Factsheet 05/08

Narcissus

Projects BOF 53, 55 & Defra project HH1747TBU

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Management of large narcissus fly

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The large narcissus fly is the most important insect pest of narcissus in the UK. The larvae of the fly feed on narcissus bulbs. Infested bulbs rarely produce flowers and many rot and die. This factsheet provides guidance on how to minimise damage by this pest through physical, chemical and cultural control methods.

Action points

- Crop rotation, particularly of crops grown on a short cycle (eg 2 year down crops), will reduce the risk of damage due to large narcissus fly. This is mainly because lifting the crop, subjecting it to hot water treatment and planting it in a new location will disrupt the life cycle of the fly.

- Hot water treatment of dormant bulbs prior to planting eliminates any large narcissus fly larvae present, allowing stocks to be disinfested before planting. However, it **does not protect** the crop against subsequent reinvasion after planting.

- At present, the only consistently effective chemical treatment is chlorpyrifos (SOLA for Cyren or Alpha chlorpyrifos 48 EC), applied in hot water treatment before planting. **This treatment provides high levels of control during the first growing season, but no control in subsequent years.**

- The large narcissus fly forecast uses local weather records (soil and air temperatures) to predict the times of adult fly emergence, egg laying and egg hatch in relation to temperature. The large narcissus fly forecast program is available from Warwick HRI as part of the MORPH software and, if they have a source of appropriate weather data, growers can produce their own forecasts. At present, forecasts of large narcissus fly activity are produced centrally using weather data provided by the Met Office and these are available on the HDC Pest Bulletin website.

- There is no conclusive evidence that foliar sprays of any of the insecticides approved currently for use as foliar sprays on outdoor crops will control large narcissus fly adults or larvae. If such a treatment were to become available then the large narcissus fly forecast could be used to time treatments.

- It is possible to control large narcissus fly damage by lifting the bulbs before some, or all, large narcissus fly eggs hatch. Obviously, early lifting can be used only in the year of harvest. The large narcissus fly forecast can be used to estimate when the eggs are likely to hatch, and therefore indicate the period during which early lifting would prevent some or all of the newly hatched larvae from invading the bulbs.

1 Bulb damaged by a large narcissus fly larva

Introduction

The large narcissus fly (*Merodon equestris*) has been the most important insect pest of narcissus in the UK since its introduction in the 19th century. The larvae of the fly feed on narcissus bulbs. Infested bulbs rarely produce flowers and many rot and die.

Traditionally, Cornwall and the Isles of Scilly were the areas most affected by the pest, due to a warmer climate and closer rotations. However, increasingly warm summers have seen populations increase in eastern England as well. The summers of 2004 and 2006 appear to have been particularly favourable for narcissus fly survival and there were reports that infestation levels were higher in Cornwall and Lincolnshire than they had been for some time. Infestation levels in certain crops have been as high as 30%, and many crops had 5–10% bulbs infested. This has considerable implications for the quality and value of the UK bulb crop.

For example, exports to both EU and non-EU countries are essential to the economy of the bulb industry, with £5m for bulbs and an additional £15 m for narcissus flowers. Narcissus fly infestation levels as low as 1% may jeopardise the export of bulbs and since the banning of the persistent organochlorine insecticide Aldrin, the current control strategy uses just one pesticide, chlorpyrifos. However, even when coupled with other measures, control of this pest is nowhere near 100% effective. Research has therefore been aimed at developing alternative insecticidal and non-insecticidal control measures for large narcissus fly and this fact-sheet summarises progress achieved to date.

Identification

The large narcissus fly is a large hover fly (Syrphid) and the adult fly resembles a bumble bee. There are a number of different colour forms of the adult fly, and flies may be a mixture of black, ginger or gold. On warm, sunny days it is possible to see large narcissus flies in flight or resting on foliage. However, they can be confused with other species of hover fly and bees. The larva is generally found inside a bulb, although larvae do move from bulb to bulb if their food supply is exhausted and, when fully grown, they leave the bulb to pupate in the soil.

Narcissus bulbs may also be infested by larvae of the small narcissus fly (*Eumerus strigatus*). Fully grown small narcissus fly larvae are much smaller (approx 8 mm) than those of the large narcissus fly (approx 20 mm). In addition, whilst large narcissus fly larvae are ‘solitary’, several small narcissus larvae can be found in the same bulb. Small narcissus flies are ‘secondary’ pests and will only colonise bulbs that have been damaged by pests, disease or mechanical operations.

Life cycle and biology

The large narcissus fly completes a single generation each year. Adult flies emerge from pupae in the soil in May – July. Once the flies have emerged, the timing of mating is dependent on ambient temperatures. The low temperature threshold for flight is about 20 – 21°C, and male and female flies need to fly to find one another and mate. At sufficiently high temperatures the flies normally mate during the first two days of adult life and once mating has occurred, low temperatures do not inhibit egg laying. However, maximum air temperatures during May and June are often below this threshold, so that newly emerged flies may have to wait for several days or even weeks before temperatures exceed 20 – 21°C. Flies emerge, mate and lay eggs over a period of at least four weeks, and any control measure applied in the field should take this into account.

2 Adult large narcissus fly

Fertilised females start laying their eggs approximately five days after mating. There are various opinions about where the eggs are laid, but recent observations (Defra project HH1747TBU) showed that female flies lay their eggs singly, pushing them below the surface of the soil. During a bout of egg laying, females move relatively short distances between egg laying sites, so that the chance of their progeny infesting the same narcissus bulb is relatively high.

On hatching, the tiny larva crawls downwards along the surface of the bulb until it reaches the basal plate. The larva penetrates the bulb through one of the root canals. After some days spent mining in and around the basal plate, the larva establishes itself in the centre of the bulb. Although several larvae may enter the bulb, only one survives, although an additional larva may survive in an offset. The larva feeds in the centre of the bulb during the rest of the summer, autumn and early winter, going through four instars (larval stages). The fully fed fourth instar larva vacates the bulb in the following spring and forms a pupa in the soil just below the surface.

3 Narcissus fly eggs

4 Narcissus fly larva (newly hatched)

5 Narcissus fly larva (fully grown)

6 Narcissus fly pupa

Monitoring and forecasting large narcissus fly

Large narcissus fly populations fluctuate from year to year and some of the factors influencing fly survival were investigated in Defra project HH1747TBU. Although it is difficult to demonstrate conclusively, there seems to be a strong association between the severity of damage and air temperatures in May – June, when flies are emerging, mating and laying eggs. In recent years, damage was most severe in 2004 and 2006 and air temperatures were higher in both years than in either 2003 or 2005. A possible explanation is that in cool years, temperatures may be too low for newly emerged adults to fly and find a mate. The longer mating is delayed, the greater the chance of fly mortality before the eggs are laid. In addition, if mating and egg laying are delayed sufficiently, crops may be lifted before larvae are able to enter the bulbs.

Attempts have been made to monitor numbers of adult large narcissus flies using sticky traps or water traps. Neither approach has been particularly effective. There are no large narcissus fly 'attractants' available for use in monitoring or control systems.

The rate at which all stages of the large narcissus fly develop is controlled by temperature. The large narcissus fly forecast, developed at Warwick HRI, uses local weather records (soil and air temperatures) to predict the times of adult fly emergence, egg laying and egg hatch in relation to temperature. The large narcissus fly forecast program is available from Warwick HRI as part of the MORPH software and, if they have a source of appropriate weather data, growers can produce their own forecasts. At present, forecasts of large narcissus fly activity are produced centrally using weather data provided by the Met Office and these are available on the HDC Pest Bulletin website: **www2.warwick.ac.uk/fac/sci/whri/hdcpestbulletin/**

Physical control

Hot water treatment

Hot water treatment of bulbs prior to planting kills any large narcissus fly larvae present, allowing stocks to be disinfested before planting. However, it **does not protect** the crop against subsequent reinvasion after planting. The standard UK recommendation is to treat all planting stocks for a 3 hour period at a temperature of 44.4ºC to kill nematodes. The 3 hour period is usually taken as starting when the tank temperature regains 44.4ºC after the cooling effect of loading the bulbs into the tank. This temperature alone is more than adequate to kill large narcissus fly larvae in the bulbs.

Some growers use longer and hotter treatments, and chemicals are usually added to the hot water treatment tank (see below), but this is unnecessary for the management of large narcissus fly.

Crop covers

Whilst it is probably neither economic nor practical on a field scale, fine mesh netting can be used to cover particularly precious bulb stocks and prevent egg laying by large narcissus flies. This technique is used on a field scale by some vegetable growers, particularly for control of cabbage root fly in swede crops. This technique is effective only if:

1 Plants are covered before large narcissus flies emerge in the spring.

2 The covers are well sealed and remain intact throughout the egg laying period.

3 The plants that are covered have not been infested previously by large narcissus fly (otherwise emerging flies will be trapped inside the cover).

An additional treatment likely to reduce the incidence of large narcissus fly in the Isles of Scilly is the practice of covering the narcissus crops with clear polythene for periods during which adult flies are active. This is done for agronomic reasons but only on Tazetta narcissi.

7 Crop covers can be considered for high value bulb stocks but are not economical on a field scale

Chemical control

Formaldehyde

Commercial formalin is usually added to the water used in the hot water treatment tank at a rate of 5 litres per 1000 litres water to provide control of nematodes and basal rot additional to that of the hot water alone. This treatment is likely to be toxic to large narcissus fly larvae, but will not provide protection in the following season. Formaldehyde (commercial formalin) is unlikely to remain available for horticultural use and, although no fully effective alternative is yet available, HDC projects (BOF 61 & BOF 61a) are under way to address this issue.

Chlorpyrifos dip

At present, the only consistently effective chemical treatment is chlorpyrifos (SOLA for Alpha chlorpyrifos or Cyren), applied in hot water treatment before planting (BOF 24). **This treatment provides high levels of control during the first growing season, but no control in subsequent years.** Cold chlorpyrifos dips or application of chlorpyrifos at planting are less effective than application as part of hot water treatment, and are therefore not recommended.

Foliar spray treatments

At present there is no effective insecticide treatment for control of narcissus fly during the second and subsequent years of the crop. Several HDC projects on forecasting and control of narcissus fly (BOF 1, BOF 1a, BOF 1c & FV/BOF 127) were carried out during 1987–96. In this period a wide range of insecticide treatments was evaluated for large narcissus fly control. One insecticide, omethoate, looked particularly promising for use as a foliar spray against the adult flies. However, this insecticide is no longer available.

As, by 2004, insecticides had not been evaluated for some time, the aim of more recent projects (BOF 53, BOF 55) was to determine which, if any, of the currently approved insecticides were effective against either large narcissus fly adults or larvae. Insecticides likely to achieve approval within the next 2 – 3 years were included. Small scale pot and laboratory trials were done in 2004 and whilst the treatments to control larvae were unsuccessful, two of the insecticides applied to narcissus foliage (lambda-cyhalothrin (Hallmark with Zeon Technology) and deltamethrin (Decis)) were effective against adult flies. These insecticides were even more effective when sugar (10%) was added to the spray solution to act as bait. The addition of bait made both the insecticides more effective with Hallmark with Zeon Technology performing better.

In 2005, field trials were done by Warwick HRI and a number of growers to assess the efficacy of the Hallmark treatment on a field scale (BOF 55). In the more detailed trial at Wellesbourne, application of foliar sprays of Hallmark with Zeon Technology (four sprays at 100 ml/ha with a maximum total of 400 ml/ha, ie 4 applications), with or without sugar, did not reduce narcissus fly infestations significantly compared with insecticide free control plots. In the commercial crops, there were no striking differences between treated and insecticide free plots, although the low level of infestation in 2005 made it difficult to compare treatments. Although none of the currently approved insecticides appear to have useful activity, it will be important to evaluate novel insecticides as they become available.

8 **Hot water treatment provides high levels of LNF control during the first growing season but no control in subsequent years**

Cultural control

Crop rotation

Crop rotation, particularly of crops grown on a short cycle (eg 2 year down crops) will reduce the risk of damage due to large narcissus fly. This is mainly because lifting the crop, subjecting it to hot water treatment and planting it in a new location will disrupt the life cycle of the fly. There is relatively little information on the dispersal distance of large narcissus fly and on alternative hosts, though the pest is known to invade some other ornamental bulbs such as snowdrop and scilla. Commercial narcissus crops and other narcissus (cultivated or naturalised plants or groundkeepers) undoubtedly provide the greatest source of 'new' flies. Planting in isolation, wherever possible, is advisable. It is likely that all narcissus varieties are prone to attack. A variety trial, using some of the more commonly grown varieties and undertaken some years ago at Warwick HRI, provided no evidence of varietal differences in susceptibility to large narcissus fly.

Premature defoliation

Tazetta narcissi such as 'Soleil d'Or' benefit from burning over (often several times) in early to mid summer. Gas or diesel burners used in the Isles of Scilly are believed to deter large narcissus fly attack by destroying or disguising the foliage. In one experiment, burning over in June was almost as effective as lifting the bulbs in late May to early June. With hotter burners the treatments are being applied earlier with apparent benefit both physiologically and in respect of large narcissus fly.

Small plot experiments by ADAS showed that it was possible to control large narcissus fly damage by defoliating the narcissus plants or scorching the foliage with a propane burner before large narcissus flies laid their eggs. In commercial practice, bulbs could be defoliated in any pre-harvest year or in the harvest year itself.

This technique was reassessed by ADAS in a large plot trial in Defra project HH1747TBU. Defoliation in May or June, by scorching with a tractor mounted propane burner, or by flailing first with a tractor mounted flail and then scorching, reduced subsequent attack by large narcissus fly larvae in only one of three field experiments. It was concluded that crop defoliation could not be developed further as a commercial control measure for large narcissus fly.

Early lifting

Previous research showed that it is possible to control large narcissus fly damage by lifting the bulbs before large narcissus fly eggs hatch. Obviously, early lifting can be used only in the year of harvest. The large narcissus fly forecast can be used to estimate when the eggs are likely to hatch, and therefore indicate the period during which early lifting would prevent some or all of the newly hatched larvae from invading the bulbs.

9 Burning over Tazetta narcissi such as 'Soleil d'Or' is believed to deter large narcissus fly by destroying or disguising the foliage

Yield penalties associated with premature defoliation and early lifting

In HDC project BOF 37, two field experiments were done to measure the effects of different commercially practicable defoliation and early lifting treatment programmes. These were applied to representative narcissus cultivars grown for two years in Cornwall and Lincolnshire. The effects of these programmes were measured in terms of flower numbers and bulb yield in Year 2. Data from this project were used to produce models for narcissus yield that could be incorporated into a larger integrated narcissus fly and crop model that would summarise the effects of these cultural practices in terms of changes in narcissus fly damage and crop yield (Defra project HH1747TBU). The model demonstrated that there was scope for implementing cultural control strategies in relation to the timing of large narcissus fly activity and that the yield penalties, particularly due to early lifting, might not be as great as expected. It is also likely that, as part of normal commercial schedules, a number of crops are lifted before at least some larvae have invaded the bulbs, which leads naturally to a certain level of 'control'.

As narcissus crops remain in the ground for two or more years in the UK, they are exposed to two or more periods of possible infestation by the narcissus fly. Any control measure taken must therefore take this into account and try to maximise the length of time for which they have an effect.

10 Early lifting of bulbs before eggs hatch can help control large narcissus fly

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Additional information:

Further information: Full copies of the final reports for HDC projects BOF 53 & 55 are available from the HDC office (01732 848383). Copies of Defra project HH1747TBU will be available from their website.

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