thinning.

- The work has shown that pre-harvest sprays are not warranted for cane Botrytis control on protected crops. Note that this assumes that spur blight is not significant and the need for sprays for other diseases at this time has not been investigated.

- Programmes of three sprays of Teldor or Switch (and some experimental fungicides) applied during flowering gave a significant reduction in latent Botrytis infection of fruits.

- Rapid removal of field heat and efficient cool chain marketing greatly slows the development of Botrytis in harvested fruit and extends shelf life.

- Preliminary results indicate raspberry and strawberry mildew are different diseases and don't cross-infect.

- Sex pheromone monitoring traps are commercially available for raspberry cane midge and should be used by all growers for determining the prevalence of the pest in their plantations and for timing sprays. The trap has been calibrated and an economic threshold determined.