

# Grower Summary

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## SF 094 (HL0191)

Minimising pesticide residues in  
strawberry through integrated  
pest, disease and  
environmental crop  
management

Annual 2011

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

Read the label before use: use pesticides safely.

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| <b>Project Number:</b>          | SF 094 (HL0191)  |
| <b>Project Title:</b>           | Minimising pesticide residues in strawberry through integrated pest, disease and environmental crop management   |
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# **GROWER SUMMARY**

## **Headline**

- New control approaches have been developed for the main pests and diseases of strawberry and these have been combined into a new Integrated Pest and Disease Management programme which will reduce pesticide use and greatly reduce the incidence of pesticide residues.

## **Background and expected deliverables**

The overall aim of the project is to develop alternative, sustainable, non-pesticidal methods for managing Botrytis, mildew, black spot, aphids, blossom weevil and capsid bugs on strawberry so greatly reducing (by >50%) pesticide use and eliminating the occurrence of reportable pesticide residues on harvested fruit. The methods developed for the individual pests and diseases will be combined with existing non-chemical methods for other pests and diseases in an overall Integrated Pest and Disease Management (IPDM) system, and this will be tested and refined in commercial strawberry production over 2 seasons.

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

***Progress on each objective of the project is summarised below***

*Powdery mildew*

### **Inoculum in planting material**

Over the last three years, we did not find a significant level of latent powdery lesions on planting materials. Furthermore, symptomatic mildew lesions (spores) on green leaves did not appear to survive in cold store if the green leaves become senescent, but can survive over the winter on green leaves.

### **Alternative products**

None of alternative products tested showed any significant control effects against powdery mildew. This is primarily due the fact that the trial was conducted on a two-year old Albion plantation where it had a very high level of inoculum.

*Mildew forecasting*

On early covered ever-bearers, the model-managed plots had similar levels of powdery mildew as the conventional managed plots. However, the managed plots only received only 4 sprays compared to more than 20 sprays in the conventional plots. However, on a late 60-day Sonata crop, the evaluation trial failed to give any result because the initial mildew level was so high that a routine control programme failed to reduce the level before the trial could commence.

## *Botrytis*

### **Occurrence of latent *Botrytis cinerea***

Fifty ex-cold store strawberry Elsanta plants, supplied by the grower on the day of planting, were examined for latent infection by *B. cinerea*. *B. cinerea* was detected in 8% of the plants sampled indicating localised infection.

### **Fungicide efficacy**

Fungicide sprays and drenches were applied 3 weeks after planting. The fungicide treatments were: Untreated control, Cercobin WG drench at 1 g/L (0.25 g per plant), Teldor spray at 1.5 kg/ha, Scala spray at 2 L/ha, Signum spray (old label) at 1.8 kg/ha, Switch spray at 1 kg/ha and Serenade ASO spray at 10 L/ha. In crop assessments were carried out 2 weeks after treatment. 20 tagged leaves per plot were sampled, surface disinfected and placed into humid incubation and assessed for *B. cinerea*. Overall within this crop *B. cinerea* was at a low level. No clear consistent differences were shown between the fungicide treatments, but Signum showed some initial promise in the leaf humid incubation assessments.

### **Control of fruit infection using Binab (*Trichoderma* spp.)**

A grower standard spray programme of 4 fungicides at weekly intervals was compared with three biocontrol treatments; Prestop (*Gliocladium* spp.) and Serenade ASO (*Bacillus subtilis*) applied as weekly sprays and Binab T-Vector (*Trichoderma* spp.) vectored by bees.

Assessments were carried out on leaves, flowers and fruit to assess levels of botrytis. A high level of latent infection by *B. cinerea* was present in flowers and leaves of strawberries in the two experimental tunnels. Both bumble bees and honey bees effectively transferred the biocontrol product from the hives to the flowers. None of the treatments significantly reduced the incidence of latent infection by *B. cinerea* in strawberry flowers or fruit, or the incidence of botrytis fruit rot.

### **BOTEM forecasting of botrytis**

Validation results in 2010 again confirms those of previous years: botrytis risk on June-bearers (Elsanta) covered early in the early spring is very low. The level of fruit with latent botrytis infection is very low in both conventional and unsprayed plots. The results from all three years (2008-2010) suggested that for early-covered June-bearers fungicide application is not necessary to manage grey mould.

### **Pesticide dissipation**

Fungicide residues are very persistent on leaves of strawberry plants grown under protection: residues virtually did not reduce 10 days after applications. In contrast, much of fungicide residue was washed off those plants in open conditions due to the rain one day after the application. Thus, it is critically important to establish harvest intervals for strawberry grown under protection for each pesticide; using the data from open-field conditions may result in significant amount of residues on fruit under protection.

### *Black spot*

#### **Molecular comparison of black spot isolates**

Molecular analysis of isolates from different hosts at several sites suggested that significant differentiation among isolates only occurred between different sites but not between hosts at the same site. Thus, it does not appear that there is significant host-pathogen association for this pathogen yet.

#### **Using artificial inoculation to confirm the molecular findings**

Thirteen isolates of *C. acutatum*, previously isolated from strawberry, apple, weeds, primula and alder were inoculated onto strawberry fruits of the variety Red Glory. All isolates caused lesions on the fruit but there were differences in lesion size and sporulation of *C. acutatum*. The highest lesion scores were on fruit inoculated with isolates from strawberry, apple and alder. The lowest scores were on isolates from weeds. The results indicate that weeds and other non-strawberry hosts could act as a source of inoculum for *C. acutatum* in strawberry plantations. Further tests will be conducted in 2011. Similar tests on plants are still in progress.

## **Evaluation of biofumigants to eliminate *Colletotrichum*-infested debris in soil**

In the Hortlink biofumigation project (HL0177 – SF 77) biofumigants to control verticillium on strawberry were investigated. The project identified lavender waste and some brassica products, including Biofence as potential biofumigants. Soil fumigation is an important part of the integrated approach to control blackspot in strawberry production. The purpose of this study is to evaluate the efficacy of these products against *C. acutatum* in the laboratory, based on the protocol developed for *Verticillium dahliae* testing. Protocols for evaluating the efficacy of the biofumigants have been established. The tests will be set up later in 2011, once blackspot-infested strawberry debris has been collected.

## **Development of simple guidelines for blackspot management**

Simple guidelines will be developed to assist growers in making decisions regarding the need for management measures against blackspot, based on published data and newly available information on blackspot from this project. These guidelines will assess the relevance of various inoculum sources (runner origin, site history, alternative hosts etc), available control methods (fungicide efficacy, BCAs and biofumigation), production systems and local environmental conditions. Draft guidelines have been produced. These will be used in the IPDM trials established in 2011 and discussed and amended as necessary.

## **European tarnished plant bug**

A large scale field experiment was done to evaluate the use of the bug vac for control of *L. rugulipennis* in strawberry. Weekly bug vacs at the peak of *L. rugulipennis* populations (from the beginning of July, peaking at the end of August) were applied to half of the plots. Both the non-bug vacced and bug vacced plots were sampled before and after each bug vac operation. Overall the numbers of most invertebrates including *L. rugulipennis* adults and nymphs were reduced by 10 - 40%. The reduction of fruit damage in the bug vacced plots was lower, but not significantly so. A number of recommendations for the bug vac operations have been made; 1) the bug vac to be front mounted to prevent bugs flying away as the tractor passes over the beds, 2) begin bug vaccing as soon as the rise in populations is detected with the pheromone traps (~4 weeks before detection in field using traditional sampling methods), 3) more frequent passes over crop – at least 3 times per week.

In an experiment to test the necessary growing conditions of alyssum (attractant of *L. rugulipennis*) in strawberry crops, alyssum seed sown directly into soil did not establish well and seedlings were subject to competition from weeds and drying out. Plug plants sown

directly into the soil were also vulnerable to competition from weeds. Plants grown in grow bags with drip irrigation developed best. Trials with alyssum varieties are showing that the variety Clear Crystal produces more vigorous growth and more flowers than Snow Crystal>Snow Drift>Easter Bonnet>Gold Ball.

Hexyl butyrate dispensers were used in combination with live female *L. rugulipennis* and artificial sex pheromone in field experiments to determine the mechanism of reported population reductions. Results were not consistent, but in general a lower % of males were found in samples when hexyl butyrate was present than when it was absent.

### **Aphids**

Small plot experiments were done to assess the effects of sowing flowering plants alongside strawberry plantings on the numbers of aphid predators and parasitoids in the crop. The plants used were lucerne (*Medicago sativa*), red campion (*Silene dioecia*), viper's bugloss (*Echium vulgare*) and a mixture of annual species, cornflower (*Centaurea cyanus*), corn marigold (*Anthemis arvensis*) and corn chamomile (*Chrysanthemum segetum*). There was no apparent effect of these flowering plants on the numbers of beneficials found in adjacent strawberry plants when compared with a bare soil control.

Earlier work has demonstrated that various plant volatiles are attractive to a range of insect predators. However, work within this project both in laboratory olfactometry and field trapping experiments has failed to identify an attractive volatile for any predators of strawberry pests, with the exception of hoverflies. Further experiments with mass releases of a commercially available predator, *Orius laevigatus*, failed to show any response of this predator to lures containing farnesene, methyl salicylate or a mixture of farnesene, methyl salicylate, phenylethanol and caryophyllene.

In a field scale field trial using 4 different timings of Calypso between the end of September and beginning of November, all applications reduced the numbers of aphids (*Macrosiphum euphoriae*) present on the crop the following spring compared to the untreated control (less than 50 aphids/100 leaves compared to more than 400 aphids/100 leaves).

The parasitoid *Aphidius eglanteriae* has proved to be a difficult species to mass produce so an alternative species, *Ephedrus cerasicola* was assessed for its effectiveness in reducing *C. fragaefolii* populations in a potted plant experiment. A mix of six parasitoids was used and compared with *E. cerasicola* alone and an untreated control; this mix has been designed to

contain species that attack all the main aphid pests of strawberry. Results showed that releasing parasitoids onto aphid-infested plants significantly reduced the populations of both *C. fragaefolii* and *M. euphorbiae*.

### **Strawberry blossom weevil super trap**

Three field trials in Kent and Hereford were set up to determine if the supertrap could be used as a mass trapping (MT) device for *A. rubi*. Supertraps were found to be a sensitive indicator of the presence of *A. rubi* populations, but it was not clear if the catches were related to the population density. Further work is needed to establish the relationship between monitoring traps (in small numbers in crops) and weevil populations and where best to site the traps in crops for monitoring purposes. The 2010 data suggest that the MT treatment (grid 36 supertraps per ha) performed well at one site where the *A. rubi* populations were low, but at the two organic sites, where *A. rubi* populations were higher, they only captured < 30% of the weevils and did not reduce severing damage in the crop. The results do suggest that the density of deployment of 36 traps in a 1 ha plot (= 25 traps per ha in large plots) is insufficient where populations are moderate or high and the density needs to be increased, or the traps used in conjunction with chemical treatments. Ideally, a smaller, low cost trap should be developed which can be deployed economically at higher densities for MT. It is likely that the supertraps will perform better at very low populations densities, in crops which come into flower later and if they are deployed continuously through the season.

A small scale field trial was done to test combinations of trap designs for *L. rugulipennis* and *A. rubi*. White cross vanes on the bucket traps were a repellent to *L. rugulipennis* males. The *A. rubi* lures did not interfere with catches of *L. rugulipennis*. In previous experiments *L. rugulipennis* catches were impeded by the grids used as bee excluders. Numbers of *A. rubi* were too small to draw conclusions from. Any future combined monitoring trap should not have white cross vanes or a grid. The ideal trap would be a green cross vane that attracts *L. rugulipennis* and *A. rubi*.

## Financial benefits

*Botrytis*, mildew, black spot, aphids, blossom weevil and capsid bugs are very common problems wherever and however strawberries are grown in the UK. A very high percentage of strawberry plantations are infected by these pests and diseases. No quantitative data on losses is available, but conservatively assuming 10% of the crop is lost as a result of these infestations, this is equivalent to 5,074 tonnes of strawberries, worth £21 million.

To calculate the expected annual added value that might result from a successful project, it is assumed that it will lead to an average halving in losses in the current crop to 5%, i.e. an additional £10,623 million of UK sales. In addition, the improved consumer acceptability of UK strawberry growing compared to foreign competitors will reduce imports by 10%, yielding an additional £17 million of sales. It is possible that increased consumer confidence in strawberries will also grow the overall market marginally.

If the incidence of *B. cinerea* in propagation material can be reduced, and if this is shown to reduce risk of fruit rot, then fungicide application during flowering to control fruit *B. cinerea* could be reduced. A secondary benefit for growers would be an end to the picking disruption entailed by delaying harvesting (or picking and destroying) fruit developing within fungicide sprayed flowering crops.

Ultimately if the use of a biological product can be shown to decrease levels of *B. cinerea* developing from flowers to fruit, the reduction in spray costs and the disruption of harvest intervals will produce financial benefits.

## Action points for growers

- The risk of Botrytis on early covered June-bearer strawberries is very low so spraying with fungicides against Botrytis may not be necessary. For everbearers later in the season, the EMR Botem computer-based forecasting model (available from Prof Xiangming Xu at EMR, [xiangming.xu@emr.ac.uk](mailto:xiangming.xu@emr.ac.uk)) can be used to time sprays of fungicides or biocontrol agents and may result in a substantial reduction in fungicide use.
- Effective early control of powdery mildew is essential to minimise the risk later in the crop and if such good early control is achieved then a computer based forecasting model available from EMR can be used to time sprays and may result in a substantial reduction in fungicide use.

- A preliminary simple management system for blackspot has been devised and is summarised in Tables 3.4.1.-3.4.4 in the science section of this report. This updates the current HDC factsheet (Factsheet 14/02). A copy of the document can be obtained from Dr Angela Berrie at EMR ([Angela.Berrie@emr.ac.uk](mailto:Angela.Berrie@emr.ac.uk)) or the HDC.
- Sex pheromone traps for monitoring European tarnished plant bug, a serious pest of late season strawberry, have been developed and are available to growers who wish to cooperate in a pre-release testing programme in 2011. For further information contact Dr Michelle Fountain ([Michelle.Fountain@emr.ac.uk](mailto:Michelle.Fountain@emr.ac.uk)).
- Application of a late season spray of an aphicide (e.g. Claypso) in late October or November will greatly reduce populations of several of the most damaging and common aphid pests of strawberry and result in greatly reduced aphid populations the following spring, possibly obviating the need to spray. New formulations of mixtures of aphid parasitoid species are available from biocontrol suppliers and can be introduced in spring and will help prevent low spring populations from increasing.
- A new Integrated Pest and Disease Management programme which should reduce the use of pesticides and greatly reduce the incidence of residues on fruits at harvest has been devised and is being tested on a large scale on three commercial farms in 2011-12. The programme to be tested on everbearers is given in Table 7.1 on pages 93-95 of this report. An electronic copy of the documents can be obtained by HDC members from Prof Jerry Cross at EMR ([Jerry.Cross@emr.ac.uk](mailto:Jerry.Cross@emr.ac.uk)).