

Report Prepared for the
Horticultural Development Council

FV 324
Field Vegetables:
cutworm development & survival:
risk assessment and early
warning programme for growers,
2007.

Final Report

By

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ADAS
September 2007

Authentication

I declare that this work was done under my supervision according to the procedures described herein and that the report represents a true and accurate record of the results obtained.

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Authorisation

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Field Vegetables: Cutworm development and survival: a risk assessment and early warning system for growers

Project Number: FV 324

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Report: Final Report, September 2007

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Grower Summary

Headline

Cutworm development was monitored for 9 weeks in 2007. Assessments of the risk of damage were made on a weekly basis from May 31st with a view to the issuing of spray warnings if appropriate. Weekly reports were published on the HDC Pest Bulletin website managed by Warwick HRI.

Background

Cutworms are the caterpillars of certain moths, especially turnip moth. The mature caterpillars feed underground and are safe from insecticides, but the young larvae feed on the foliage of host crops where they are vulnerable to heavy rainfall as well as pesticides. By computing the rate of development of cutworms and integrating this with rainfall records it is possible to predict where and when the threat of cutworm damage has become sufficient to justify a pesticide treatment. In some years there is sufficient rain to keep the risk of cutworm damage at low levels without any treatment.

Results and Conclusions

Nine cutworm reports were prepared between 31st May and 27th July 2007. These were made available to HDC members on the HDC Pest Bulletin website managed by Warwick HRI. See appendix for copies.

The British summer of 2006 was relatively dry, which in theory permitted greater survival of cutworm caterpillars, thereby allowing the population of turnip moths to increase. This in turn would lead to a potential for greater cutworm damage in 2007.

As it happened, catches of adult moths in pheromone traps in 2007 were both early (about 2 weeks in advance of the usual timing) and relatively numerous, which reinforced the potential for cutworm damage. However, the subsequent weather in both June and July was exceptionally wet, with heavy rain on more than one occasion in all areas, which reduced the risk of damage to very low levels. As a result, no spray warnings needed to be issued in 2007 and it should not have been necessary to apply treatments for this pest, even on the most susceptible crops, during this year.

Action Points for Growers

- During the 'cutworm season', between June and August, the cutworm forecasts should be consulted on a regular basis.
- Crops should only be treated against cutworm when the predicted risk of damage reaches the trigger level. In most years this will save the expense and potential environmental effects of routinely-applied treatments.

Expected Practical and Financial Benefits

- Minimisation of unnecessary treatment against cutworms saves both costs and possible environmental effects

Science Section

Background

- Cutworms are the larvae (caterpillars) of certain moths of the genus *Agrotis*, particularly *Agrotis segetum*, the turnip moth.
- Later-instar caterpillars feed underground and can cause severe economic damage to a wide range of crops by either severing them or excavating holes in roots.
- Susceptible crops include lettuce, leek, red beet, onion, carrot, leaf and flowerhead brassicas, swede, turnip, sugar beet, potato, strawberry and some ornamentals.
- Cutworm development rate and survival are influenced by temperature and rainfall respectively. The potential for damage is much greater in warm, dry summers than it is in cool, wet ones as the survival of young cutworms is significantly reduced by rainfall.
- Early instar cutworms (which feed above ground) can be controlled by the use of pesticides or irrigation if there is a significant risk of damage. The timing of treatment is critical and must be made between egg-hatch and the time when cutworms enter the soil half way through their development.
- The established ADAS cutworm forecasting system has been in operation for many years and uses meteorological and cutworm development data to predict the risk of cutworm damage in British crops.
- Using a forecasting system enables growers to treat crops when the risk of damage is high and to leave them unsprayed when the risk is low. This saves unnecessary use of pesticides and allows growers to comply with crop production protocols.

Summary

Individual weekly reports made in 2007 can be summarised as follows:

- 31st May. Potential for serious problems after dry weather in 2006 highlighted. Turnip moths caught from the end of April with a marked increase towards the end of May. May 25th was designated as the day that first significant egg-laying would have happened. Development was slow in cool conditions.
- 7th June. Turnip moths now caught in all areas. First hatch was predicted to occur in the week beginning 11th June.
- 14th June. First hatch probably occurred slightly earlier than originally predicted, on June 8th, following a rise in temperature. However, at the time of writing heavy rain was falling in many areas which is likely to have caused high mortality of the very young caterpillars that were hatching.
- 21st June. Cutworms were theoretically reaching the third instar (the invulnerable stage) in all areas. However, there had been widespread

heavy rain since the previous report which would have caused high mortality amongst the earlier-instar caterpillars. No treatment was likely to be necessary for at least a week, probably more in many areas.

- 28th June. Widespread further rainfall set back the need for any treatment for at least two weeks.
- 5th July. Further heavy rain had occurred since the previous report and more was predicted. No action likely to be necessary for at least 2 weeks.
- 12th July. Warm, drier weather encouraging cutworm development from eggs laid at about the peak of the moth population. Treatment may be necessary in 10 days if there is no further rain.
- 23rd July. Further heavy rain in all areas except east Suffolk and east Essex. As a result, the risk of cutworm damage to crops in most areas in 2007 could be considered to be negligible. Eastern parts of Suffolk and Essex were an exception and growers of susceptible crops in these areas were warned that it might be necessary to spray on about 27th July if no rain fell in the meantime.
- 27th July. Heavy rain fell on the potentially at-risk area of east Suffolk and east Essex on 23rd July, removing any need to spray crops in these areas. No crops in any part of Britain were considered to be at any further risk of cutworm damage in 2007.

Note that the Appendix comprises copies of all weekly reports.

APPENDIX – Copies of weekly cutworm reports 2007.

Horticultural Development Council **Cutworm Monitoring & Prediction, 2007.**

Prepared by Mike Lole
ADAS Wolverhampton

Report No 1, 31st May 2007

Background

Cutworm

“Cutworm” is the name given to caterpillars of certain Noctuid moths, in particular those of the turnip moth *Agrotis segetum*. The name derives from the habit of the older caterpillars of feeding underground, damaging plant roots and stems (including the storage organs that we use for food), sometimes so badly that the plant topples.

The adult moths lay eggs on plants or on pieces of litter and debris in the soil, usually from the end of May or early June. These hatch in around 8-24 days, depending on temperature. The young caterpillars seek out and feed on the aerial parts of plants. In a further 10-20 days, again depending on temperature, the caterpillars go through their second moult, becoming “third instar” caterpillars. It is at this point that they adopt the cutworm habit, becoming subterranean and feeding on roots etc.

Unhatched turnip moth eggs and the older, subterranean cutworms are largely invulnerable to the effects of the weather and insecticides. The two early caterpillar instars differ, however. If there is substantial rainfall (defined as 10mm or more of rain falling in showers of moderate intensity over a 24-hour period) whilst these caterpillars are feeding above ground then this causes high mortality among them. They are also vulnerable to insecticides whilst feeding on the foliage.

Crop Susceptibility

Crops differ in their susceptibility to cutworm damage. The most vulnerable are lettuce, leek and red beet. Young lettuce and leek plants are easily bitten through by cutworms, and though beet plants may survive an attack the bulbous root is rendered unmarketable by cutworm feeding. Moderately-susceptible crops include brassicas, carrot, celery, parsnip and sugar beet. The least susceptible of those vulnerable to damage are onion, potato, swede and turnip.

The Cutworm Model

The cutworm model is a computer programme that uses weather data to predict the rate of development of turnip moth eggs and caterpillars. It also predicts the level of rain-induced mortality among the early-instar caterpillars. The weather data used covers 600 sites in the whole of Great Britain, so that local differences in temperature and rainfall can be reflected in the forecasts of development that are used in the model.

Rate of development and the level of rain-induced mortality must both be known if a rational choice is to be made about the need for insecticide treatment of vulnerable crops. The cutworm model is therefore an important tool for the grower.

Moth Activity

The activity of adult moths is monitored by ADAS, Warwick HRI and Consultants in order to provide information on when oviposition may be taking place. In 2007, traps are being run in Kent, Lincs, Cambs, Norfolk, Cheshire, Yorks, Worcs and Warwicks.

The risk in 2007

The risk of damage from cutworms does not depend entirely on their rate of survival. The size of the population also has a considerable influence – clearly, 100% survival of a small population is not as potentially damaging as 50% survival of a very large population. Estimating the size of the population is very difficult to do, as the catches of moths in the pheromone traps do not necessarily reflect the size of the population.

However, 2006 was fairly dry during the ‘cutworm season’ and it seems likely that, as a result, the residual, overwintered population of turnip moths will be higher in 2007 than it was in 2006. Given another dry summer, the risk of cutworm damage in 2007 is likely to be higher than it has been in recent years.

Current Situation

To date turnip moths have been caught at the majority of sites. Warwick HRI at Wellesbourne have been catching them since the end of April, which is exceptionally early, but at this and the other sites numbers have gone up markedly from about 22nd – 29th of May. We will take the 25th of May as the starting date for significant egg-laying in 2007, which is about 2 weeks earlier than in a ‘typical’ year.

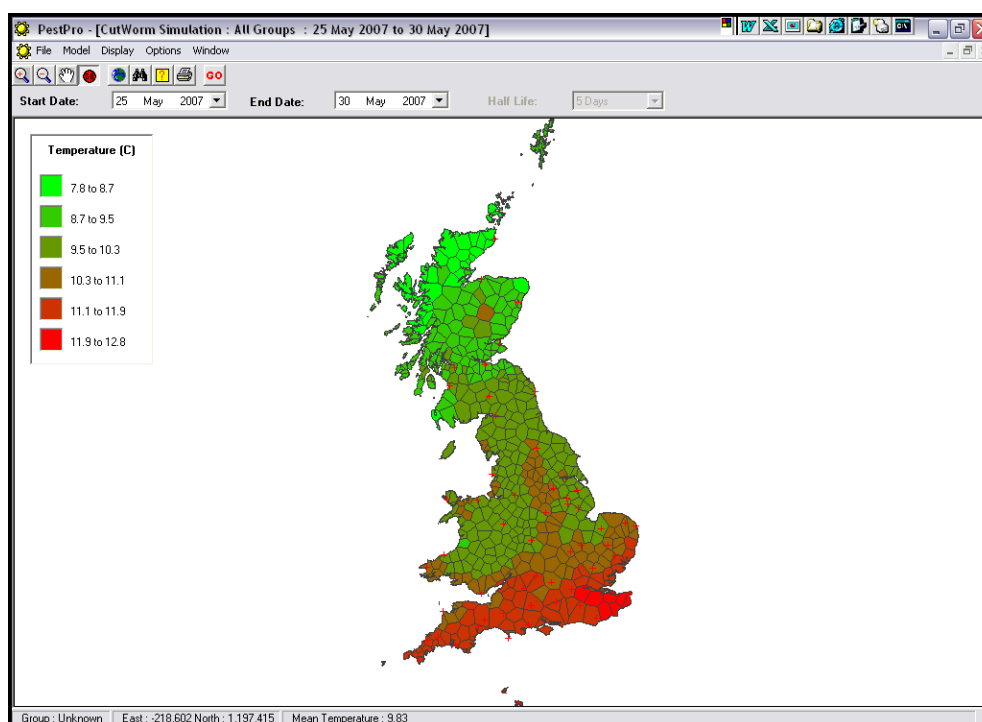
Egg development at current temperatures is very slow, running at a maximum of 4-5% per day. Eggs laid on 25th May have just reached 30% development in the warmest area, the far south-east of England (see map).

Temperature and rainfall after hatching are important as these dictate both the speed of development of the larvae and the mortality of the young instars.

Action

- No action will be necessary for at least three weeks. We will however produce weekly updates on the cutworm situation from now until August 2007.

Mean daily temperatures, 25th – 30th May 2007



Horticultural Development Council Cutworm Monitoring & Prediction, 2007.

Prepared by Mike Lole
ADAS Wolverhampton

Report No 2, 7th June 2007

Background

An introduction to cutworms, their damage and the cutworm monitoring and prediction service was provided to coincide with the first report of this series. The introduction is available on this HDC Pest Bulletin website.

Current Situation

Catches of turnip moths in pheromone traps have been widespread and largely simultaneous this year, from Kent to the Vale of York. Only one monitoring site has failed to pick up moths to date, but this is more likely to be a quirk of the site rather than an indication that moth activity in this region (Lincs) has yet to begin.

Trap catches went up markedly all round the country from about 22nd – 29th of May, and it has been decided to take the 25th of May as the starting date for significant egg-laying throughout England and Wales in 2007. This is about 2 weeks earlier than in a 'typical' year.

Egg development in the first week after significant egg-laying began was very slow in the single-figure temperatures that tended to predominate at that time, running at a maximum of 4-5% development per day. In the last week temperatures have risen considerably so that further development has been occurring at 6-9% per day. As a result, eggs laid on 25th May have reached 90% development in the warmest area, which is a triangle with Hampshire, Herts and E. Sussex at the three corners (see map). In much of the rest of England & Wales development has reached 70-80%, and even in the coolest area, the East Coast from Lincs northwards, egg development has reached 60%.

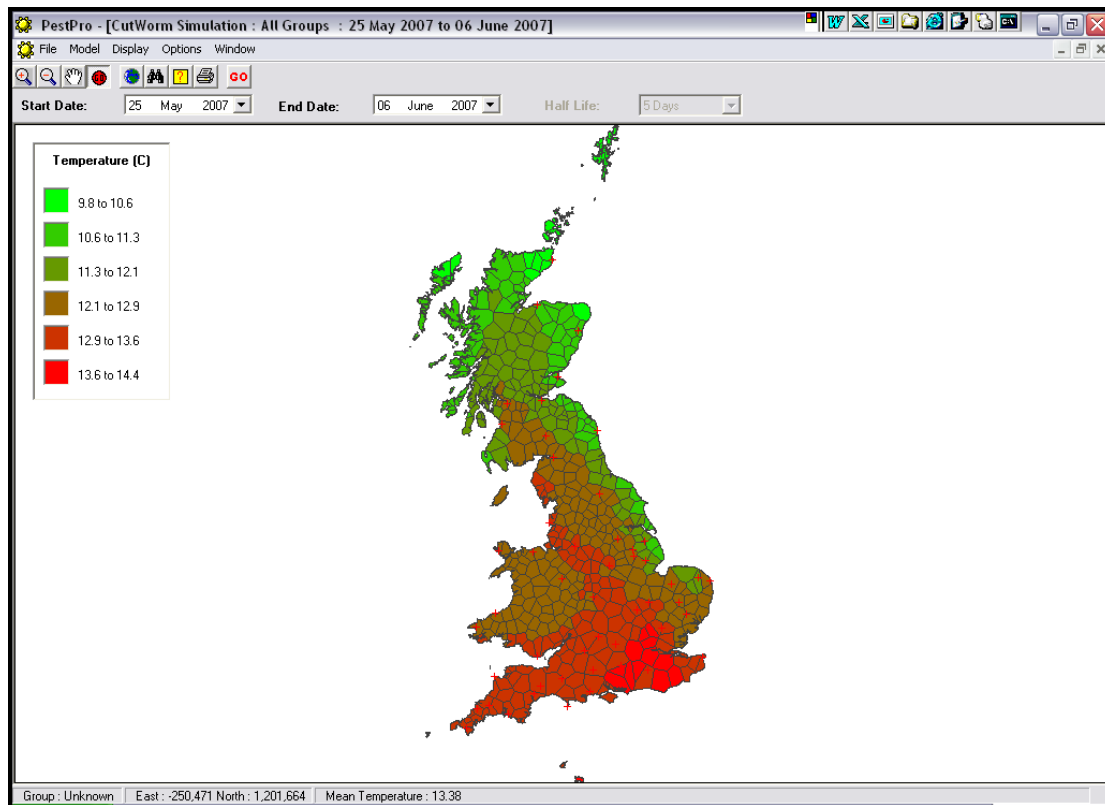
If temperatures remain at current levels then egg hatch will begin in the most advanced areas by the weekend (9-10 June), and will occur elsewhere during the following week.

Once hatch occurs, rainfall levels become important as this can have major effects on the survival of the young caterpillars (cutworms). Rainfall events of 10mm or more are usually significant. Rain is predicted for eastern England at the weekend but this is too early to have any effect on cutworm survival.

Action

- It will not be necessary for growers to implement any control measures against cutworms for at least two weeks.
- The only action advised at present is to continue to access these regular, weekly reports. Updates will normally be available on the HDC Pest Bulletin website each Friday until August 2007.

Mean daily temperatures, 25th May – 6th June 2007



Horticultural Development Council Cutworm Monitoring & Prediction, 2007.

Prepared by Mike Lole
ADAS Wolverhampton

Report No 3, 14th June 2007

Background

An introduction to cutworms, their damage and the cutworm monitoring and prediction service was provided to coincide with the first report of this series. The introduction is available on this HDC Pest Bulletin website.

Current Situation

The 25th of May has been taken as the starting date for significant egg-laying throughout England and Wales in 2007, based on pheromone trap catches from around the country. This is about 2 weeks earlier than in a 'typical' year.

Egg development was very slow in the single-figure temperatures that tended to predominate immediately after oviposition, but in the last week temperatures rose considerably, speeding development. As a result, eggs laid on 25th May began to hatch on June 8th in the warmest areas, on the 10th in 'average' areas and on the 13th in the cooler areas of the East Coast from the Wash northwards (Map 1).

The caterpillars that hatched have been developing towards the third instar at a steady rate, this taking from 11-14 days depending on temperature. The most forward caterpillars (those in the warmest areas – see Map 1) have completed about 70% of this development, so none have yet reached the invulnerable underground-feeding stage.

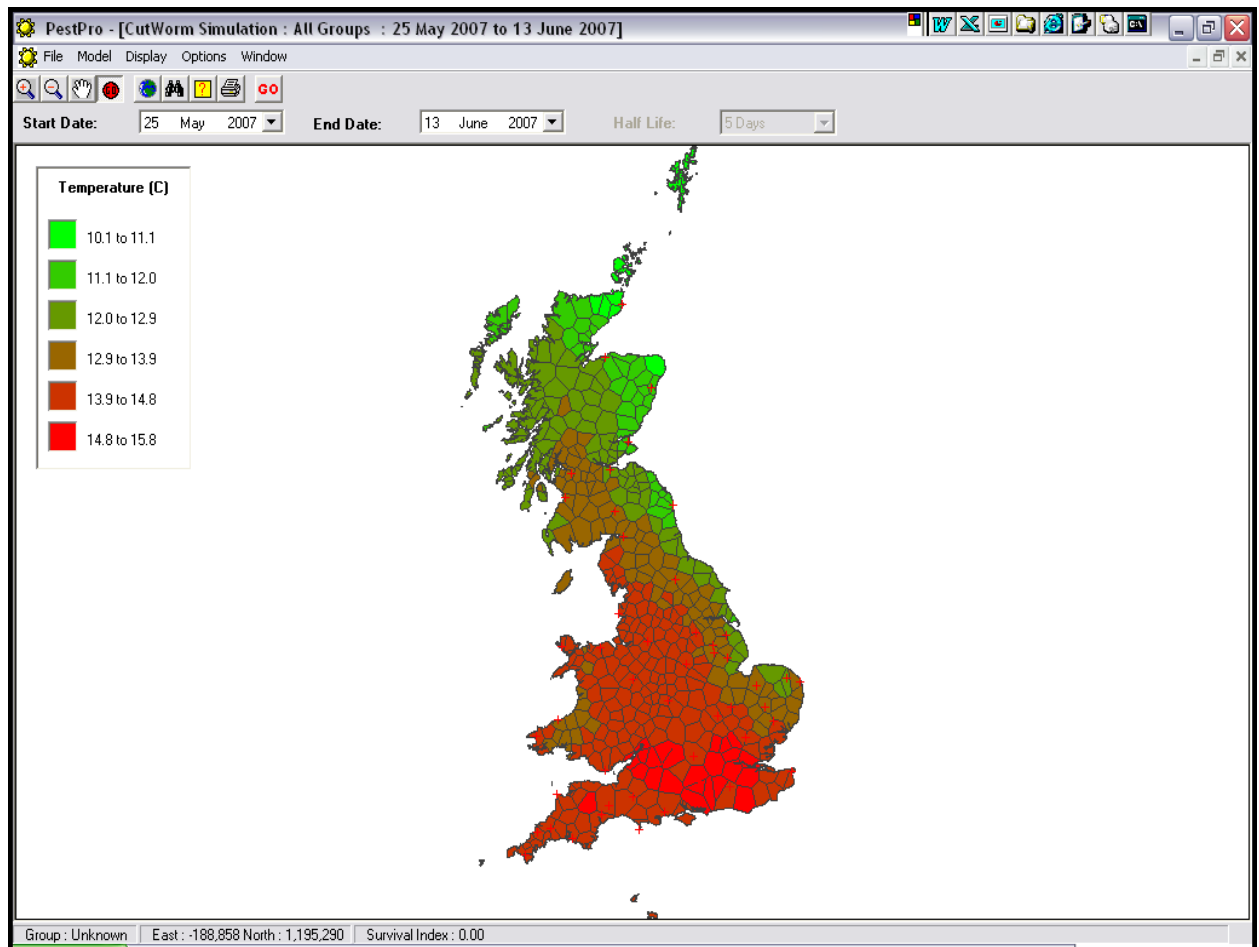
The young caterpillars (cutworms) are very vulnerable to rainfall, which has major effects on their survival. Rainfall events of 10mm or more are usually significant. As this is being written, heavy rain is being experienced all over England and Wales, with more to come. All areas are likely to have had at least 10mm since 12th June, though as it is still raining figures are not yet available. In these conditions the caterpillars will not survive in any significant numbers.

Any eggs that hatch or have hatched before the end of the current wet period will not make the cutworm stage, so we can turn our attention to those that hatch immediately after the current rain events are over. Assuming that the rain ceases on the 14th, eggs that hatch on Friday 15th are the earliest that might become cutworms. These will not reach the cutworm stage for at least 10 days.

Action

- As a result of the current rainfall it will not be necessary for growers to implement any control measures against cutworms for at least ten days.
- The next report will provide an update several days before any possible action will be required. It is therefore recommended to continue to consult these regular, weekly reports. Updates will normally be available on the HDC Pest Bulletin website each Friday until August 2007.

Map 1. Mean daily temperatures, 25th May – 14th June 2007



Horticultural Development Council Cutworm Monitoring & Prediction, 2007.

Prepared by Mike Lole
ADAS Wolverhampton

Report No 4, 21st June 2007

Background

An introduction to cutworms, their damage and the cutworm monitoring and prediction service was provided to coincide with the first report of this series. This introduction is available elsewhere on this HDC Pest Bulletin website.

Current Situation

The 25th of May was taken as the starting date for significant turnip moth egg-laying throughout England and Wales in 2007, based on pheromone trap catches from around the country. Eggs laid by the early moths began to hatch on June 8th in the warmest areas, on the 10th in 'average' areas and on the 13th in the cooler areas of the East Coast from the Wash northwards.

The cutworms that hatched at the end of the incubation period were due to have developed to the third instar in 11-14 days, according to the temperature forecast, but cooler weather than predicted has resulted in development taking at least 13 days, longer still in cooler areas (Map 1). The most forward cutworms began to reach the invulnerable underground-feeding stage on 20th June.

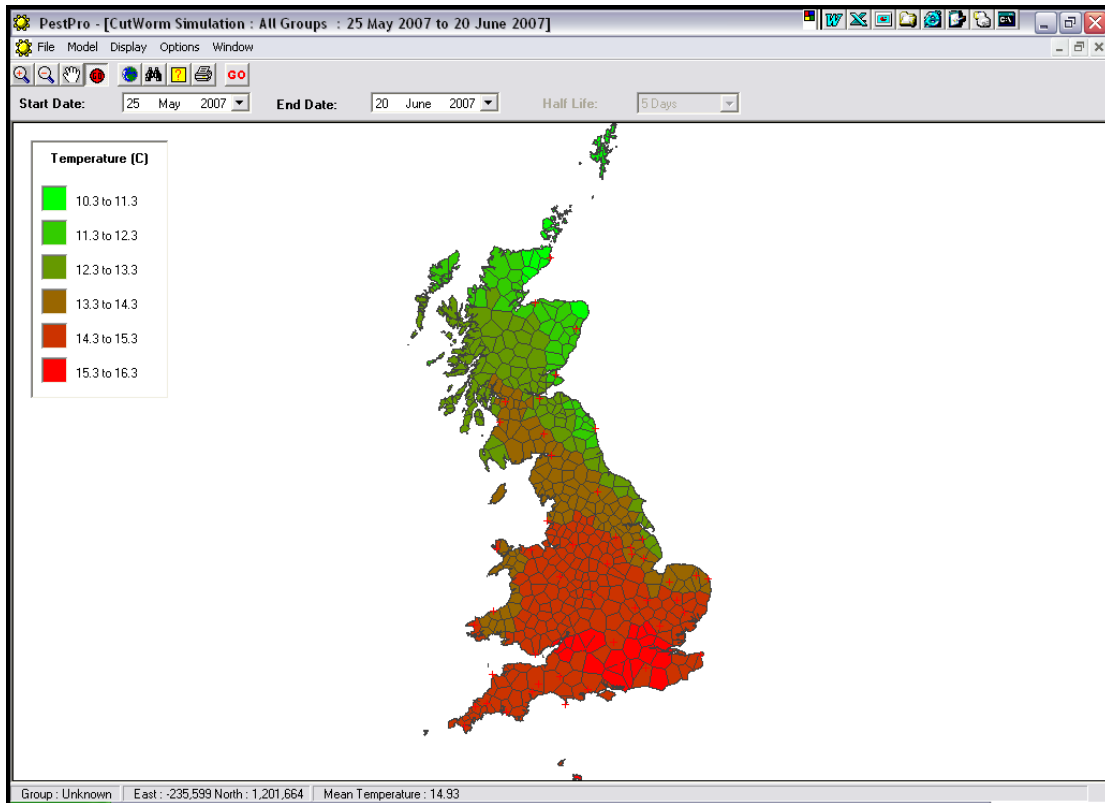
Rainfall events of 10mm or more have major effects on the survival of young cutworms. Heavy rain has been experienced all over England and Wales in the last week, with more to come. All areas have had more than 10mm since 12th June, often much more, with only parts of the south coast from Devon to Sussex and some areas inland of this escaping rain events of 10mm or more (Map 2). In these conditions the caterpillars will not have survived in any significant numbers.

Young cutworms that hatched after the rainstorms will now be developing towards the third instar, but this will take at least 10 more days. Some may have survived in the drier areas of the south, but even here survival will have been adversely affected and damaging populations of third-instar cutworms will not have developed before the next report is due. The weather continues to be unsettled and may further influence events this week.

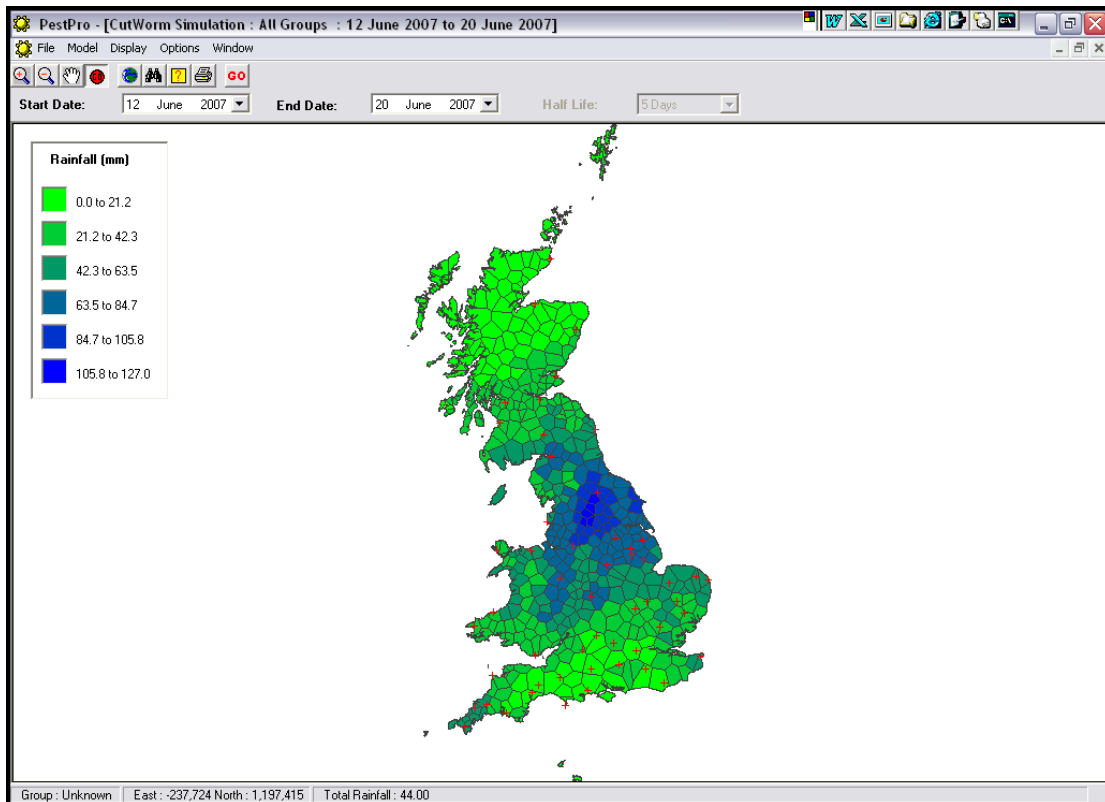
Action

- As a result of the recent rainfall it will not be necessary for the majority of growers to implement any control measures against cutworms for at least fifteen days.
- Highly susceptible crops in the drier areas of the south coast and neighbouring inland areas (Map 2) will be the first to become at risk from cutworm attack unless there is further rain. Treatment in these areas will not however be required for at least a week.
- A rainfall event of at least 10mm will further postpone the need for any action.
- The next report will provide an update before any possible action will be required, even for those growers in the drier areas. Updates of this report will normally be available on the HDC Pest Bulletin website each Friday until August 2007.

Map 1. Mean daily temperatures, 25th May – 20th June 2007



Map 2. Total rainfall, 12th – 20th June 2007



Horticultural Development Council Cutworm Monitoring & Prediction, 2007.

Prepared by Mike Lole
ADAS Wolverhampton

Report No 5, 28th June 2007

Background

An introduction to cutworms, their damage and the cutworm monitoring and prediction service was provided to coincide with the first report of this series. This introduction is available elsewhere on this HDC Pest Bulletin website.

Current Situation

Cutworms have been hatching since about June 8th in the earliest areas and a few days later than this in the cooler areas (e.g. the East Coast of Lincs northwards). Development through the first two instars has been taking about 14 days in the cool weather that we have experienced. These early instars are very vulnerable to rainfall, rainfall events of 10mm or more having major effects on survival.

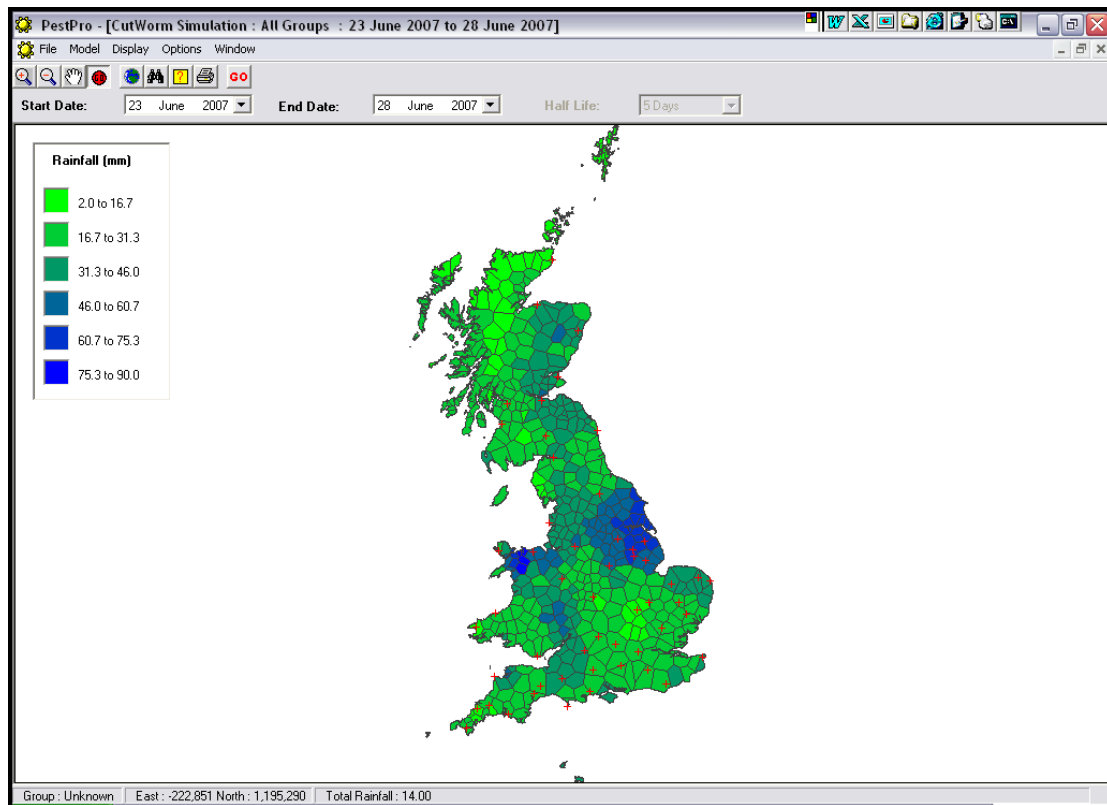
It now looks like we are experiencing the wettest June on record, with bouts of heavy rain sweeping across most of the country at intervals. Exceptionally heavy rain has been experienced in western and northern England and all over Wales in the last week (see Map 1). Even in the driest areas (parts of Cambs, Northants, Bucks and Herts) there seems to have been enough rain to cause high levels of mortality. The rain came early enough in all areas to affect the early-hatched caterpillars and the subsequent bouts of rain have severely affected the survival of subsequent batches. More heavy rain is now forecast to cross the country between Saturday 30th June and the following Monday.

Moth numbers in traps have now begun to decline but eggs laid previously are still to hatch. Any that do so before the next weather system hits the country are likely to be hit hard when it arrives. Those that hatch after this weekend's rain will take at least 10 more days to reach the invulnerable third instar stage.

Action

- As a result of the recent rainfall it will not be necessary to implement any control measures against cutworms for at least fifteen days.
- Further rainfall events of at least 10mm will again postpone the need for any action.
- The next report will provide an update before any possible action will be required. Updates of this report will normally be available on the HDC Pest Bulletin website each Friday until August 2007.

Map 1. Total rainfall, 23rd June – 28th June 2007



Horticultural Development Council Cutworm Monitoring & Prediction, 2007.

Prepared by Mike Lole
ADAS Wolverhampton

Report No 6, 5th July 2007

Background

An introduction to cutworms, their damage and the cutworm monitoring and prediction service was provided to coincide with the first report of this series. This introduction is available elsewhere on this HDC Pest Bulletin website.

Current Situation

As previously reported, cutworms have been hatching since about June 8th in the earliest areas and a few days later than this where it was cooler. Development through the first two instars has been taking about 14 days in the temperatures that we have been experiencing (surprisingly, slightly above average for June). Early instars are very vulnerable to rainfall, rainfall events of 10mm or more having major effects on survival.

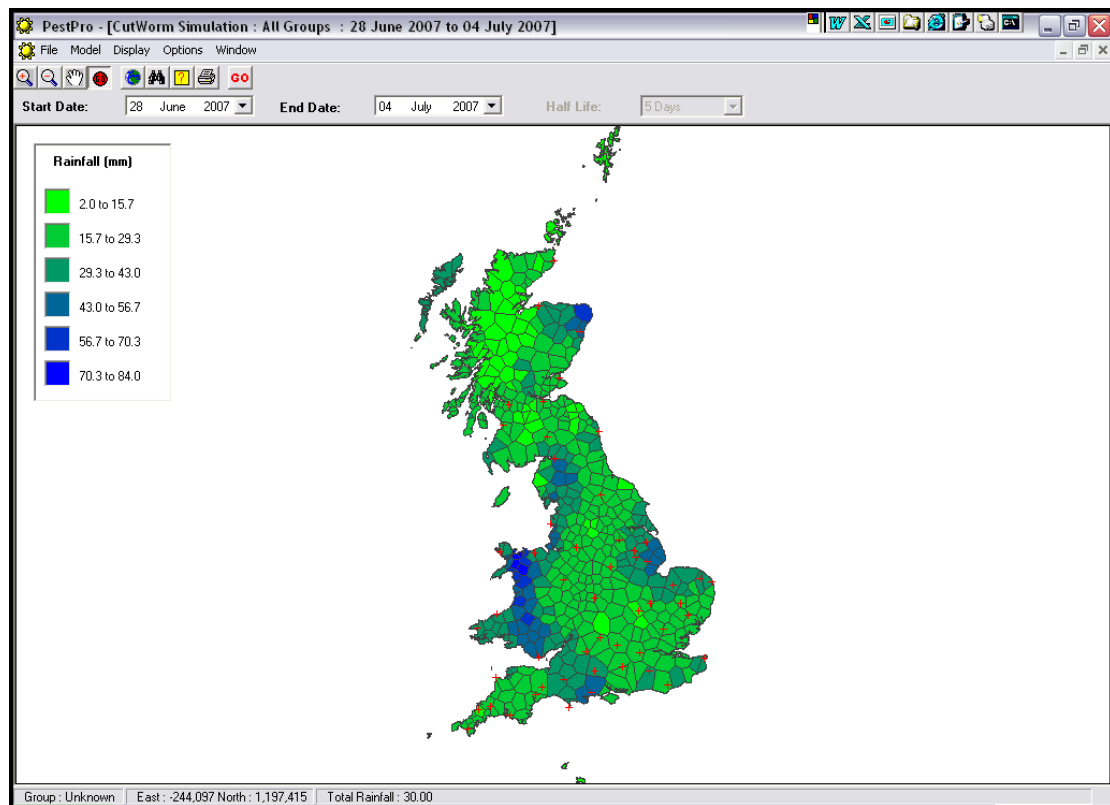
June 2007 has been the wettest June on record in England, and July has started in a very similar vein. Just about the whole country has had bouts of heavy rain since the last report was written a week ago and in such conditions cutworm survival will have been minimal.

Moth numbers in traps are declining but eggs laid since about the 19th June have still to hatch. Development to third instar is taking about 17 days, so it is still possible, though increasingly unlikely, that spray treatment could be required in two week's time if the weather in the meantime is warm and dry. The forecast however is for more unsettled weather.

Action

- As a result of the recent rainfall it will not be necessary to implement any control measures against cutworms for at least fifteen days.
- Further rainfall events of at least 10mm will again postpone the need for any action.
- The next report will provide an update before any possible action will be required. Updates of this report will normally be available on the HDC Pest Bulletin website each Friday until August 2007.

Map 1. Total rainfall, 28th June – 4th July 2007



Horticultural Development Council Cutworm Monitoring & Prediction, 2007.

Prepared by Mike Lole
ADAS Wolverhampton

Report No 7, 12th July 2007

Background

An introduction to cutworms, their damage and the cutworm monitoring and prediction service is available on this HDC Pest Bulletin website.

Current Situation

At this stage of the season most turnip moth eggs will have already been laid (moth numbers in traps have been declining for the last three weeks). The earlier egg-batches will have hatched long ago and the larvae that emerged will not have survived the record rainfall of late June. There was further significant rainfall in early July, which will also have caused high levels of mortality. We are therefore now only concerned with eggs that might have hatched since about July 3rd or 4th – these will have been laid on about the 19th, 20th or 21st June, when moth activity was at its peak, and so could be present in significant numbers.

Eggs hatching on 3rd or 4th July have by now completed 50-70% of their development to the third instar and will begin to reach the invulnerable underground-feeding stage by about 19th July. The level of rainfall in the next few days is therefore important, particularly in those parts that have had relatively little rain since the 4th July (Map 1). If there is significant rain (defined as 10mm or more in a 24-hour period) before July 19th then that will result in there being no further risk of cutworm damage this season. If there is no rainfall by that time then there could be a chance that a spray warning may need to be issued for the week beginning July 23rd.

The forecast is for unsettled weather for the next few days.

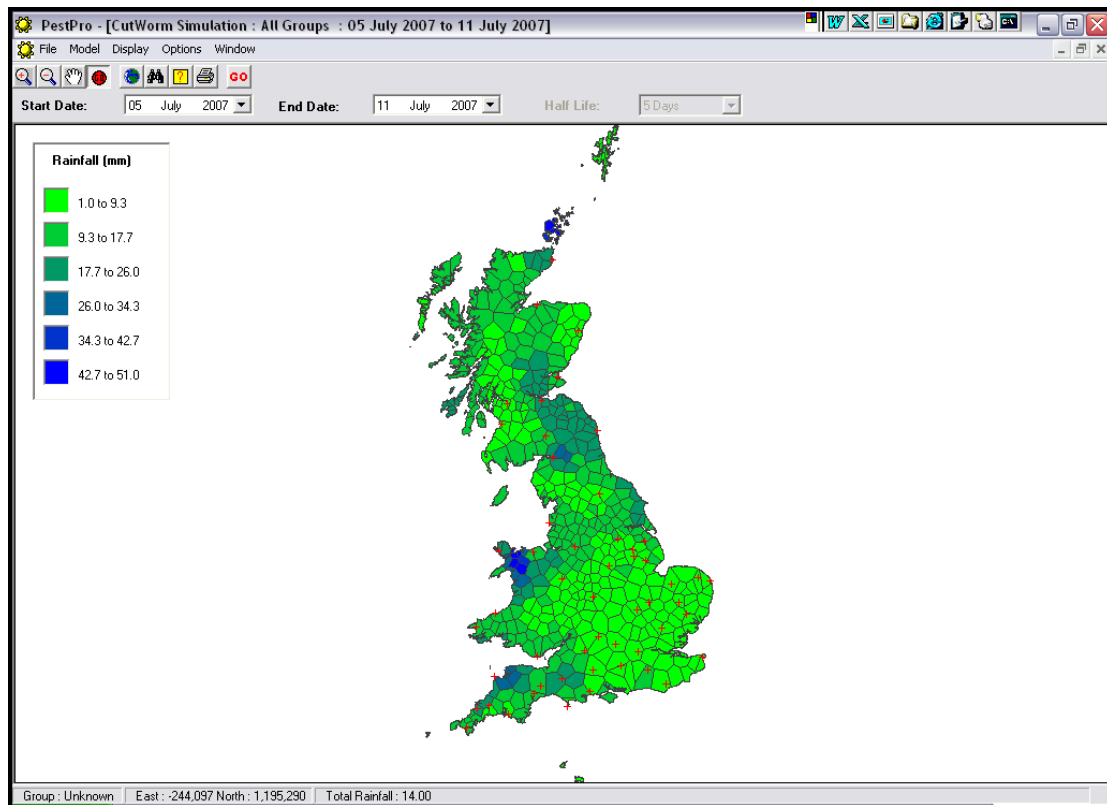
Action

- No action will be necessary for at least 10 days.
- If there is no further rainfall it may be necessary to spray the most vulnerable crops in some areas during the week beginning 23rd July
- A further rainfall event of at least 10mm before 23rd July will result in no action being necessary this season.
- Ensure that you consult the next report.

Timing of next report

The next report will be critical. IN VIEW OF THE TIMING OF EVENTS, THIS WILL BE PRODUCED ON MONDAY JULY 23RD.

Map 1. Total rainfall, 5th – 11th July 2007



Horticultural Development Council Cutworm Monitoring & Prediction, 2007.

Prepared by Mike Lole
ADAS Wolverhampton

Report No 8, 23rd July 2007

Background

An introduction to cutworms, their damage and the cutworm monitoring and prediction service is available on this HDC Pest Bulletin website.

Current Situation

Turnip moth numbers in traps have been declining since mid-June and therefore there has been no further significant egg-laying since mid-late June.

Heavy rainfall (events of 10mm or more) has occurred in most areas during the week ending 23rd July. This will have caused high levels of mortality where it fell and in the great majority of areas there is therefore no further risk of significant cutworm damage this season.

EXCEPTION

Parts of east Suffolk and east Essex (see map 1) have not seen rainfall events of any magnitude since about 4/5th July. In these areas it is possible that there may have been some survival of young cutworms from eggs laid on about the 24th June and these could now be entering the underground-feeding stage. By 27th July, treatment of the most vulnerable crops (lettuce, leeks, red beet) in those areas of east Suffolk and east Essex that have not had a 10mm rain event since 6th July may be justifiable, if the following conditions are met:

- The crops have not been sprayed with an insecticide that will kill caterpillars since 7th July
- The crops have not received 20mm of irrigation or more since 7th July
- There is no rain event of 10mm or more by 27th July

N.B. It should be noted that by 24th June, egg-laying by turnip moths was probably well past its peak, which diminishes the risk of significant damage occurring.

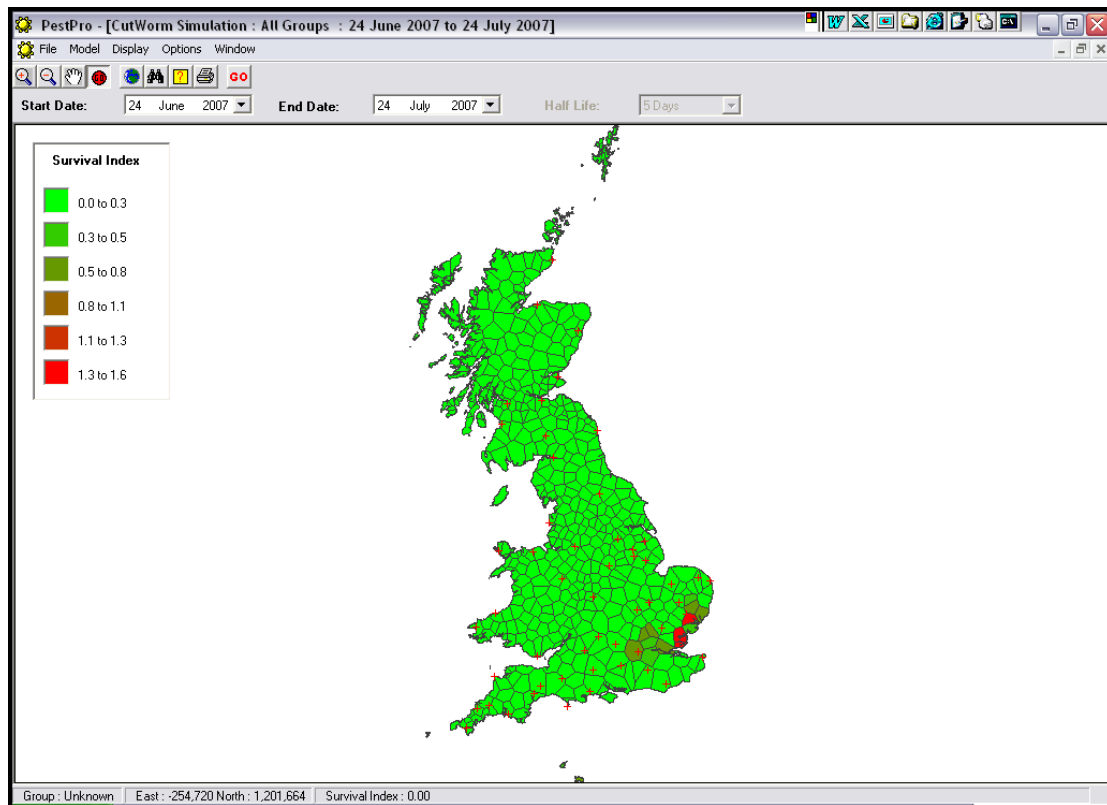
Action

- In almost all areas no action will be, or will have been, necessary against cutworms this season.
- Growers of lettuce, leeks or red beet in east Suffolk and east Essex should consider the need for treatment by 27th July

Timing of next report

A further report will be produced on Friday 27th July.

Map 1. Cutworm survival, 24th July 2007



Horticultural Development Council Cutworm Monitoring & Prediction, 2007.

Prepared by Mike Lole
ADAS Wolverhampton

Final Report, No 9, 27th July 2007

Background

An introduction to cutworms, their damage and the cutworm monitoring and prediction service is available on this HDC Pest Bulletin website.

Current Situation

The last report (23rd July) pointed out that for most areas there was no further risk of significant cutworm damage this season. There was an exception. Parts of east Suffolk and east Essex had not seen rainfall events of any magnitude since about 4/5th July, and in these areas it was possible that there may have been some survival of young cutworms from eggs laid on about the 24th June, with the potential to need treatment.

Since that report was written the areas in question have had significant rainfall (defined as a rainfall event of 10mm or more in 24 hours), particularly on the 23rd July, and this has eliminated any need for treatment.

The current situation, therefore, is that rainfall throughout the UK has been sufficient to minimise any risk of cutworm damage. Egg laying by the adult moths has long since become insignificant and there will be no need to treat any crops against cutworms anywhere in the UK in 2007.

Action

- No action will be, or will have been, necessary against cutworms in this exceptionally wet season.

Timing of next report

No further reports will be issued in 2007.