Wireworm Factsheet

Background

Wireworms, the larvae of click beetles (Elateridae), are soil-inhabiting pests, typically found in grassland but also capable of attacking a wide range of crops. In the UK, potatoes are particularly vulnerable, but carrot, sugar beet and leeks may also be affected. By contrast, although cereal crops (both autumn- and spring-sown) may be attacked, damage to cereal crops is not currently causing concern.

Reports of wireworm damage on potato in the UK have been increasing in recent years. This trend has been noted both in the mixed farming areas of northern and western regions, where risk of wireworm damage has traditionally been high following long-term grass, and in the eastern regions, where crops are often grown in fields in all-arable (no grass) rotations. In the latter situation the pest is known as ‘arable wireworm’. An increased incidence of wireworm damage is particularly serious for UK potato growers, packers and processors as wireworms can cause a significant reduction in tuber marketability, even at low populations. This can make the difference between a crop worth >£100/tonne, or one ploughed in or used for animal feed, at a significant loss. Because of this risk of total crop rejection (estimated to be 6% of all GB ware crops), some potato growers now regard wireworms as a more serious issue than potato cyst nematode.

Despite there being recent advances throughout Europe in wireworm risk assessment, through the development of pheromone trapping systems, the ability of the industry to manage wireworm populations has progressed little. The lack of improved wireworm control has been in part, due to the fact that no new suitable chemistry with the required soil persistency and an acceptable environmental profile has been forthcoming. Therefore, effective use of risk assessment tools is essential to minimise losses due to wireworm damage.

This guide is based on current available knowledge and highlights the key wireworm risk assessment tools. Follow the guide to help minimise losses due to wireworm damage.
Life-cycle

Adult click beetles emerge April to August with peak in May. Lay eggs just below soil surface in grassy or weedy ground. Larvae make holes in potato tubers. Larval colour deepens as they grow. Larvae feed on live vegetable matter in soil. Larvae moult up to three times each year. Pupate in soil cavities 5 - 30 cm below soil surface. Adults overwinter in soil cavity.

Key species

Wireworm damage in Britain is generally attributed to three species; *Agriotes lineatus*, *A. obscurus* and *A. sputator*. There is some evidence to indicate that different ones of the above species may dominate in different parts of the country, but often all three can be found within a single field. The three species are thought to have similar damage potential, but the larvae are indistinguishable by conventional means, so this is difficult to confirm. Pheromone traps and genetic tools (recently developed at University of Plymouth) for the accurate identification of wireworms may shed new light on the damage associated with each species. Wireworm populations within a field often consist of a mix of species of *Agriotes* as well as wireworms belonging to other genera, including *Athous* and *Corymbites*. 
Click beetle species generally associated with wireworm damage in the UK (Photos: Syngenta)

Discriminating between *Agriotes* and *Athous* species of wireworm (Photos: ADAS)

**Managing risk**
The currently-available chemicals for the control of wireworms, ethoprophos (Mocap 10G) and fosthiazate (Nemathorin), are applied at planting and cannot be used later than this. This makes a pre-planting assessment of the risk of wireworm infestation, and therefore the need for a pesticide application, an essential part of a wireworm management strategy. In order to achieve this, site history and crop rotation need to be considered. Assessment of wireworm population size should be completed at more than one time of the year, avoiding extremes of drought or cold, and should use a range of sampling techniques.
Risk factors:

Site characteristics

High risk: South-facing, sloping fields.

Factor: Field characteristics such as orientation, slope, soil density etc may play an important role in determining the level of wireworm infestation.

Action: Although farmer perception is that grass fields are invariably wireworm infested, surveys conducted by ADAS have indicated that a significant proportion, 30-40%, do not contain detectable populations. Although field characteristics may be important, this does not remove the need for directly assessing the wireworm population.

Technical: Current population prediction models or presence/absence rules do not fully account for the large inter-field variation in wireworm infestation status. Although altitude does not appear to be a significant factor, aspect (angle of slope) does appear to be important. South-facing fields have a tendency to be infested while north-facing fields have the opposite tendency. Flat fields appear to be as likely to be infested as to be uninfested.

Radar plot of percentage of infested; and uninfested sloping fields in different aspect (direction of slope) categories.
Crop rotation

High risk: Long-term grass, minimum cultivation of cereal crops.

Factor: Crops have always been considered to be at risk following long-term grass. More recently there has been an increase in the incidence of wireworm damage to potato crops in all-arable (no grass) rotations. Recent work has found minimum-tillage plots to support wireworm populations similar in size to those in grass plots and significantly higher than populations recorded in conventionally-tilled plots in the same field.

Action: Although a significant proportion of grass fields may not have detectable wireworm populations, the duration of grassland in the cropping history of individual fields remains perhaps the best indicator of the likely presence/absence of wireworm. Therefore, extra care should be taken to assess the wireworm population size when considering a potato crop following long-term grass. Where the potato crop is included in an arable rotation, use of plough-based cultivation may help to reduce wireworm population size.

Technical: In a long-term experiment completed as part of Sustainable Arable LINK project LK0982, rotational factors influencing wireworm population size were investigated. Researchers at ADAS found minimum-tillage wheat plots to support wireworm populations similar in size to those in grass plots and significantly higher than populations recorded in conventionally-tilled wheat plots. These results indicate that the use of plough-based cultivation through the rotation is likely to be useful in minimising wireworm populations when growing potatoes.
Variety

**High risk:** Late lifted potatoes are at greater risk of wireworm damage.

**Factor:** All commonly-grown potato varieties are attacked by wireworms, although recent research suggests that some varieties, such as Maris Peer and Marfona, may be more susceptible than others, such as King Edward, Nadine and Maris Piper. In addition, wireworm damage tends to increase with time from mid-August onwards.

**Action:** If potatoes are to be grown in a field where wireworm infestation has been confirmed, then consider growing a variety that can be harvested early to avoid the worst of the wireworm damage.

**Technical:** Variability in the susceptibility of potato varieties to wireworms has been recorded. Susceptible varieties are selected in preference to less susceptible varieties in choice tests. In addition, when feeding on susceptible varieties wireworms consume more of the tuber and grow faster. However, although variability in varietal susceptibility has previously been attributed to glycoalkaloid levels, recent work found only a weak link between levels of these chemicals and susceptibility. There are no commercial varieties that are immune from attack.
Wireworm assessments:

1) Soil sampling

Timing: In the autumn e.g. October before the potato crop is to be planted.

Threshold: The limit of detection of the standard soil sampling method is 62,500 per hectare. Unfortunately, wireworm populations below this level are still capable of causing significant damage to potato crops. The relationship between wireworm population size determined through soil sampling and subsequent damage to the potato crop is reasonably good.

Method: Soil sampling for wireworms typically involves taking 10 cm-diameter cores to a depth of 15 cm. Twenty cores should be taken along a W-shaped sampling transect covering between four and 10 hectares. The soil cores should be bulked together and processed in a laboratory with suitable 'soil washing' equipment. Although soil sampling is very labour-intensive it remains the only method available to growers which can estimate wireworm population size.

Technical: Overall, the relationship between wireworm population size and subsequent damage to the potato crop is reasonably good. However, at low wireworm populations these sample estimates may be subject to significant sampling errors. The presence of any wireworms in a soil sample should be taken as an indication of the need for pesticide use when growing potatoes in that field.

![Graph showing the relationship between wireworm population and percent tubers damaged](image-url)

▲ = untreated; ■ = treated with ethoprophos at 60 kg product per hectare
2) Bait traps

**Timing:** In the spring e.g. late March, ideally as soil temperatures rise but before crops are planted.

**Threshold:** Presence/absence.

**Method:** Although these traps are less commonly used in the UK today, a simple trap consists of a bag of grain, which is placed in a plastic pot drilled with wireworm sized holes. The traps are soaked before they are buried to a depth of approximately 20 cm and left for 10-14 days. The sprouting grain releases carbon dioxide which acts as an attractant to the wireworms, which move either into the plastic pot or near to the trap. Traps are assessed by checking for wireworm in the plastic pot or in the soil around the pot.

**Technical:** As a presence/absence monitoring tool, the presence of even a single wireworm can represent a significant risk in the following crop.

Example of a wireworm bait trap showing wireworm sized holes (Photo: Bill Parker)
3) Pheromone traps

**Timing:** Late spring or summer in the year before the potato crop is to be planted.

**Threshold:** Presence/absence of key click beetle species: *A. lineatus*, *A. obscurus* and *A. sputator*.

**Method:** Species-specific sex pheromones are released by female click beetles in order to attract males with which to mate. The different sex pheromones produced by *A. lineatus*, *A. obscurus* and *A. sputator* females have been identified and synthesised. Lures releasing the synthetic sex pheromone for each species may be fitted separately to plastic traps, which can then be placed in the field. As it is the female beetle that naturally produces the sex pheromone the traps only catch males and not the egg-laying females. Traps placed in the field in the morning can be assessed for the presence of click beetles in the afternoon/evening.

**Technical:** It was originally recommended that pheromone traps should be checked approximately once a week. However, more recent research has found a broadly linear relationship between the number of beetles trapped and the length of time that traps are left in position. Given this linear relationship and the sensitivity of the pheromone traps, meaningful data on click beetle numbers can be obtained after just three hours.

![Graph showing the cumulative trap catch over time for *Agriotes sputator*.](image-url)

*Mean pheromone trap catch for *Agriotes sputator*.***
Identifying wireworm damage

Wireworm damage and slug damage are superficially similar, as both pests produce small, round entrance holes in the potato tuber. However, wireworms produce only narrow tunnels into the tuber, whilst slugs often hollow out cavities within the tuber flesh, which wireworms do not.

![Typical wireworm damage seen as small round holes in harvested potato crop (Photo: Bill Parker)](image)

Wireworm control

**Cultural:** where possible, avoid growing potatoes in wireworm infested fields. Plan ahead and utilise a range of risk assessment methods such as pheromone and bait trapping as well as soil sampling to confirm the status of each field. In arable rotations plough-based cultivation may help to reduce wireworm populations.

**Biological:** currently there are no commercial biological control agents available for controlling wireworms, although some strains of the insect-pathogenic fungus *Metarhizium anisopliae* have shown encouraging results under experimental conditions.

**Soil amendments:** recent work in Italy, using cruciferous plants grown as green cover crops or de-fatted mustard meals as soil amendments, has indicated that these products may be effective in controlling wireworms. By contrast, in UK trials these soil amendments did not provide useful levels of control.

**Insecticides:** to be effective, insecticides for the control of wireworms need to be incorporated into the soil at planting and remain active until late in the life of the crop. Initially, organochlorines such as aldrin and lindane were used effectively, but environmental hazards meant that these have been replaced by the organophosphorous insecticides ethoprophos (as Mocap 10G) and fosthiazate (as Nemathorin). However, while organophosphorous insecticides are effective at controlling wireworms they do not prevent all damage to potato tubers by this pest.

Some insecticides from different chemical groups, including pyrethroids and neonicotinoids, have activity against wireworms. These are available as seed treatments...
for sugar beet, cereals and oilseed rape in the UK. Use of these products on the appropriate crops in the rotation will help reduce the wireworm population size.

**Integrated control:** wireworm management should be seen in the context of the crop rotation. Where wireworms are a concern, consider plough-based cultivation to help to reduce the wireworm population. Approximately a year before planting the potato crop, use pheromone traps to confirm the presence or absence of click beetles within the field. In the autumn of the same year soil sampling will give an estimate of the wireworm population size. Finally, immediately before planting consider the use of bait trapping to confirm the presence of wireworms. These results will inform crop decisions aimed at minimising wireworm damage. Such decisions may include not growing potatoes where wireworm populations have been confirmed or, when potatoes are to be grown, using early-harvested varieties and applying insecticides at planting.

**For further information:** please contact Chris Steele csteele@potato.org.uk

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