Project title:	Novel insecticide treatments to control large narcissus fly
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Location of project:	Warwick HRI, Wellesbourne, Warwick CV35 9EF
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Key words:	Large narcissus fly, *Merodon equestris,* narcissus, Hallmark lambda-cyhalothrin, foliar spray.

CONTENTS

Headline

- Experiments were done to determine whether Hallmark (lambda-cyhalothrin) applied with or without sugar bait is effective against large narcissus fly adults under field conditions.
- In a field trial at Warwick HRI Wellesbourne, the strategy used to infest the plots was successful and 23% of the insecticide-free bulbs were damaged and 8% contained live larvae. However, there was no overall difference between treatments, indicating that neither of the insecticidal control strategies had worked.
- In un-replicated trials in commercial crops of narcissus, damage levels were lower than at Wellesbourne and relatively low numbers of larvae were found. Two crops were completely unaffected. Overall, there were no striking differences between the treated and insecticide-free plots, although the low level of infestation makes it difficult to compare treatments.
- The overall conclusion is that the application of foliar sprays of Hallmark, with or without sugar, did not reduce narcissus fly infestations significantly. Although this is disappointing, it does demonstrate the value of undertaking field trials, as the use of ineffective insecticides cannot be justified on either economic or environmental grounds.

Background and expected deliverables

The large narcissus fly (*Merodon equestris*) is the most important pest insect of narcissus crops in the UK. Large narcissus flies overwinter as fully fed larvae within narcissus bulbs. In March or April, the larvae leave the bulbs and burrow through the soil to find suitable pupation sites near the soil surface. The adults emerge during May and June. After a period during which they feed and mate, the flies lay their eggs in the soil, close to the base of narcissus leaves, at a time when the leaves on many crops have already senesced. The eggs hatch after several days and the newly emerged larvae crawl down the outside of the plant and enter the bulbs through the basal plate. The larvae feed and grow inside the bulbs. Although more than one larva may enter a bulb, only one survives. The larvae are usually fully-grown by early winter. Infested bulbs fail to produce flowers and the most severely affected bulbs rot and die.

In the UK, narcissus crops remain in the soil for two or sometimes more seasons, which means that they are exposed to two or more periods of infestation by the narcissus fly. Of the insecticide treatments available currently, a pre-planting chlorpyrifos dip (Spannit) is the most effective and provides high levels of control during the first growing season. There is no effective insecticide treatment for control of narcissus fly during the second and third growing seasons, although early-lifting can help to reduce attack.

The UK narcissus crop covers over 3000 hectares, approximately 35% of which is grown in south-west England. Traditionally, Cornwall and the Isles of Scilly have been thought of as those areas most affected by the pest, due to a warmer climate and closer rotations. However, increasingly warm summers have seen populations on the increase in eastern counties, and the pest is now a significant problem on a number of farms. Summer 2004 appeared to have been particularly favourable for narcissus fly survival and there were reports that infestation levels were higher in Lincolnshire and Cornwall than they had been

for some time. Extreme levels of infestation were as high as 30% and there were large numbers of stocks where 5-10% bulbs were infested. This could have severe implications for the quality and value of the UK bulb crop.

The overall objective of the project is to determine whether Hallmark (lambda-cyhalothrin) will kill adult large narcissus flies under field conditions. The study consisted of field plot experiments at Warwick HRI, supported by field-scale trials on commercial holdings. It follows on from laboratory experiments done in 2004 (BOF 53), when adult narcissus flies were exposed to narcissus foliage treated with one of four insecticides (active ingredients: lambda-cyhalothrin, deltamethrin, spinosad, thiacloprid) in small cages in the laboratory at Warwick HRI. Flies exposed to Hallmark were affected most severely by the treatment, although many of them took several days to die, becoming moribund in the intervening period. In a second experiment, a small amount sugar was added to the spray solution to act as bait. The addition of bait made all the insecticides more effective, but Hallmark was still the most active compound.

Summary of the project and main conclusions

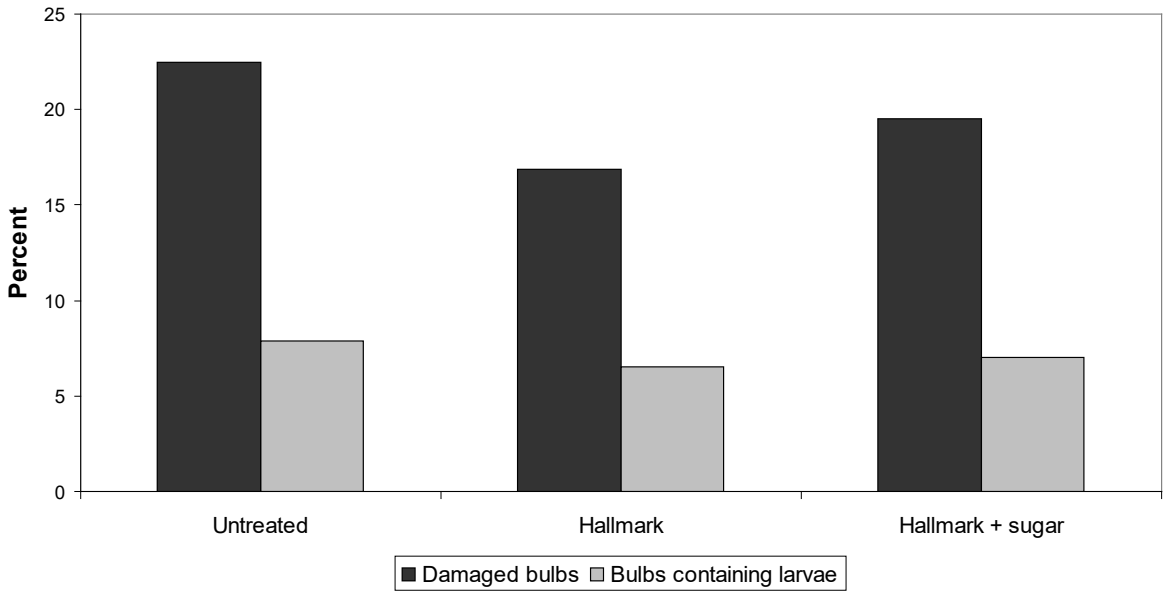
Two trials were done:

1) *Determine whether Hallmark applied to narcissus foliage kills adult large narcissus flies (plot experiment)*

Twelve plots of narcissus cv Carlton were planted at Wellesbourne in late summer 2005. Bulbs infested with large narcissus flies from a field population maintained at Wellesbourne were planted in a single row on either side of each of the 12 small plots of Carlton. The bulbs were then left to grow and flower. The large narcissus fly forecast was used to predict when flies would start to emerge in the plots. On 11, 18, 25 May and 1 June 2005, one third of the plots was sprayed with Hallmark (lambda-cyhalothrin) at 100 ml product/ha (100ml/ha with a maximum total of 400ml/ha (i.e. 4 applications) is the highest rate with full approval on an edible crop), one third was sprayed with Hallmark at the same rate, but in a 1% solution of sugar as bait, and the remaining plots were left insecticide-free. The bulbs were then left until late autumn 2006, when samples of bulbs were taken from each plot and assessed for narcissus fly damage and the presence of larvae.

The strategy used to infest the plots was successful and 23% of the insecticide-free bulbs were damaged and 8% contained live larvae. However, there was no overall difference between treatments (Figure 1), indicating that neither of the control strategies had worked.

Figure 1. The percentage of damaged bulbs and bulbs containing large narcissus fly larvae from the field plot trial at Wellesbourne.

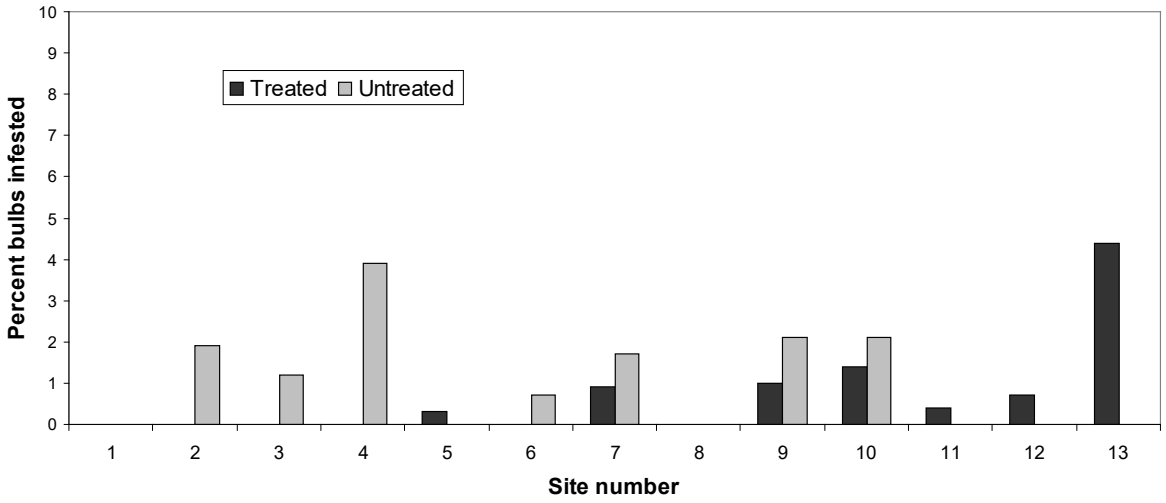


2) Field scale trials to verify results of plot trials

Bulb growers were contacted in spring 2005 to ask if they would participate in the trial. Participants were asked to select a field where they would apply Hallmark or Hallmark in a sugar solution to one area of the crop and leave another comparable area untreated. Application rates and timings were agreed with Warwick HRI. Most growers applied four sprays between mid May and early June. In the late summer – autumn, samples of 300+ bulbs were lifted from the treated and insecticide-free areas and assessed at the Kirton Research Centre, which also took part in the trial.

Damage levels were lower than at Wellesbourne and relatively low numbers of larvae were found (Figure 2). Two crops were completely unaffected. Overall, there were no striking differences between the treated and insecticide-free plots, although the low level of infestation makes it difficult to compare treatments.

Figure 2. The percentage of bulbs containing large narcissus fly larvae from the grower trials.



Main conclusions

The overall conclusion from these trials is that the application of foliar sprays of Hallmark, with or without sugar, did not reduce narcissus fly infestations significantly. Although this is disappointing, it is not an exceptional case, since we have observed similar differences between laboratory and field experiments when attempting to control adult cabbage root fly with foliar sprays. It does, however, demonstrate the value of undertaking field trials, as the use of ineffective insecticides cannot be justified on either economic or environmental grounds.

Financial benefits

- Exports to both EU and non-EU countries are essential to the economy of the bulb industry, with £5m for bulbs and an additional £15m for narcissus flowers. Together with forced flowers, pot-grown bulbs and UK sales to retail outlets, the UK industry has an estimated farm gate value of £44m per annum.

- Narcissus fly infestation levels as low as 1% may jeopardise an entire consignment of bulbs, particularly if these are destined for export. Current control measures are nowhere near 100% effective, and the control strategy uses just one pesticide, chlorpyrifos.

- The proposed research was timely because:

    - uses of chlorpyrifos (including the bulb dip) were being questioned by PSD, due to concerns about adverse environmental effects of this insecticide
    - narcissus fly infestations had increased during 2004

Action points for growers

- The results from both the plot trials and grower trials indicate that Hallmark sprays do not cause a significant reduction in narcissus fly damage and that application of this insecticide to control large narcissus fly cannot be justified on either economic or environmental grounds.

- Use of a chlorpyrifos dip (Spannit) continues to be the most effective means of controlling large narcissus fly larvae in the first year after planting. However, this treatment does not persist sufficiently to provide control in subsequent years. In the year of harvest, growers can reduce narcissus fly infestations by lifting their bulbs early.

- The large narcissus fly forecast (posted on the HDC Pest Bulletin web site http://www2.warwick.ac.uk/fac/sci/hri2/hdcpestbulletin/narcissus/) gives regional predictions of fly emergence, egg laying and egg hatch. This information can be used to time bulb lifting to avoid narcissus fly damage and can give an indication of the likely severity of attack in any particular season.

SCIENCE SECTION

INTRODUCTION

The overall objective of the proposed project is to determine whether Hallmark (lambda-cyhalothrin) will kill adult large narcissus flies under field conditions. It follows on from laboratory experiments done earlier in 2004 (BOF 53), when adult narcissus flies were exposed to narcissus foliage treated with one of four insecticides (active ingredients: lambda-cyhalothrin, deltamethrin, spinosad, thiacloprid) in small cages in the laboratory at Warwick HRI. Flies exposed to Hallmark were affected most severely by the treatment, although many of them took several days to die, becoming moribund in the intervening period. In a second experiment, a small amount sugar was added to the spray solution to act as bait. The addition of bait made all the insecticides more effective, but Hallmark was still the most active compound.

MATERIALS AND METHODS

The overall objective is to determine whether Hallmark applied with or without sugar bait is effective against large narcissus fly adults under field conditions.

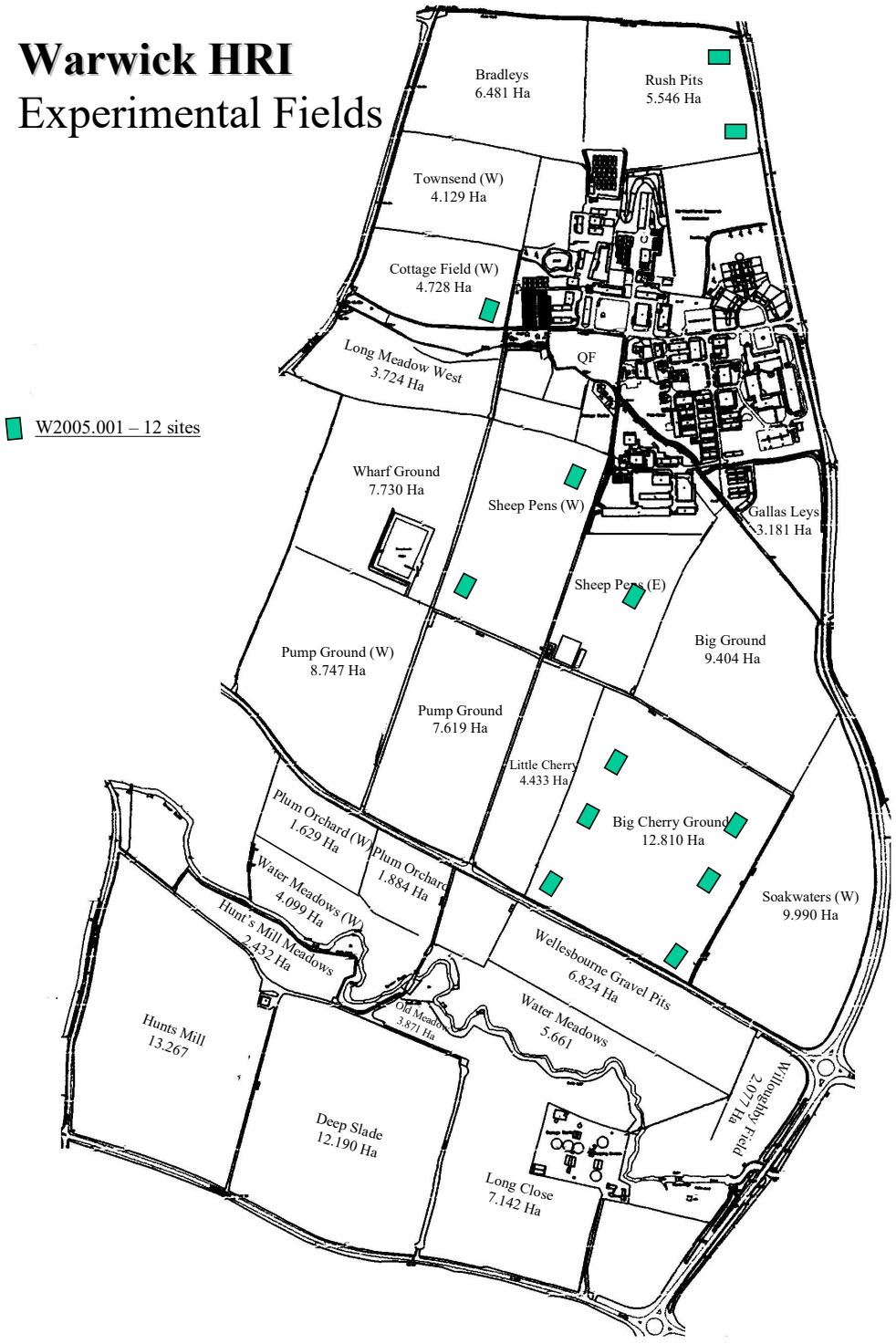
Determine whether Hallmark applied to narcissus foliage kills adult large narcissus flies (plot trial at Warwick HRI, Wellesbourne)

Twelve plots of narcissus cv Carlton were planted at Wellesbourne in late September 2005. Each plot was 4 rows wide x 10 m long. Each plot was in a location isolated from the other plots and from other sources of narcissus fly (Figure 1). This was to create 'mini fields' where 'separate' narcissus fly populations could be established.

Large narcissus flies from a field population maintained in a large plot of narcissus (cv Ice Follies) at Wellesbourne were used to infest each plot. In November 2004, several thousand bulbs were dug from the large plot and examined for the presence of narcissus fly larvae. The infested bulbs were separated out and planted in a single row on either side of each of the 12 small plots of Carlton. The same number of infested bulbs (approximately 200 per plot containing live larvae) was planted around each plot. The bulbs were then left to grow and flower. A strip of land on either side of each plot was left uncultivated to allow weeds to develop. This was to provide shelter and a food source for the flies as they emerged in May and June, to encourage them to stay close to the plots and lay their eggs there.

The large narcissus fly forecast was used to predict when flies would start to emerge in the plots. It predicted that 10% of flies would emerge by 17 May and that the mid-point of emergence would be 27 May. Flies were observed in the plots on a number of occasions during May and June. On 11, 18 , 25 May and 1 June 2005, one third of the plots was sprayed with Hallmark at 100 ml product/ha, one third was sprayed with Hallmark at the same rate, but in a 1% solution of sugar as bait, and the remaining plots were left insecticide-free. To ensure that the treatments were 'evenly distributed' the plots were divided into four groups of three and one of the three treatments was allocated to each plot in the group. The bulbs were then left until late autumn 2006, when samples of approximately 500 bulbs were taken from each plot and assessed for narcissus fly damage and the presence of larvae. The data were analysed using regression analysis.

Figure 1. Location of 12 small plots at Warwick HRI, Wellesbourne.



Field scale trials to verify results of plot trials

Bulb growers were contacted in spring 2005 to ask if they would participate in the trial. Participants were asked to select a field where they would apply Hallmark or Hallmark in a sugar solution to one area of the crop and leave another comparable area untreated. Application rates (the same as the plot trial at Wellesbourne) and timings (using the large narcissus fly forecast) were agreed with Warwick HRI. In the late summer – autumn,

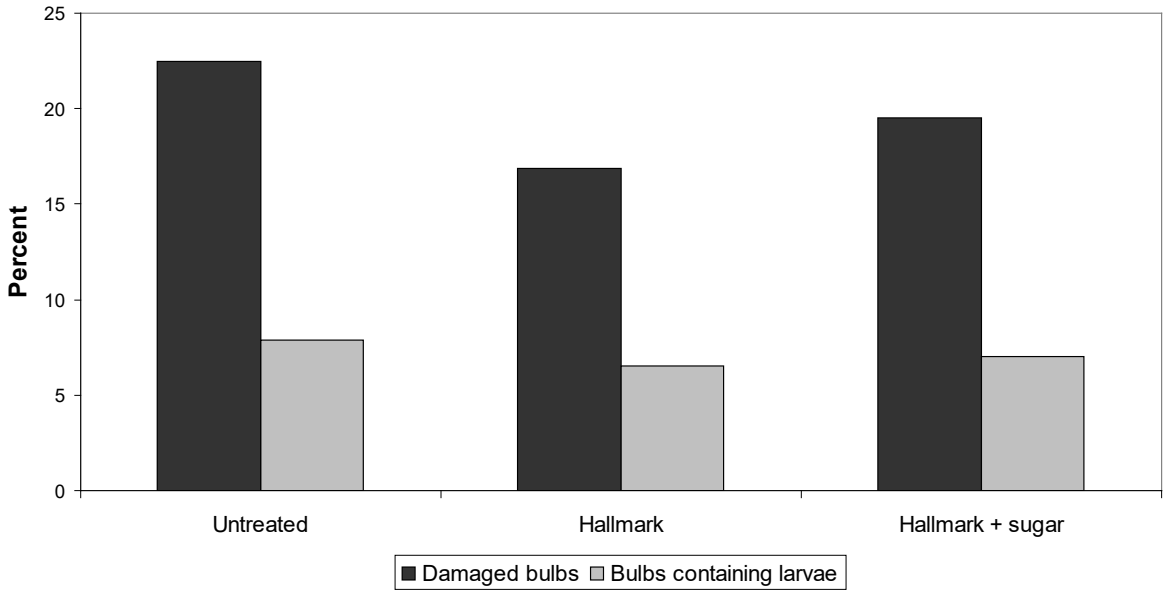
samples of 300+ bulbs were lifted from the treated and insecticide-free areas and assessed at the Kirton Research Centre, which also took part in the trial and applied treatments both with and without sugar.

RESULTS

Determine whether Hallmark applied to narcissus foliage kills adult large narcissus flies (plot trial at Warwick HRI, Wellesbourne)

The strategy used to infest the plots was successful and 23% of the insecticide-free bulbs were damaged and 8% contained live larvae. However, there was no overall difference between treatments (Figure 2; p=0.701 for damaged bulbs; p=0.793 for bulbs containing larvae), indicating that neither of the control strategies had worked.

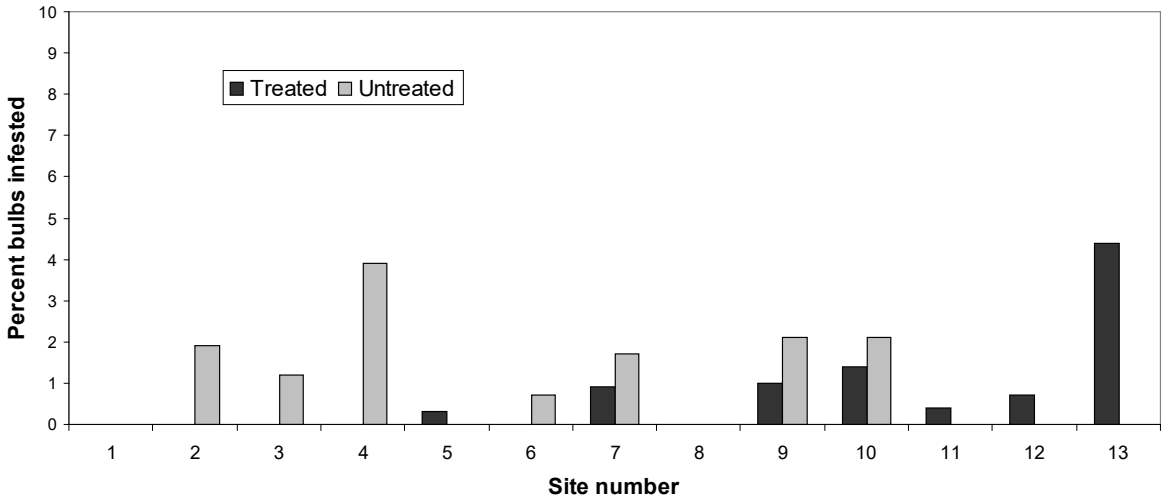
Figure 2. The percentage of damaged bulbs and bulbs containing large narcissus fly larvae from the plot trial at Wellesbourne.



Field scale trials to verify results of plot trials

Overall, 13 comparisons were made between treated and untreated bulbs by 8 growers and the Kirton Research Centre. Most growers applied Hallmark without sugar. Three growers were located in Cornwall and the others in Eastern England. Damage levels were lower than at Wellesbourne and relatively low numbers of larvae were found (Figure 3). Two crops were completely unaffected. Overall, there were no striking differences between the treated (treatments with or without sugar) and insecticide-free plots, although the low level of infestation makes it difficult to compare treatments.

Figure 3. The percentage of bulbs containing large narcissus fly larvae from the grower trials.



CONCLUSIONS

The overall conclusion from these trials is that the application of foliar sprays of Hallmark, with or without sugar, did not reduce narcissus fly infestations significantly. Although this is disappointing, it is not an exceptional case, since we have observed similar differences between laboratory and field experiments when attempting to control adult cabbage root fly with foliar sprays. It does, however, demonstrate the value of undertaking field trials, as the use of ineffective insecticides cannot be justified on either economic or environmental grounds.

The large narcissus fly is normally a 'low density' pest and field experiments to demonstrate the efficacy of insecticides are often difficult to interpret because of the patchy distribution of the fly and the relatively low numbers of infested bulbs. The technique used at Wellesbourne was effective and flies appeared to be sufficiently arrested by the narcissus plants to remain at their emergence site, mate and lay eggs.

Summer 2004 was particularly favourable for narcissus fly survival and there were reports that infestation levels were higher in Lincolnshire and Cornwall than they had been for some time. Infestation levels in certain crops were as high as 30% and many crops had 5-10% bulbs infested. Although there were concerns that fly numbers would remain high in 2005, grower reports and the results of our grower trials indicate that numbers have decreased.

Although it is difficult to demonstrate conclusively, it seems likely that the weather at the time of fly emergence is the critical factor that determines whether populations are relatively high or low. Once they emerge from the soil, adult flies require relatively high temperatures (approximately 20°C) to be sufficiently active to mate. If temperatures are lower than 20°C, mating and subsequent egg-laying are delayed. This delay is likely to have two effects 1) firstly the longer flies are around before they lay eggs, the more likely they are to die before reproducing and 2) the longer egg-laying is delayed, the more likely it is that at least some bulbs will have been lifted before newly-hatched larvae are able to penetrate the bulb. There is usually a period of 10 or more days between egg-laying and subsequent egg hatch.

TECHNOLOGY TRANSFER

Results from the project were presented at an ADAS Bulb Centre meeting at Holbeach, Lincolnshire on 23 March 2006 and will be presented at an HDC Bulbs meeting at the Duchy College, Camborne Cornwall on 20 April 2006.

Articles:

Collier, R.H. & Jukes, A.A. (2006). Facing up to large narcissus fly. HDC News March 2006, 40-42.

ACKNOWLEDGEMENTS

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