Grower Summary

SF 094 (HL 0191)

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

Final 2013

Disclaimer

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.ahdb.org.uk), quoting your HDC number, alternatively contact the HDC at the address below.

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

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Headline

Novel pest and disease control techniques can be incorporated into a new IPDM programme to reduce pesticide use and subsequent incidence of pesticide residues, without a reduction in yield or quality.

Background and expected deliverables

The overall aim of the project was 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 were combined with existing non-chemical methods for other pests and diseases in an overall Integrated Pest and Disease Management (IPDM) system, and this was tested and refined in commerical strawberry production over two seasons. In this report we summarise the results from the second year of IPDM assessments in commercial strawberry and include a financial assessment of the strategies.

Summary of results from year 5 and main conclusions

Objective 7. To develop and evaluate an Integrated Pest and Disease Management strategy, determining how components interact, its economic performance, effects on other pests, diseases and beneficials and the incidence of pesticide residues

Task 7.1 - Devise an IPDM programme (years 4-5, all partners)

An integrated pest and disease management programme was devised in year 4 by combining the results from objectives 1-6 on the six specified pests and diseases together with existing established non-chemical control methods. For diseases the strategy comprised three aspects:

- Reduction of initial inoculum
- Development of risk-assessment system for better timing of management practices
- Increased use of BCAs and natural products during flowering.

For insect pests, an integrated approach using habitat manipulation, semiochemical lures and biocontrol agents together with more species specific controls was developed. Where treatment was required, priority was given to use of natural products, commodity substances and the use of biocontrols (e.g. for aphids). Conventional fungicides or insecticides were only used when a need was identified and the risk of leaving a residue in fruit was assessed as low. Pesticides which have been found to leave detectable residues were not used on fruit, wherever an alternative treatment or chemical was available.

Task 7.2 - Test IPDM in commercial crops (years 4-5; all partners)

IPDM trials were conducted at five sites: four in Kent (two in 2011 and two in 2012) and one in Surrey (trialled for two seasons). Treatment comparisons over the three commercial tunnel strawberry crops in 2011 and 2012 support the use of IPDM to manage pests and diseases. The IPDM strategies used appeared to be as effective as the host grower's standard practices in controlling the key strawberry pests and diseases whilst maintaining equivalent yield and quality with many fewer detections of pesticide residues in fruit.

Pest control

For aphid control, well timed out-of-season sprays were combined with three releases of Aphidsure fragaria (a six parasitoid wasp mix) at three week intervals from the first signs of plant growth prior to seeing aphids. This approach showed promising results in both years at certain sites and has the added benefit of not requiring aphid identification to be effective. However on one site where there was a large population of melon-cotton aphid (*Aphis gossypii*), introduction of the single species parasitoid *Aphidius colemani* was more successful. Most success was achieved where the parasitoids were introduced preventively one to two weeks after the plants start growing.

For strawberry blossom weevil, a grid of super traps developed in the early stages of this project was set out over the IPDM area (36/ha). The pest was successfully detected in the traps but was present at low levels and so did not reach a threshold for control; this was a good result as it avoided an unnecessary insecticide application, which did occur in the grower control at more than one site.

For capsid and European tarnished plant bug control, a combination of approaches was adopted over the different sites including: monitoring traps with lures, alyssum trap plants and bug vaccing. The traps provide a relatively inexpensive way to monitor for the presence of the pest. It allows growers to target spays accordingly or to avoid their use altogether if the pest is not present. These traps are now commercially available. The alyssum did not perform as hoped, struggling to establish and failed to flower before the strawberries. Bug vaccing requires further development, identifying optimal equipment mounting and timing runs through the crop.

For two-spotted spider mite, western flower thrips, and tarsonemid mite control, release programmes of *Phytoseiulus persimilis* and *Neoseiulus* (*Amblyseius*) *cucumeris* (as slow release sachets) were used. These are already widely adopted in the industry but incorporation with a more complete IPM strategy and limiting insecticide applications further, appeared to enhance the efficacy of the of these strategies. Also trialled on a smaller scale was the use of pheromone delta monitoring traps for three common tortrix species found on strawberry, along with the use of sticky glue around table top legs for earwig control. With all these strategies, careful monitoring, placement and early introductions were crucial to success.

Disease control

In terms of disease control, the IPDM strategy focussed on non-chemical control of powdery mildew and botrytis (grey mould) during flowering and harvest. Outside of this period, protective and curative fungicide applications for crown rot, botrytis, powdery mildew and blackspot were applied to clean up the crop and reduce potential inoculum present and protect new growth from re-infection at a time when these products are unlikely to leave a residue on fruit. For powdery mildew, the computer based disease forecasting tool developed in the earlier stages of the project, which uses hourly in-crop temperature and humidity records and disease monitoring, was used to trigger spray applications of potassium bicarbonate and sulphur. Potassium bicarbonate has eradicant properties but provides little protectant activity. Sulphur is mainly a protectant with some eradicant properties. This strategy has shown encouraging results in early season crops with a low mildew pressure, maintaining equivalent levels of mildew control with many fewer fungicide applications required.

For control of botrytis, the bee-dispersed biological control agent (BCA) Prestop Mix (*Gliocladium catenulatum* - used under Extrapolated Experimental Approval), was combined with the use of the BOTEM prediction model and spray application of both Serenade ASO (*Bacillus subtilis*) and Prestop (*G. catenulatum*). These were trialled over the two years. Bumble bees were demonstrated to be more suitable to UK strawberry production systems in polytunnels than honey bees for this mechanism. The native *Bombus terrestris, Audax* species, has been used to transfer Prestop Mix powder to strawberry flowers. In the three crops where this was trialled, equivalent and in some cases lower levels of botrytis was found on the fruit compared with a conventional fungicide programme, although it was not always possible to relate the botrytis control to the amount of Prestop Mix delivered. The BOTEM model was used to trigger spray applications of the two BCAs outside of the bee dispersal periods and on two sites where bees were not used.

Yield and residues

Over the two years and six crops in which the IPDM strategy was implemented only one site was adversely affected in terms of yield and fruit quality and this was as a direct result of an exceptionally high powdery mildew pressure and poor spray coverage. At all other sites the IPDM programme achieved equivalent yield and fruit quality compared to a conventional programme with between 50% and 100% fewer chemical residues detected in fruit.

Financial benefits

Estimated changes in costs due to typical implementation of the IPDM programme are summarised in Table 1 compared with a typical grower programme. The annual total for the IPDM programme varies from an estimated £250 cheaper to £2,800 per hectare more expensive depending on the extent to which the IPDM approaches are adopted and also the crop type and situation. A detailed break-down is available in the science section of the report. The additional cost of the IPDM programme would be £137 per tonne assuming a typical yield of 20 tonne/ha for full adoption of the IPDM programme.

Table 1. Changes in variable costs per ha per annum that are likely to occur typically as a result of implementing the IPDM program in comparison with a typical growers programme

Target pest/disease	**Approach**	**Additional cost/ha/annum £ (excl VAT)**
Botrytis	Bee vectored Prestop Mix	+ £ 115
	BOTEM model and timed fungicide applications	Variable depending on weather conditions +/-
Powdery mildew	Applications of fungicide, potassium bicarbonate and sulphur according to forecasting model and field observations	Variable depending on disease pressure and weather 2012 estimate - £300 to - £404
Aphids	Aphid parasitoid 6 wasp mix – 1 tube/200m^2 x 3 introduction at 3 week intervals	+ £ 1,731
Strawberry blossom weevil	Grid of 36 bucket traps and lures per hectare. 10 man hours to service traps	+ £ 449
Two spotted spider mite	High introduction rates of *Phytoseiulus persimilis* at first sight of pest 100k/ha followed by 25k/ha 2 weeks later as required	+ £ 404
Capsids	2 green cross vane bucket traps for European tarnished plant bug, and 2 blue sticky traps for Common green capsid per hectare with pheromones	+ £ 86
Western flower thrips and tarsonemid mites	*N. cucumeris* ABS release sachets, followed by loose product 50/m^2 as required	+ £ 325
Earwigs	Insect barrier glue on table top legs	+ £ 94
Net cost increase		**+ £ 2,800**

Action points for growers

- Results in 2012 at one site in particular highlighted the importance of effective spray coverage. This IPDM programme focuses on reducing and targeting fungicide applications for powdery mildew control and for this to be effective the coverage needs to be complete, especially to the underside of the leaves and to the young leaves and flowers. Understanding sprayer technology, particularly on table top systems, and developing quick easy methods to assess sprayer efficacy to ensure good coverage in the field has been highlighted as requiring further investigation to provide advice to growers. Poor coverage leads to increased numbers of applications and knock-on effects on resistance development in the pest or pathogen and residues in the fruit.
- Several newer strawberry varieties appear to be more susceptible to mildew infection of fruits and flowers. The current powdery mildew model was developed for the conditions conducive to leaf infection. The temperature and humidity parameters for the infection of fruits and flowers appear to be different to those for leaves so the model should not be relied on to predict mildew infection of flowers and fruits.
- For optimum efficacy the aphid parasitoid mixes for aphid control should be released as early as possible, before aphids are seen in the crop.
- Early releases of *Neoseiulus cucumeris* sachets are essential for effective control of thrips and tarsonemid mites.