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Daylesford Organic Market Garden

Leek Moth

Leek Moth (*Acrolepiopsis assectella*) is a pest widely distributed across continental Europe, which has now found its way to Britain and is causing significant damage to leek crops (Buczacki, 2005). Early sightings of this pest appeared in the warmer southern coastal regions of the UK; however the pest seems to be moving northwards with reports of damage from growers in the Midlands. It is not a pest restricted to large scale production, affecting small and large growers alike. It is also a hot topic with gardeners as it spreads across allotment sites. Much of the limited, but sound advice on coping with this pest is to be found on internet gardening forums and from societies such as Garden Organic and the RHS. Being until recent years a minor pest, there are at the moment few mentions of this pest in books. The focus of this project will be in regard to damage to leek crops. Research is being carried out into the control of this pest in Canada, which will be discussed.

Damage

The larvae (caterpillars) of the leek moth cause damage by eating the leaves of cultivated alliums (leeks, onions, garlic, chives) and wild alliums. As the larvae mature they tunnel deeper into the leaves, and down into the stem/bulb. The damage is often extensive, with secondary rotting, causing brown, wet patches (Davies, 2010). At harvest, when stripping away the damaged leaf, the larvae may sometimes be found, moving deeper into the plant. The effect on the crop varies, depending on individual circumstances. Damage ranges from collapsed plants, with tattered leaves, not worth harvesting; to superficial damage that is easily removed by stripping a couple of extra leaf layers off. Typical leaf damage may be seen in plate 1.



Plate 1: In some cases superficial outer leaf damage may be stripped off quite easily at harvest.

Description

The leek moth is a fairly innocuous looking pest, being fairly small (wing span 16mm) and grey/brown in colour. The larvae are light green/white, roughly 10mm long, with a brown head; (it is the larvae that growers are most likely to spot, tunnelling away through the leek). A feeding larva may be seen in Plate 2. The pupae are brown, 6-7mm long, and appear within a loosely spun cocoon (BCPC, 2011). The cocoons are often located on the undersides of leaves, see Plate 3. Leek moth should not be confused with allium leaf miner, which is also a growing problem. The larvae of the allium leaf miner are orange/brown in colour (Sumption, 2012).



Plate 2: The leek moth larva. Source: <http://www.omafra.gov.on.ca/english/crops/facts/08-009.htm>



Plate 3: The pupae are often found on the underside of leaves. Source: <http://www.omafra.gov.on.ca/english/crops/facts/08-009.htm>

Lifecycle

In the UK, there are, usually, two generations of leek moth, although in the warmer climates of southern Europe there may be up to six. It is generally accepted that the adult moths overwinter in crop debris, (Buczacki, 2005), although it is also thought that the pupae can overwinter (Allen et Al., 2008). In spring, as temperatures rise the adult moths emerge from hibernation and after mating, the females lay eggs singly on the leaves of host plants (Alford, 2011). Roughly a week later the eggs hatch and the caterpillars start to feed on the plants, with the first generation causing damage in May and June. The caterpillars then move back up the plant to pupate in loosely spun cocoons, emerging as adults. The caterpillars from this second generation cause damage between August and October. The second generation of caterpillars cause the most damage to leek crops, particularly in hot, dry summers (Davies, 2010). The lifecycle of the Leek Moth may be seen in Figure 1. Research has found that the development time, from egg to adult leek moth, as you would expect is temperature dependant. With egg to adult taking, on average, 115 days at 10°C, and only 25 days at 25°C. At temperatures over 30°C, the development time does not necessarily get faster still (Mason *et al.*, 2010).

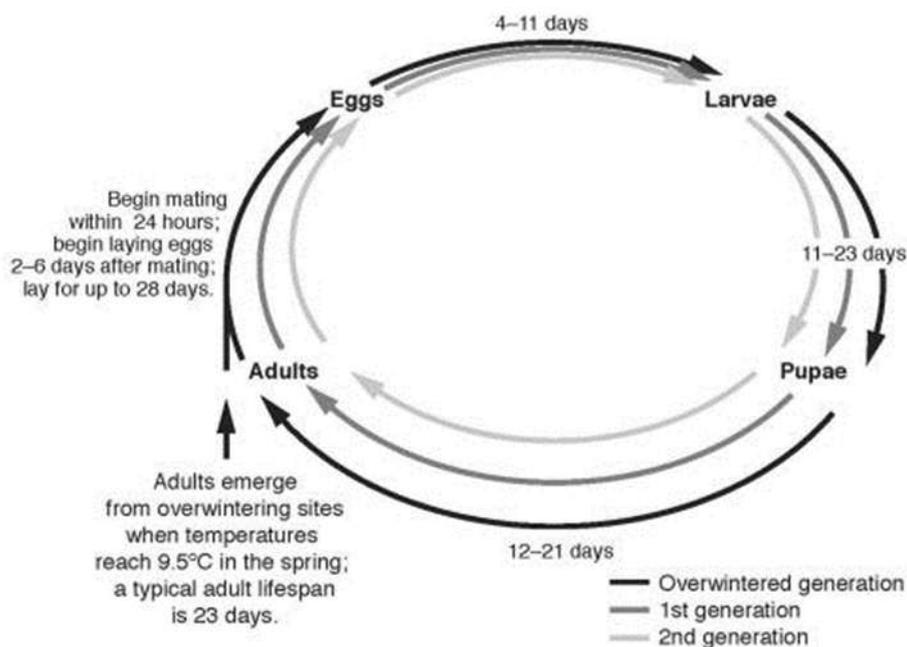


Figure 1. Leek Moth Lifecycle (Allen *et al.*, 2008).

Growers Survey

As part of this report I invited grower members of the Organic Growers Alliance (OGA), who had encountered leek moth on their holdings, to complete a survey. This enabled me to create a map of the grower sightings, which may be seen in Figure 2.

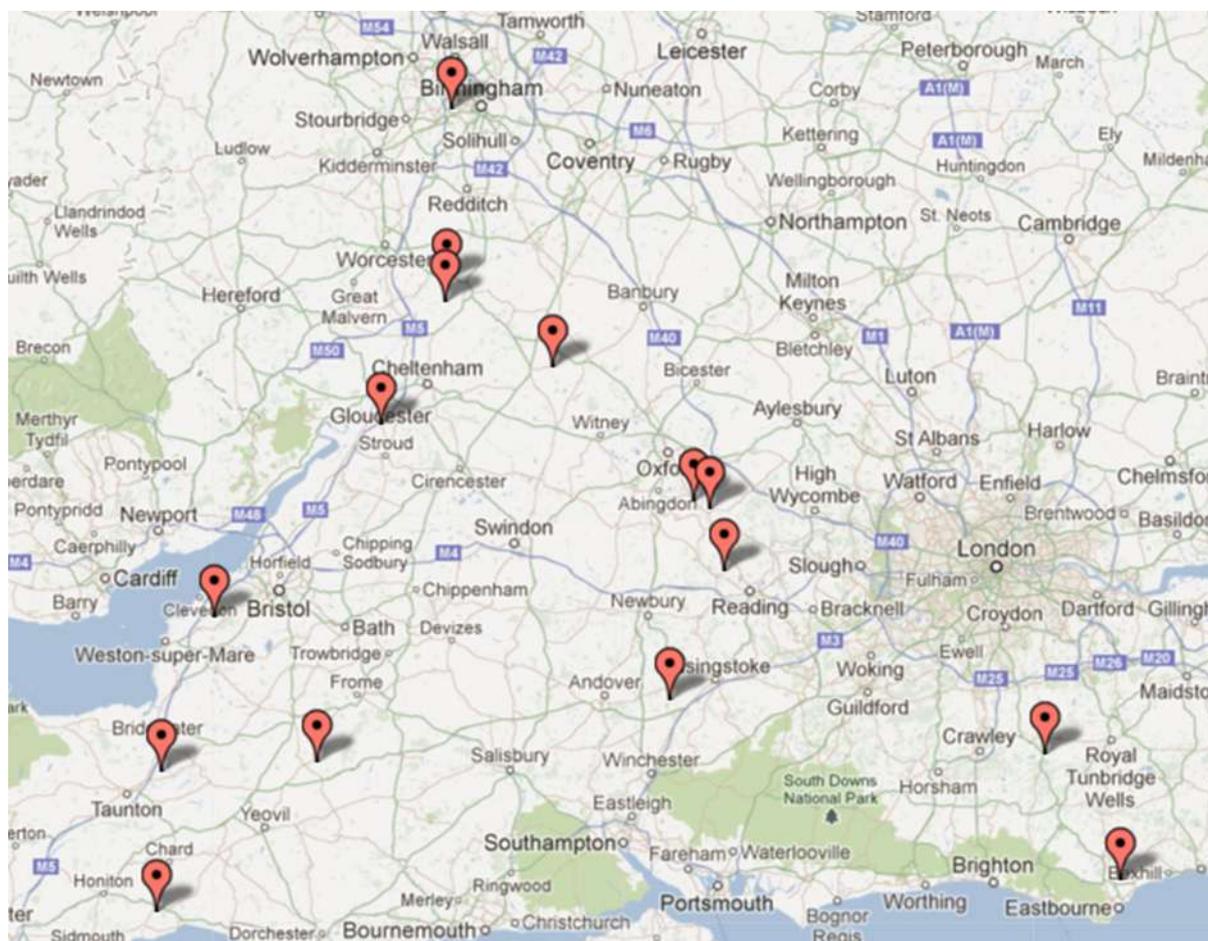


Figure 2: Distribution of leek moth sightings by growers.

Within the survey, to which 14 growers responded, I asked a range of questions to ascertain how badly their leek crops was affected, what action they took (if any); if the marketability of the crop was affected and what strategies they would use in the future to combat the effects of this pest. The survey may be seen in Appendix I. To the responses of other growers I added our observations (leek moth has been present at Daylesford Organic since 2010). This provides the total of 15 sites recorded across Figure 2. It is almost certain that leek moth is more widely distributed across the south, but our knowledge of its distribution is limited, in this instance, by the number of responses from growers.

Survey Analysis

All of the growers had encountered leek moth on their leek crops, with approximately 15% also noticing damage to garlic and onions. Year on year, 29% thought the damage caused by leek moth to be variable, 7% though it was decreasing, but 64% thought damage was increasing. The survey went out in April 2012, which was to turn

out to be the wettest year on record, so the thoughts of growers may have since changed. Comments returned revealed that growers thought damage may be worse in hot, dry conditions, which is corroborated by some of the current published information on leek moth. Others observed that damage was relatively light on garlic crops, when sold as 'wet' garlic. This is likely as wet garlic is harvested relatively early (starting from approximately mid June) and so is probably only standing in the field to encounter damage from the first generation of leek moth in May and June.

The area of leeks grown by the respondents varied, with heaviest losses reported in early leeks (those harvested in late summer/early autumn). Several growers reported a loss of up to 50% of their early leeks, and one smaller grower, with 1800 plants, lost them all to leek moth. Regarding the lifecycle of this pest this is perhaps unsurprising as the leeks will have been planted early and so would encounter both the first generation of caterpillars, and as harvesting starts in the autumn, they are likely to have the second generation of caterpillars actively feeding upon them. Later plantings of leeks would hope to avoid the first generation, and depending on when the cultivar matures, (and weather conditions) might have opportunity to 'grow away' from damage after the second generation caterpillars stop feeding. It is worth noting, however, that two growers found damage to be minimal on their holding and one had decided that for the present no additional crop protection methods were warranted; choosing instead to allow for extra trimming/stripping back of the crop at harvest.

Over a third of growers had used traps for monitoring purposes. Three quarters of the growers questioned used crop covers to try and exclude the moth from their crop, and consequently found this a viable enough option to plan to continue doing this. Around one quarter of growers had sprayed their crops and had decided to continue to do so. One grower had decided not to grow leeks anymore, and another had decided that the solution to the problem lay in improving the quality of the leeks planted. This ties in with observations that bare-root leek transplants may be tougher than module grown leeks and therefore seem more likely to tolerate, and then continue growing, after attack. Another grower commented that they found hybrid leek varieties fared better, being more vigorous and likely to 'grow away' after attack.

Despite damage from this pest, all growers with harvestable leeks found that the quality of their crop was sufficient to avoid lowering the price/kg. Indeed lowering the price is particularly undesirable as growers are likely to encounter both extra crop protection costs and reduced yields.

Daylesford Market Garden

We first noticed leek moth in our autumn leeks in 2010, and again in 2011. The worst damage occurred during particularly hot, dry weather. Damage was bad enough that harvesting time was considerably extended, due to stripping back of damaged leaf. This resulted in a much diminished final product, and so we abandoned the autumn leeks altogether and then when possible started harvesting of our winter leeks early. With the few abandoned leeks we tried a strategy of mowing the leeks down to a couple of inches (using a flail to pulverise the tops) and allow the leeks time to grow back. They did so, but were small, and still required much stripping back (when we returned to them much later, in the spring of 2012) as the outer layers were soft and

slimy. In the much wetter autumn of 2012 our leeks were situated on a slightly heavier piece of land, containing more clay and silt. We were still finding enough leek moth damage to cause extra stripping back but were able to harvest our entire area of autumn leeks before moving onto our winter crop. The soil varies across the 20 acre market garden and where leeks are grown on the lighter, sandier areas the damage appears to be worse, with the autumn crop always suffering more. We presume the more freely draining soil contributes to the crop suffering water stress in dry weather. Our over wintering leeks seem to fare better, presumably for reasons already discussed (see Survey Analysis). We grow a mix of cultivars, including F1 hybrids, and our total area of leeks grown is approximately 1 acre, with 1/5 acre being autumn leeks and the rest over wintering. Irrigation is via sprinklers (using a borehole) and all of our leaf trimmings are dropped in the field and left until being ploughed in.

In 2011 we first noticed light damage to our garlic crop, but not enough to cause significant grading out when packing.

After planting our leeks are either covered with fleece or mesh to protect from rabbits grazing, but when large enough to be unappealing to rabbits the covers are removed, and moved onto other crops awaiting them. In drier growing seasons, when we may expect more leek moth damage, more of an effort is made to use any spare mesh to cover established leek crops.

With 2012 having been so wet, we found leek moth damage to be light enough to be quite tolerable. In a year when many other crops suffered with the weather, we found the time to persevere and strip back the damage on our autumn leeks.

Our head grower, Jez Taylor, has found that, at Daylesford, our best strategy is to attend closely to the irrigation of the crop, especially with the autumn leeks. However, this pest is still relatively new to us, damage varies year to year, and so we expect our strategy to evolve. Now I shall discuss the control strategies available to growers.

Control Strategies

Monitoring Traps

Pheromone traps may be placed within the crop to gauge the amount of leek moth activity. This is useful as the adult moths only fly at night, and so may otherwise remain unseen by the grower until it is too late (Allen *et al.* 2008). The traps contain a lure, pheromones, which attract adult moths into the trap. They become caught on a sticky base, allowing growers to make regular counts, usually every 2-3 days. The traps should be hung from posts at crop height, with 1 trap/ha in flat fields and 2 traps/ha in fields with uneven topography. It is recommended that traps are placed out from mid-April to late May, and again between early July and late August. The lure will need replacing every 5 weeks. The traps are designed for monitoring purposes, (not control) and allow the grower to decide what action to take. If spraying, an application is recommended between 10 and 14 days after peak moth activity is recorded (Agralan Ltd, 2013).

Spraying

When spraying for leek moth, the timing of application is vital to ensure that the larvae ingest the product. It is estimated that after hatching the larvae mine into the leaves of the plant within 24 hours, and then do not emerge until ready to pupate (Mason *et al.*, 2010). Therefore growers should monitor both the flight of the adult moths, using traps, and the average temperature (to indicate development time) in order to maximise the impact of the spray.

Bacillus thuringiensis

Spraying affected allium crops with an insecticide spray containing *Bacillus thuringiensis*, (Bt), is an option. Bt is a bacterial pathogen that is toxic to caterpillars (Buczacki, 2005). The feeding larvae ingest the bacteria which poisons them and stops them from feeding 'within as little as half an hour', and they 'die in 1-3 days' (Valent, 2013). There are several strains of Bt, each specific to different caterpillars, so the grower must obtain the correct strain from their supplier. The spray must touch the leaf surfaces upon which the larvae are actively feeding. As the caterpillars burrow into the plants this can make achieving contact difficult and therefore once infestations have developed 'the application of insecticides is usually of limited value (Alford, 2000). However; if spraying, several applications of Bt will probably be required, as transmission of the infection between treated larvae is reported to be limited, and Bt is degraded by sunlight. Spraying of Bt does not require a derogation from UK organic certifying bodies, and is already widely used in both organic and conventional brassica production growing to combat caterpillars (Davies, 2010).

Spinosad

Spinosad® is the product name of another spray, which contains spinosyns. These are fermentation products made by actinomycetes (soil bacteria). Spinosad® is non-specific, affecting a range of both pests (including the target caterpillars/larvae) and beneficial insects (such as ladybirds, lacewings and honeybees). After being ingested Spinosad® causes death through excitation of the insects' nervous system. Like Bt, Spinosad® degrades quickly in sunlight, but because of its broad range of activity, in organic systems it must only be used once derogation has been obtained from the growers certifying body; with a strategy in place to minimise harmful effects to beneficial insects (Davies, 2010).

Crop covers

Covering crops is an expensive option and creates extra labour; though as many growers may already be covering leeks for a time after planting, to either bring the crop on, or to protect from grazing rabbits etc., this appears to be a viable option. Taking the covers off during the daytime to weed the crop is not a problem, as the moths only fly at night, however, the covering must be securely pegged down the rest of the time (Allen et Al., 2008).

Fleece

Fleece is the cheapest covering that will exclude leek moth, and other pests, from the crop. Its warming effect will help to bring the crop on, so it is useful after planting out. However, fleece is less durable than mesh and susceptible to tearing when being handled (especially when wet), and being damaged by wildlife. Weeds also benefit under fleece, (being out of sight, out of mind) until uncovered by the grower, who by that time may have missed their chance to weed (Davies, 2010). Depending on the weight (thickness), and quantity ordered, fleece costs approximately between 18p and 25p/m² (Agralan, 2013).

Mesh

Mesh, or netting, allows through up to 90% of sunlight and rain, and allows 70% of natural air flow. To exclude leek moth the size of mesh must be 0.85 x 0.95mm or smaller (this size will also exclude allium leaf miner). Mesh is expensive, costing approximately 22-26p/m², or £1000/acre, although buying second hand may be an option (Chesher, 2010). Manufacturers recommend a lifespan up to 12 years (making the initial investment more bearable) and with care mesh may well last longer.

Water

Lack of water leads to stressed plants which may then be more susceptible to pest attack. Therefore it is important to try and supply enough water to try and keep the plants vigorous and, hopefully more resilient to pest attack (Davies, 2010). Where irrigation is available it may be an idea to water freely during the periods when the

larvae are actively feeding, in order to try and keep the plants growing 'away' from the damage. It may also be worth, if possible, planning rotations to avoid growing leeks on the lightest areas of the field. Good soil husbandry, such as composting and incorporation of green manures will help increase the humus content of the soil and so aid water retention for future crops.

Noticeably the very wet growing season of 2012 has led, in our experience in the Cotswolds, to reduced moth damage. We attribute this to the wetter weather, but perhaps also to the fact that the cooler temperatures may have slowed down the development of each generation of leek moth.

Choice of Cultivar

As yet there are no leek cultivars recommended for resistance to leek moth, and at Daylesford we haven't noticed a difference in damage between F1 hybrids and non-hybrid leeks. However, it has been suggested that F1 hybrid seed may 'grow away' more strongly after leek moth damage, due to its hybrid vigour; although the plants will usually need good growing conditions to display such vigour.

Propagation

Some growers who responded to the survey suggested that bare-root transplants appear more resistant to leek moth. This suggestion is interesting and warrants more investigation. Bare-root transplants will generally be tougher plants. As they are raised in a seed-bed, they will both have been raised in, and planted out, into the same soil type. This may help to them to establish quicker (after transplanting) than module grown plants. Module-grown plants will have been pampered in their propagation environment, as residing in such a small amount of growing media, they will have had to be carefully watered, and may have received additional feeding if the compost ran short of nutrition. This leads to softer, lush growth and plants which may be more susceptible to pest attack when planted out.

Crop Residue

Leek moths overwinter on crop residue; however, on a large scale the removal of crop residue from the field is often too costly and time consuming to be considered. If possible it is useful to incorporate the trimmings back into the soil after chopping up in some way to try and destroy the pest. This may be done by rotavating, or flailing the crop residue before cultivation of some kind. On a small scale where crop trimmings are put back into compost, care should be taken to turn the heap regularly to ensure the high temperatures required to kill off any pests and disease present. Severely infected material could be burnt, but as this action results in the loss of nutrients and organic matter from the growing system it would seem undesirable to do so.

Natural predators

Adult leek moths, pupae and the larvae are all on the menu for birds, bats, hedgehogs, frogs and beetles (Garden Organic, 2008). They will also eat other pests that trouble growers and so encouraging such wildlife, wherever possible, is a good idea.

Research

CABI (Centre for Agricultural Bioscience International) has a leek moth research program taking place in conjunction with Agriculture and Agri-Food Canada (AAFC). The work being done is to investigate the possible use of a biological control agent, *Diadromus pulchellus*, to control leek moth. Work started in 2004, is scheduled to finish in March 2016 and is taking place in Switzerland, where CABI is based and Canada, where leek moth has also become established (CABI, 2013). *D. pulchellus* is a parasitoid wasp; the females of which lay their eggs in the pupae of the leek moth. *D. pulchellus* appears to be quite specific to leek moth. Results so far have been encouraging; *D. pulchellus*, (reared in the laboratory) has been found capable of establishing (remaining and reproducing) in the field release plots. In 3 out of the 4 trial releases attack rates on leek moth pupae exceeded 50%, with average pupal mortality at 71.4%. In addition to this, where there were uneven densities of leek moth pupae, *D. pulchellus* was found to forage effectively for them (Jenner, 2010 I). The wasp overwinters as an adult and was found to survive cold temperatures of between -4°C and -12°C, with the females being slightly more hardy (Jenner *et al.* 2010 II) However, it must be noted that the results so far have concerned short term studies, and it is unclear how *D. pulchellus* will cope with multiple generations of leek moth over several years, and what the effect of mating will be between the lab reared *D. pulchellus* and those that occur naturally (Jenner *et al.*, 2010 I).

The scientists involved in this work have been encouraged by the successes of the project thus far but stress that it is still too early to know what the real impact will be upon the pest populations. Commercialising the biological control agent has been lightly discussed but is reported unlikely until the efficacy of *D. pulchellus* has been sufficiently proved to make mass production worthwhile (Jenner, 2013).

An IPM (Integrated Pest Management) strategy has been suggested by Mason *et al.* for leek moth:

1. Use of pheromone traps (to detect presence and flight of adult moths).
2. Monitoring of average daily air temperature (to predict the development time.)
3. Use of physical barriers (crop covers) to prevent egg laying.
4. Use of suitable insecticide, such as Bt or Spinosad®, applied at point suggested by points 1 & 2.

And possibly;

5. The introduction of *D. pulchellus*.

(Mason *et al.*, 2010).

Conclusion

As previously stated, damage from this pest appears worse in dry, hot years, so we would expect the amount of damage to vary with the weather, year on year. If there is a general trend to warmer summers, we may well see the advancement of this pest northwards and see the number of generations increasing, as we know there are more generations in southern Europe. The best approach to dealing with this pest appears to be a combination of strategies.

Most effective for the small grower seems to be the use of crop covers and irrigation. With allium leaf miner also spreading across the south and into the midlands, if growers want to continue growing alliums, investing in mesh small enough to exclude both the moth and the leaf miner would seem to be a good idea. I would also suggest reducing the number of autumn leeks grown, and relying slightly more on winter leeks.

Spraying for leek moth involves careful monitoring in order to time the spray application for maximum impact, but some may prefer to try this, as Bt is already in the organic growers arsenal, being used for cabbage white caterpillars. The basics of good growing; a sound rotation and the provision of habitats for beneficial wildlife are also essential. It may be some years before any biological control is available, and so, in the mean time, leek moth is here to stay.

Acknowledgements

Thanks to Jez Taylor of Daylesford Organic Farms, Wade Jenner of CABI, Pershore College for the use of their library and all the growers who answered the survey.

Appendix I.

*

1. Please give your postcode. Please also add your email if you wouldn't mind being contacted on this subject.

**ZIP/Postal
Code:**

**Email
Address:**

2. Which alliums are affected on your holding?

- Which alliums are affected on your holding? Leeks
- Onions
- Shallots
- Garlic
- Chives

3. If leek moth has been present for several growing seasons; year on year, is damage...

- If leek moth has been present for several growing seasons; year on year, is damage... Increasing
- Decreasing
- Variable
- Don't know/NA

Comments. Is damage worse in certain conditions?

4. Questions specific to leeks.

Have you used any of the following methods for crop protection?

- Questions specific to leeks. Have you used any of the following methods for crop protection? Monitoring traps
- Covering with fleece/mesh
- Spraying (for example with bT)
- Cutting back damage and allowing leeks to regrow

Other (please specify)

5. If growing leeks this year, which control method/s will you be using?

If growing leeks this year, which control method/s will you be using?

6. What area of leeks did you plant in 2011 and can you estimate the percentage crop loss (too badly damaged to harvest)?

What area of leeks did you plant in 2011 and can you estimate the percentage crop loss (too badly damaged to harvest)?

7. With the crop (planted 2011) did leek moth damage (instead market forces) force you to lower your price/kg for leeks?

With the crop (planted 2011) did leek moth damage (instead market forces) force you to lower your price/kg for leeks? Yes

No

Please give your price high and low for leeks from last season.

OPTIONAL.

8. Are there any varieties that you feel cope better with/grow away better from, damage?

Are there any varieties that you feel cope better with/grow away better from, damage?

9. How do you deal with crop debris? I.e leave in field and flail/remove and compost

How do you deal with crop debris? I.e leave in field and flail/remove and compost

10. Please add any comments you may have regarding leek moth and its management.

Please add any comments you may have regarding leek moth and its management.

Done

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