Grower Summary

SF 012 (HL 01105)

Developing biocontrol methods and their integration in sustainable pest and disease management in blackcurrant production

Annual 2012

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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Project Leader:	Tom Maynard
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Headline

Progress is being made in developing biocontrol methods for Botrytis, leaf midge and sawfly in blackcurrant.

Background and expected deliverables

The overall aim of the proposed project is to develop new management methods for key pests and diseases of blackcurrants, giving priority to alternative, biological methods. These will then be integrated into an Integrated Pest and Disease Management (IPDM) programme which will be evaluated and refined in large scale field experiments in the final two years of the project. Work will target Botrytis, the most important disease of blackcurrants which causes significant losses in fruit quality, and two important pest problems, blackcurrant leaf midge and blackcurrant sawfly which are currently controlled by routine insecticide applications. The aim will be to develop appropriate improved management methods for each target to improve control, whilst reducing dependence on and unnecessary use of pesticides.

Summary of project and main conclusions

Progress on each objective of the project is summarised below

Objective 1: Botrytis cinerea

Determining whether varietal differences in susceptibility are correlated with physiological characters

The incidence of latent Botrytis has been assessed in fruit from samples collected in the two variety trial sites in East Anglia and the other in West Midlands. Fruit were sampled in May-June. At least 50 (usually 100) fruit were randomly sampled from each line at each site. In addition, morphological and physical characters were assessed at the two sites for each line by ADAS. There was no significant correlation between the incidences of latent botrytis over the two seasons. Incidence of latent infection appeared to be increased with late development within a season, number of flowers per node, fruit losses on the floor, and decreasing fruit weight. However, it should be noted that the magnitude of correlation is generally very low. The susceptibility of a number of selected advanced breeding lines has been measured for botrytis and skin thickness. For both characters, there is considerable variability. Further data will be collected in 2012 to establish whether there is significant correlation between these two characters.

Time fungicide application and supplementary sprays of BCAs during flowering to improve control

The efficacy of the biocontrol agents Serenade, Prestop, Trianum P and Boniprotect Forte, applied as 4 or 5 spray programmes starting pre-flowering or at first flower for control of botrytis fruit rot on blackcurrant cultivars Ben Hope and Ben Tirran, was compared to a standard fungicide programme at similar timings and an untreated control. Programmes based on fungicides for the first 3 sprays followed by one, two or no sprays of Serenade were also included. The incidence of botrytis was assessed on green fruit samples on paraquat agar and on harvested fruit following 7 days damp incubation. The incidence of botrytis fruit rot pre-harvest on bushes was negligible. The incidence of botrytis in green fruit samples varied from 0-100% botrytis and in post-harvest tests varied from 0-70%. For Ben Tirran the incidence of botrytis post-harvest in untreated fruit was around 12%. All treatments, including the BCAs, significantly reduced the incidence of botrytis rot compared to the untreated. Best control was achieved by treatment 2 (4 x fungicide treatments) and 7 (3 early fungicides + 2 late Serenades). Replacing the fourth fungicide with two treatments with the BCA Serenade appeared to have some benefit in botrytis control.

Botrytis rot incidence was more variable on fruit from Ben Hope most likely due to the drier weather and hence lower botrytis risk, when this cultivar was flowering. This made the data more difficult to interpret. The lowest incidence of botrytis in the post-harvest tests was recorded in fruit from treatment 2 (4 x fungicide treatments).

Effect of pollinating insects on blackcurrant yield and quality

Field tunnel experiments showed that supplementing blackcurrant with *Bombus terrestris* nest boxes at 100% open flower increased yield and fruit size especially during poor weather conditions when naturally occurring pollinating insects were less active. Trials in both years on the 9 plantations surveyed have identified 15 species of wild bee foraging on blackcurrant flowers. However, very few honeybees were found foraging blackcurrant flowers, and so play little part in the contribution to blackcurrant pollination. Even though plots in 2011 were supplied with 3 bumblebee nest boxes each, no increase in foraging bees was recorded compared to plots not supplemented with bumblebees. However, the weather during flowering was good and, hence, maximum pollination with wild bees may have been achieved.

When bumblebees from the nest boxes and wild solitary bees were sampled from the plantations and examined for the presence of blackcurrant pollen, 60% and 38% had blackcurrant pollen on their heads, respectively, showing that they were foraging the flowers and, therefore, aiding pollination.

Placing insect exclusion bags over trusses of flowers resulted in up to 36% less fruit set highlighting the importance of bee pollination for blackcurrant. There was some evidence that bees were vectoring botrytis to the berries (analyses were close to significant). However, the amount of botrytis cultured from berries from the 8 plantations varied widely between plantations. This made the analyses inconclusive. Botrytis was cultured from the legs of three bees and head and body of one bee of the 20 *B. terrestris* sampled from the nest boxes. 52 berries sampled from the blackcurrant plot (Ben Gairn) on site were surface sterilised and cultured with the flower excised from the body of the fruit. Most of the fungal infection was in the flower. Generally the berries had no growth. Only 3 of the berries/flowers had botrytis on them.

Determine the role of B. cinerea and/or other fungi in blocking filters

Artificial inoculation studies have been conducted to study the possibility of fungal accumulation within latently infected fruit. Six samples of Ben Hope fruit have been collated at a weekly interval following inoculation. Currently, the real time PCR protocols are being tested to quantify fungal biomass, in particular extracting fungal DNA from blackcurrant fruit.

Objective 2: Blackcurrant leaf midge

Crop damage assessment in fruiting plantations

A 3 year, replicated large plot experiment was started in April 2010 in 7 commercial blackcurrant plantations in England to investigate the effects of blackcurrant leaf midge attacks on crop growth and yield. The plantations included establishing versus fully established crops of the cultivars Ben Alder, Ben Hope and Ben Tirran. Galling damage, yields and shoot growth were recorded in replicate plots treated with synthetic pyrethroid insecticides (bifenthrin and/or lambda cyhalothrin) where blackcurrant leaf midge attacks were low, versus untreated plot where populations were high.

There were large differences in the numbers of midges captured at the different sites. Greatest numbers were caught in the untreated plots at Chasfield followed by Wellbrook. Smallest numbers were caught at Provender followed by Bradenham. The highest and lowest sites were the same as in 2010. The first generation flight started in early April and reached a peak in mid-April, the peak being ~2 weeks earlier than in 2010. A mean peak number of 165.8 midges per trap were captured for the first generation in the untreated plots, over six times the numbers (25 per trap) captured in 2010.

The second generation midge flight started in early May though a clear start to the second generation could not be distinguished at Provender where the catches were very low. Peak numbers captured averaged 131.9 per trap, again higher than in 2010 (81 per trap).

The insecticide treatments applied to the treated plots reduced but did not eliminate galling damage in the treated versus the untreated plots. For the first generation, the numbers of galls per shoot was reduced by 82% (from 0.66 to 0.12 galls per shoot) by insecticide treatment on average ($P = 0.001$). For the second generation, the numbers of galls per shoot was reduced by 91% (from 1.40 to 0.12 galls per shoot) by insecticide treatment on average ($P = 0.0001$). Catches of midges in the sex pheromone monitoring traps were also reduced, by 72% for the first generation ($P = <0.001$) and by 83% for the second generation ($P < 0.001$)

Linear regressions (constrained through the origin) of the numbers of galls recorded per shoot and the mean and peak numbers of midges caught in the sex pheromone traps in the untreated plots for the 2nd generation accounted for 54% and 55% of the variation indicating that trap catches may be useful for predicting galling damage.

The grand mean yield for the treated plots (5413 kg/ha) was very similar to the grand mean yield for the untreated plots (5515 kg/ha) and the yields did not differ significantly ($P = 0.326$). Thus, insecticide treatment for blackcurrant leaf midge provided no yield benefit. As in 2010, highest yields were recorded in the mature established plantations at Burrs Hill and Provender. As in 2010, lowest yields were recorded at Bradfields and in the 3rd year plantation at Bradenham.

Dormant season shoot growth measurements for the year have yet to be made. The experiment will be continued for a further year to determine long term effects of blackcurrant leaf midge attacks on growth and yield.

Crop damage assessment in cut down bushes

A replicated trial was done at Adamston Farms, Muirhead, Dundee, in 2011, to determine the effects of attacks by blackcurrant leaf midge on shoot regrowth in the first year of regrowth in cut down blackcurrant bushes. Two sprays of Talstar were applied in 22 April and 5 May against the 1st generation midge attack and one spray of Hallmark was applied on 7 June against the 2nd generation. Treatments compared control of both generations of the midge, control of the 2nd generation only with no control. The timing of sprays was determined by sex pheromone traps.

- The 3 insecticide sprays gave >96% control of leaf midge galling which was severe on the untreated plots.

- The 1st generation blackcurrant leaf midge attack was highly damaging to the regrowth of cut down blackcurrant bushes reducing shoot growth by >50%.

- Control of both the first and second generations of midges is needed as the first generation attack can do serious damage.

Timing and efficacy of insecticides

A small plot replicated field experiment was done in 2011 to evaluate the efficacy of foliar sprays (500 l/ha) of UKA385a or Hallmark for control of 1st and 2nd generation blackcurrant leaf curling midge. Treatments were a factorial comparison of single sprays of the 2 products (UKA385a, Hallmark) at 4 timings (1, 4, 8 and 15 days after a threshold catch of >10 blackcurrant leaf midge males had been captured per trap in the two sex pheromone monitoring traps deployed in the plantation) versus an untreated control (double replicated). For the first generation, sprays were applied on 5, 8,13 and 20 April at growth stages C1, C2, D1 and F1, respectively. For the second generation, sprays were applied on 9, 13, 16 and 24 May at the F3, I1, I1 and I1-I2 growth stages. Numbers of galls and the larvae they contained were assessed in samples of 25 shoots per plot sampled on 3 May and 7 June, 2 weeks after the last sprays for each generation had been applied, respectively. A summary of the findings of the experiment is as follows:

- Hallmark performed significantly better than UK385a in reducing the numbers of leaf galls compared to the control. Hallmark and UK385a reduced gall numbers by 49% and 38%, respectively.

- The results with Hallmark were disappointing, and tie in with growers' experience that this product is less effective for blackcurrant leaf midge control than other synthetic pyrethroids such as fenpropathin (Meothrin) or bifenthrin (Talstar), which are no longer available.

- UK385a is known to be slow acting, so the fact that it did not greatly reduce numbers of galls is not surprising, and was shown in the trial in 2010.

- Timing of application had no significant effect on the efficacy of control of leaf galling for either product, in contrast to the 2010 experiment where earlier applications performed better.

- The efficacy of control of larvae by both pesticides increased progressively with later spray timing. On average UK385a performed significantly better than Hallmark. The two products reduced the numbers of larvae per gall by 82% and 61%, respectively. The latest spray timing of the UK385a reduced larval numbers by 99.2%.

- For the 2nd generation assessment the UK385a and Hallmark reduced the numbers of larvae per gall by 98% and 78% on average, respectively.

- Further work is needed to explore timing of application of UKA385a and Hallmark in relation to pheromone trap catches more closely. For experiments in 2012, it is suggested that the 2011 experiment is repeated to validate the results.

Objective 3: Blackcurrant sawfly

In GC-EAG analyses of volatiles and hexane washes from virgin female sawfly on polar and non-polar GC columns, at least two EAG responses from the antennae of male sawfly were recorded. No responses were recorded to volatiles collected from male sawflies. A small peak at the retention times of the strongest response in GC-MS analyses on both polar and non-polar columns had a mass spectrum indicating an *iso*-propyl tetradecenoate isomer. Synthetic *iso*-propyl (*Z*)-9-tetradecenoate elicited a small response from the antennae of male sawflies in GC-EAG analyses. Comparison of retention time shifts of tetradecenyl acetate isomers with double bonds in different positions indicated that iso-propyl (*Z*)-5-tetradecenoate was the most likely candidate for the candidate pheromone component, and this will be synthesised. This would be a novel compound, although *iso*-propyl (*Z*)-9-tetradecenoate is a pheromone component of *Dermestes* spp. (Coleoptera: Dermestiidae).

The identities of the compounds responsible for the other EAG response(s) are uncertain, although it is possible that they are homologues of the main component as the retention indices are essentially whole numbers of carbon atoms different on both columns and some evidence for traces of homologues was found in the mass spectra. We have also shown using virgin females that red delta traps with transparent window are effective for catching mates.

Commercial benefits

New knowledge obtained in this project will enable growers to manage the important pests and diseases on blackcurrant more effectively with less reliance on pesticides. In particular:

1) Accurate predictions of *B. cinerea* infection risk may enable growers to time sprays and hence to increase spray efficacy.

2) Integration of biocontrol agents with fungicides may reduce botrytis development without increasing fungicide use.

3) Potential correlation of physiological characters with botrytis development may accelerate breeding of less susceptible cultivars.

4) Understanding fungi responsible for filter blockage may enable appropriate control measures to be developed and implemented.

5) Crop damage assessment of blackcurrant leaf midge would allow growers to focus control measures where they are needed and avoid spraying in plantations where damage is cosmetic.

6) Establishment of thresholds for the newly developed leaf midge sex pheromone trap will enable sprays to be scheduled and timed to improve control and reduce insecticide use.

7) A pheromone based control method for leaf midge would allow growers to control the midge without use of insecticides.

8) A monitoring trap for blackcurrant sawfly and attendant treatment thresholds would allow growers to focus control measures where they are needed and avoid spraying in plantations unnecessarily close to harvest.

9) An improved Integrated Pest and Disease Management programme combining the above components would allow a substantive reduction in pesticide use, reduced incidence of residues and improved sustainability

Action points for growers

- The trials are at a preliminary stage, but growers should consider supplementing pollination in blackcurrant plantations with commercially available boxes of the native bumblebee *Bombus terrestris audax* in the future.
- Sustain and increase bee numbers when orchards are not in flower, by providing alternative food sources – ground flora (e.g. daisy family, scabiouses, clovers). Bees need to refuel after emerging from over-wintering sites (February to March) and a good food supply (April to September) will help to ensure high populations into the following year.
- Provide undisturbed, south-facing areas of sparsely vegetated ground for solitary bees to nest in. Bare ground compacted by vehicles is also good, as long as these areas are in sunshine.
- Avoid waterlogging soil.
- Leave untidy areas of rotting wood, preferably areas of woodland, and tussocky grasses for bumblebees to overwinter and nest in.
- Growers interested in using the newly designed blackcurrant leaf midge trap to time spray applications should contact Jerry Cross (jerry.cross@emr.ac.uk).