Factsheet 13/11

Cane fruit

Project SF 74 (Defra Horticulture LINK HL0175)

Horticulture Development Company

Stoneleigh Park
Kenilworth
Warwickshire CV8 2TL
T: 0247 669 2051
E: hdc@hdc.ahdb.org.uk

Pesticide residue reduction in commercial raspberry crops

Scott Raffle, HDC

Raspberry growers have come under increasing pressure to supply berries that are free from detectable pesticide residues (Figure 1). This factsheet summarises the recommendations made following the completion of a Defra Horticulture LINK project. The research resulted in improved application timing of crop protection products and developed novel pest and disease control methods to reduce the reliance on chemical pesticides.

Introduction

Commercially produced raspberries are susceptible to a number of insect pests and diseases which lead to fruit damage, fruit contamination, cane death and ultimately loss of yield. To gain acceptable levels of control, growers have traditionally relied upon the use of chemical pesticides, including applications on developing fruit, sometimes close to harvest.

However, this may result in the presence of chemical residues (Figure 2) below the maximum residue level (MRL) permitted in marketed fruit, which although perfectly legal is undesirable to some retail customers. Retail surveillance before the start of the project demonstrated that more than 50% of UK produced fruit contained fungicide residues and 22% contained residues of the organophosphate insecticide chlorpyrifos.

1 Raspberry growers are coming under increasing pressure to produce high quality fruit that is free from detectable pesticide residues

2 Pesticide residue analysis sometimes detects the presence of chemical residues

As a broad spectrum insecticide which is particularly effective at controlling several raspberry insect pests, chlorpyrifos has been widely used by raspberry growers. As there are few suitable alternative control measures, the UK industry needs novel control methods which do not rely on broad spectrum insecticides. For disease control, techniques need to be developed which rely less on the use of chemical fungicides close to harvest.

To help to find solutions to these challenges, a Defra Horticulture LINK project (HL0175, SF 74) was started in 2005 with the aim of developing sustainable methods of integrated management of Botrytis, powdery mildew, raspberry beetle, raspberry cane midge (and the associated disorder 'midge blight') and aphids in protected raspberry crops. Disease forecasting, pest monitoring and methods of cultural control were examined as components within an Integrated Pest and Disease Management (IPDM) programme. Such methods would not rely on sprays of fungicides and insecticides during flowering or fruit development so that quality fruit could be produced with minimal risk of occurrence of detectable pesticide residues at harvest.

New technologies were developed in the first three years of the project. In the final two years they were combined with existing control methods to form a minimal residues IPDM programme, which was successfully tested on commercial raspberry farms.

This factsheet summarises the new recommendations made for managing and controlling these insect pests and diseases as a result of this research project.

Cane and fruit Botrytis

The disease

Both raspberry canes and fruit are affected by Botrytis. On primocanes, pale brown water soaked lesions (Figure 3) develop between and around buds in the summer and autumn months. During the winter, lesions turn silver/grey in colour and are often covered by the black resting bodies (Figure 4) of the fungus (sclerotia). This can give rise to damage and death of buds, leading to a reduction in yield potential.

Developing flowers and fruits can be infected by Botrytis, which may develop into the characteristic grey mould on ripe fruits (Figure 5), rendering them unmarketable. Latent infection can sometimes manifest itself only after the fruit has been delivered to customers, leading to a rejection of a whole consignment.

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3 Typical pale brown water soaked lesion on a primocane caused by Botrytis infection

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4 During winter, Botrytis lesions turn silver/grey in colour and are often covered by black sclerotia (fungal resting bodies)

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5 Characteristic grey mould caused by Botrytis on developing fruits

Infection and spread are favoured by warm, wet and humid conditions.

Optimum cane management

To reduce the incidence of cane and flower infection, growers should avoid using high cane densities which increase humidity in the crop canopy. After harvest, spent floricanes (fruiting canes) should be removed from the plantation within two to three weeks of the final pick, with care taken to avoid damage to primocanes. The floricanes should be pruned cleanly at ground level to avoid leaving cane stubs. These can rub against and damage the rind of developing primocanes, which can provide wound sites for infection. Where training systems impede easy removal of spent floricanes, they should be cut into sections prior to removal.

After leaf fall, primocanes with visible Botrytis (lesions and/or sclerotia) and other obvious cane diseases should be pruned out. A final check should be made and diseased and damaged primocanes removed at or just before the final selection for tying-in (Figure 6).

Controlling Botrytis infection on canes

Fungicide products with activity against Botrytis include Amistar (azoxystrobin), Folicur (tebuconazole), Rovral WG (iprodione), Scala (pyrimethanil), Signum (boscalid & pyraclostrobin), Switch (cyprodonil &

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6 Final stand of primocanes selected and tied in to fruit the following season

fludioxonil) and Teldor (fenhexamid). A programme of 2-3 post-harvest fungicide sprays should be applied to control cane Botrytis. Consider the other disease problems (e.g. rust, cane blight) that need to be controlled when selecting which fungicides to use in each crop.

Further research revealed that when applied in winter at rates up to 50 kg/ha, urea consistently suppressed sporulation of Botrytis sclerotia on canes without resulting in any obvious signs of phytotoxicity. Sclerotia on canes are an important source of Botrytis spores leading to flower and fruit infection.

The work also found that if a crop is covered very early in the spring before spawn emergence, there is no opportunity for Botrytis sclerotia on canes to be wetted and so no sporulation occurs. Therefore no fungicide applications are required in spring or summer as long as the crop canopy remains dry.

Flower and fruit management

If wet weather occurs before covering in the spring, pre-flowering sprays should be applied to the canopy of canes and leaves to prevent subsequent Botrytis spread to flowers. Unlike in open-field crops, little or no benefit in the control of fruit Botrytis in covered crops was found from sprays applied during flowering. Therefore, once protective covers are in place, the project results suggest that there is limited value to be had in applying Botrytis fungicide sprays during flowering and fruit development. As good or better control of flower and fruit Botrytis can be achieved by good crop hygiene, by cane management to ensure the canopy does not become dense, so allowing good air circulation in the crop (see optimum cane management section) and by rapid cool storage of fruit (see below).

Fruit management after harvest

Compared to ambient storage, initial cool storage of the fruit significantly delays the onset of fungal rotting. It is therefore critically important to cool the fruit rapidly to 1-2°C immediately after harvest, followed by cool storage at 3-4°C, to delay the onset of fruit rotting.

Other cane diseases

Although not included in the scope of the Defra Horticulture LINK project, other cane diseases such as spur blight (Figure 7), cane spot (Figure 8) and cane blight (Figure 9) are known to infect primocanes, both during the summer and after harvest. To reduce infection and gain control, growers should follow the same cane management practices as set out for Botrytis. Additionally, specific fungicides for cane diseases may be required pre and/or post-flowering.

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7 Spur blight infection on primocane

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8 Cane spot infection on floricane

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9 Cane blight infection on primocane

Powdery mildew

The disease

Powdery mildew attacks both green (Figure 10) and ripe berries, producing a white powdery growth. Infection can also occur on leaf tissue, particularly in the tips of primocanes (Figure 11). The disease is favoured by dense cane canopies and shaded conditions. It is most active and damaging during warm humid weather conditions.

10 Powdery mildew infection on green fruits

11 Powdery mildew infection on shoot tips

Cane management

Growers should follow the same cane management guidelines as set out for Botrytis. In particular, attention should be given to cane density, with the aim of reducing the density to an optimum for the chosen variety. Reducing cane density will improve air movement around canes and reduce humidity.

In the spring and summer, adequate tunnel ventilation is essential to avoid the build up of excess humidity.

Disease control

In the IPDM programme used in the Defra Horticulture LINK project, the application of 1-2 sprays of a powdery mildew fungicide in the spring, as soon as the tunnel was covered, helped to avoid early infection. The earlier the sprays are applied, the better the chance of minimising the risk of residues. Should subsequent infection be observed, the use of potassium bicarbonate will help to eradicate infection.

Aphids

The pests

The large and the small raspberry aphids are of greatest concern to raspberry growers.

The large raspberry aphid can be 3-4mm in length and has long siphunculi. It is shiny and light green in colour (Figure 12). Colonies are often found throughout the growing season, on the underside of new raspberry foliage or in the apex of the primocane. Although it does not cause obvious physical damage to the foliage, it is an important vector of raspberry leaf mottle virus, raspberry leaf spot virus, black raspberry necrosis virus, rubus yellow net virus and vein-banding mosaic disease. Infected raspberry crops cannot recover from these viruses, which can lead to loss of vigour and a reduction in yield and fruit quality.

The small raspberry aphid is smaller (Figure 13). Wingless adults are pale green and covered with a waxy powder. It is initially found on fruiting canes in late spring, then from mid-summer on primocanes. Colonies of wingless aphids develop on leaves and petioles, with feeding causing leaf curl and distortion. Winged adults are pale cream in colour, occur singly and are found hidden in the junction of two veins on the undersides of leaves. The small raspberry aphid is an important vector of raspberry vein chlorosis virus.

12 Large raspberry aphid on primocane

13 Small raspberry aphid

Autumn control

Both aphid species develop winged forms and have a migratory period in summer. Research in the LINK project demonstrated that an application of Calypso (thiacloprid) in early to mid October reduced populations of large raspberry aphid by up to 99% the following season. Application at this time appeared to coincide with the majority of males and sexual females and killed the aphids before they laid overwintering eggs on the canes. Calypso provided more consistent control than the other aphicide products tested (Aphox, Phantom and Plenum).

Summer control

In the event that a small percentage of aphids do survive and appear in spring and summer, recourse can be made to the use of predator and parasite introductions.

For small species such as the small raspberry aphid and peach potato aphid, the parasitic wasp *Aphidius colemani* (Figure 14) and the predatory midge *Aphidoletes aphidimyza* (Figure 15) have been found to be effective. It is best to rely upon preventive programmes of predator introduction from early leaf development of the crop onwards (i.e. starting as soon as possible after the hatch of aphid eggs or as soon as the first aphid is seen).

For larger aphids such as the large raspberry aphid and the potato aphid, weekly preventive introductions of *Aphidius ervi* along with *Aphidoletes aphidimyza* can be used.

Naturally occurring predators such as ladybirds, lacewings (Figure 16), parasitic wasps, anthocorid bugs and hoverflies can also be encouraged to provide some level of control.

Biological control of aphids works best in glasshouses and fixed tunnels where climatic conditions suitable for the activity of the predators and their confinement within the crop can be assured. Full details on optimum introduction rates are available from biological control companies or in HDC Factsheet 01/07 (Sucking insect pests of cane fruit crops).

14 Aphid parasitised by a parasitic wasp

15 Aphidoletes larvae feeding on aphids

16 Lacewing larva feeding on aphid

Raspberry beetle

The pest

17 Raspberry beetle adult in raspberry flower

Adult beetles are 4 mm long (Figure 17). They emerge from the soil in spring and feed on the young expanding leaves of primocanes for several days. Some remain in raspberry crops. However, when temperatures rise above 14-15°C others migrate to feed on flowers of other plants such as hawthorn, apple, pear, wild blackberry or raspberry. The flowers of these species act as temporary feeding sources. As soon as the first raspberry flowers open, they migrate back into raspberry plantations, laying their eggs in the developing flowers.

Larvae feed on developing drupelets, initially causing little damage. Mature larvae (6-8 mm long) feed mainly inside the ripening fruit on the softening receptacle (Figure 18). The larvae can contaminate harvested fruit, leading to rejections of whole consignments.

18 Raspberry beetle larva burrowing into receptacle of fruit

Cultural management

As wild blackberry and raspberry and rosaceous species such as hawthorn offer alternative food sources for adult raspberry beetle. where possible, it is best to remove any such plants from the vicinity of commercial protected raspberry crops, or avoid cropping in such places.

Monitoring traps

Research in the Defra Horticulture LINK project identified that funnel (bucket) traps with white (non sticky) cross vanes are ideally suited for use by growers to monitor their crops for the presence of raspberry beetle adults (Figure 19). The traps contain a host volatile lure which attracts the adults.

19 Raspberry beetle funnel trap

After hitting the vanes, they fall into the bucket below, which contains water and detergent (to break the surface tension), and drown. The traps are commercially available from Agrisense Ltd (see Further information section) and can be used for precision monitoring, thus allowing the grower to detect 'hot spots' within a plantation where high densities of the pest are present.

When using precision monitoring, these traps should be set out in the plantation 3-4 weeks before flowering in a 'regular grid' pattern at a rate of at least 50 per hectare.

Given the high cost of investing in this many traps (which should last for 5+ years, plus the annual cost of new lures), some growers may prefer to monitor at lower precision, using 5-10 traps/ha rather than 50/ha. This has several advantages:

- It reduces initial grower costs.
- It allows growers to become more familiar with IPDM technology before making a bigger investment.
- Growers can move traps around their farms, allowing them to monitor crops with differing flowering and fruiting periods.
- Growers can easily monitor the efficacy of applied insecticides in different parts of the farm.

Growers should also use additional traps outside the crop and close to wild hosts and woodland. This allows for early detection. Additionally, organic growers may adopt the use of interception fences to interfere with the raspberry beetle flight path into the crop.

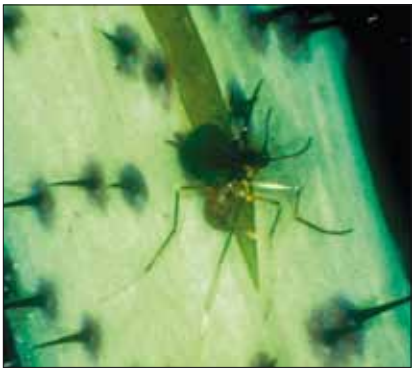
Thresholds for spraying

When employing precision monitoring, if more than 5 beetles have been caught in any trap by the start of flowering, apply a spray of Calypso (thiacloprid) locally to those tunnels where the threshold has been exceeded. Calypso will work at any time up until first pink fruit stage and is safe to bees. Insecticide treatment may be unnecessary, or may only be required in hot spots or at the edges of the crop.

Raspberry cane midge

The pest

Adult midges (Figure 20) lay their eggs in the spring, in the splits in the rind of primocanes. The eggs hatch into white/translucent larvae which turn salmon/pink. The larvae (Figure 21) feed on the periderm of the cane, giving rise to dark brown patch lesions (Figure 22). The damaged areas of these canes can then be invaded by a number of fungal organisms, leading to midge blight. Varieties that produce high numbers of splits in the rind of primocanes are most susceptible to attack.



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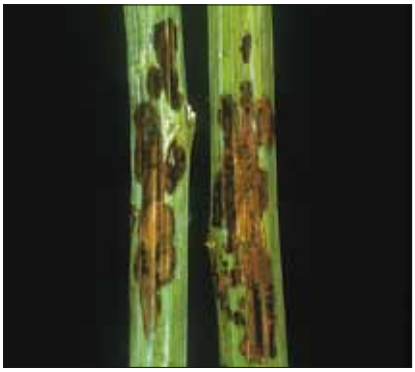
20 Adult raspberry cane midge laying eggs in split of rind



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22 Patch lesions on cane caused by raspberry cane midge feeding

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21 Raspberry cane midge larvae feeding on periderm

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23 Sex pheromone trap used for monitoring purposes

Monitoring traps

Within the Defra Horticulture LINK project, the female sex pheromone of the raspberry cane midge was identified and synthesised for use in sex pheromone monitoring traps (Figure 23). It was shown to be highly attractive to male midges in the field.

Red traps are recommended for practical use and these should be hung in the crop canopy at a height of 0.5m above ground level. Two of these traps should be deployed in each field in early spring (March in early protected crops, early April outdoors). They should be monitored weekly for adult midges.

Within the project, a sex pheromone mating disruption system was developed for raspberry cane midge but further refinement and approval is needed before it can be made available for use by growers.

Thresholds for spraying

When monitoring with sex pheromone traps, when a threshold catch of 30 midges per trap is exceeded, apply a directed spray of chlorpyrifos to the base of primocanes a few days later.

Action points for growers

- Avoid the use of high cane densities which can increase humidity in the crop canopy.
- After harvest, remove spent floricanes (fruiting canes) within 2-3 weeks of the final pick.
- Remove any canes with visible symptoms of cane disease.
- A programme of 2-3 post-harvest fungicide sprays should be applied to control cane Botrytis.
- Cool fruit rapidly to 1-2°C immediately after harvest and store at 3-4°C to delay onset of fruit rotting.
- Apply an approved protectant fungicide very early after covering tunnels with polythene in spring to reduce the risk of powdery mildew infection.
- Control aphid populations in early to mid October with an aphicide and rely on predators and parasites in the spring and summer months.
- Funnel traps containing a host lure should be used at 50 per hectare for precision monitoring of raspberry beetle adults.
- To monitor for raspberry cane midge adults, deploy two sex pheromone monitoring traps in each field in early spring and check weekly.

Further information

Contact details for monitoring traps

Agrisense Ltd
Treforest Industrial Estate
Pontypridd
South Wales
CF37 5SU
Tel. (01443) 841155

www.agrisense.co.uk

Other useful publications

HDC Factsheet 01/07
Sucking insect pests of cane fruit crops

HDC Factsheet 07/11
Beetle and weevil pests of cane fruit crops

SAC Technical Note
Recognising pest damage on raspberries

HDC Crop Walkers' Guide
Cane Fruit

Project reports

Integrated pest and disease management for high quality raspberry production (SF 74, Defra Horticulture LINK HL0175)

Additional information

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