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Farm Advisory Service

Aphid vectored virus disease in potato crops

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Summary

- **Some aphids can carry viruses that cause yield and quality issues in potato crops.**
- **Feeding damage from aphids can be a risk, but transmission of viruses is the key concern, particularly for seed potato crops.**
- **The issue is important for both seed and ware growers, but seed crops must have a very rigorous management programmes in place as the threat is larger.**
- **Only an Integrated Pest Management (IPM) approach is effective against aphid vectored viruses in potato crops.**
- **IPM includes removal of infected material, reduction in field generations, cultural approaches such as mulches, use of oils, and targeted insecticide programmes.**
- **The Scottish Aphid Borne Virus Working Group (SABVWG) publishes best practice guidance regularly.**

Introduction

Aphids pose threats to potato crops in two ways. Firstly, if infestation levels are severe enough direct feeding damage can occur which hampers yields. Secondly and more importantly, several species of aphid can act as vectors for potato viruses.

Aphid vectored viruses are a much greater concern than feeding damage, particularly for seed potato crops. Infection with aphid vectored viruses can occur within the growing season (so called primary transmission) or infected plants and give rise to infected daughter tubers (secondary transmission). As potatoes are a vegetatively propagated crop, infection of early field generations can amplify each time a crop is multiplied. Indeed, one of the key purposes of Seed Potato Classification Schemes (SPCS – administered by SASA in Scotland, APHA in England and Wales, and DAERA in Northern Ireland) is as a disease control measure to prevent accumulation of virus burden over multiplication cycles.

The threat of aphid vectored viruses is increasing due to a changing climate and more limited availability of plant protection products. An Integrated Pest Management (IPM) approach is required to manage aphid vectored virus effectively.

A grower's approach to aphid management will depend on if production is for seed potatoes or ware potatoes. Cropping where the larger size faction of potatoes ("tops") are destined for ware and the smaller size fractions for seed present a number of difficulties and is discouraged.

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In general, a much more intensive crop protection programme is required for seed potatoes than for ware, but ware growers should not neglect the issue and should be aware that infected ware crops may act as a reservoir of virus.

Growers are permitted under the classification scheme to “home save” seed for a single field generation. Such crops should be managed as if they were a seed crop entered into the SPCS.

Monitoring aphids

A prerequisite of effective aphid management is monitoring of pest activity. Individual crops can be monitored for aphids by direct searching (i.e. during crop walking) but this is only sufficient for ware crops when determining if an infestation at damaging levels has occurred.

Aphid species differ in the danger that they pose to potato crops. A small number of aphid species are capable of colonizing potato plants and producing colonies asexually on potato leaves. Of these, by far the most important are peach-potato aphid (*Myzus persicae*) and potato aphid (*Macrosiphum euphorbiae*), although other species such as glasshouse potato aphid (*Aulacorthum solani*) can also cause infestations.

Other aphid species can carry and transmit potato viruses, but do not colonise potato plants. Somewhat counter-intuitively these can pose a very high threat to the virus health of potato crops as they can move transiently through and between crops, probing for a brief period, acquiring viral particles, and spreading the infection to healthy plants. Some non-colonising species with relatively high transmission potential are grain aphid (*Sitobion avenae*), pea aphid (*Acyrthosiphon pisum*), and willow-carrot aphid (*Cavariella aegopodii*).

Monitoring of aphid activity is important as virus pressure is a function of (1) the number of aphids active and (2) the species of aphids present. Aphids differ in their ability to transmit viruses, but even aphid species with low “transmission efficiency” can be problematic if present in sufficient numbers.

Direct feeding damage

Aphids are sap feeding insects, and heavy infestations can cause direct feeding damage. In potatoes this can manifest as a condition called “false top roll”. This can be distinguished from leaf roll in that upper leaves are affected (due to the aphids attacking phloem which supplies them) and that distinct patches of affected plants will appear in fields, rather than individual plants in the case of potato leaf roll.

Direct feeding damage can cause yield losses if infestations are severe enough – the size of the yield loss is in direct proportion to the number of aphids. There are no clearly established threshold for aphid feeding damage in potato crops, and some varieties may be more susceptible than others. Treatment with an appropriate insecticide to prevent false top roll may be necessary if aphid numbers are increasing rapidly (a mean of 5 aphids per compound leaf is sometimes cited as an action threshold).

Potato viruses carried by aphids

There are a large number of viruses which infected potato plants that can be carried by aphids, but the two of chief importance are potato virus Y (PVY) and potato leaf roll virus (PLRV) both of which are capable of causing both quality and yield issues depending on the variety. It is important to remember that viruses evolve rapidly, and there are many different strains of PVY and PLRV which differ in their transmissibility and the symptoms they cause.

One crucial aspect of virus transmission to understand is the difference between persistent and non-persistent viruses. These terms refer to behaviour within the aphid vector *not* in the duration of infection within plants. PVY is a non-persistent virus and PLRV is a persistent virus. Different management measures must be employed to manage the threat of each.

Persistent viruses are present in high levels within the phloem sap of plants and must past through the digestive system of an aphid before the aphid is capable of transmission. There is thus a gap of several hours between an aphid feeding on an infected plant and its saliva becoming infective. Once an aphid has acquired the virus it will be infective for the remainder of its lifespan. For persistent viruses (e.g. PLRV), colonising aphids are the main transmission vectors.

For non-persistent viruses viral particles are present in epidermal tissues of plants, and are thus picked up rapidly when an aphid feeds. These particles then adhere to aphid mouthparts. An aphid feeding or probing on an infected plant can acquire the virus within minutes. However, these viruses are non-persistent as aphids can lose infectivity over time if they feed on non-infected non-host plants.

Myzus persicae (peach-potato aphid) is a very efficient transmitter of both PYV and PLRV and is therefore a key indicator species for virus risk, but the importance of other aphid species should not be neglected.

Table 1. Aphid species that transmit potato viruses. Please note this list is **not exhaustive**. More detailed estimates of transmission efficiency are available, but they vary depending on source.

Species	Transmits PVY	Transmits PLRV	Colonises Potato
Peach-Potato Aphid (*Myzus persicae*)	YES	YES	YES
Potato Aphid (*Macrosiphum euphorbiae*)	Somewhat	YES	YES
Glasshouse and Potato Aphid (*Aulacorthum solani*)	Somewhat	Somewhat	YES
Buckthorn-Potato Aphid (*Aphis nasturtii*)	YES	Somewhat	YES
Pea Aphid (*Acyrthosiphon pisum*)	YES	N/A	N/A
Willow-Carrot Aphid (*Cavariella aegopodii*)	YES	N/A	N/A
Grain Aphid (*Sitobion avenae*)	YES	N/A	N/A
Bird Cherry-Oat Aphid (*Rhopalosiphum padi*)	YES	N/A	N/A

Potato Virus Y (PVY)

Potato virus Y is a non-persistent virus that can cause mosaic symptoms in some potato varieties. It is one of the main aphid vectored virus species of concern for potato crops in the UK. PVY is a complex and rapidly evolving viruses that exists as many different strains and variants (for example: PVY^{O}, PVY^{N}, PVY^{NTN}).

Different strains may cause differing severities of symptoms and symptom expression varies depending on variety and time of infection. In general, PVY infection causes a range of symptoms in the foliage from asymptomatic through to very severe mosaic mottling. Infected plants can be stunted, lack vigour, and suffer a sizeable yield penalty.

Other quality related symptoms can occur with some viral strain-cultivar interactions, such as a higher incidence of growth cracking or necrotic ring spots on tubers. At present PVY^{NTN} is the dominant strain in Scotland.

Figure 1 - PVY infected plants

Potato Leaf Roll Virus (PLRV)

Potato leaf roll virus is a persistent virus which causes the characteristic “leaf roll” in some varieties. Symptoms of primary (in season) infection are very subtle and may not be seen depending on time of infection. Secondary infection (i.e. plants grown from infected daughter tubers) is usually more distinctive depending on variety. Symptoms can often be seen in lower leaves which curl upwards towards the leaf centre. Infected plants can also be stunted and chlorotic.

In some varieties (e.g. Russet Burbank) PLRV can cause a condition in daughter tubers called net necrosis where necrotic flecks appear in tuber phloem tissue. Although rarely seen in the UK, this condition can cause serious losses when it does occur.

Until recently PLRV was thought to be well controlled in the UK, but at time of writing (March 2024) incidence has increased to the point where it is one of the more commonly encountered viruses in potato crops.

Figure 2 - Potato leaf roll

Other viruses

There are several other aphid vectored viruses such as PVA, PVV, PVS etc. These are sometimes encountered in Scotland at low frequencies. There generally cause mosaic symptoms similar to some strains of PVY. The general management principles outlined in this technical note should also apply to these strains.

The Six Steps for Effective Virus Management in Potato Crops

The Scottish Aphid Borne Virus Working Party (SABVWP; a consortium including SASA, SRUC, JHI, SPO, BPTA, PBGA, Agrovista, Scottish Agronomy, & McCain) produce a best practice *Six Steps to Effective Virus Management* document which forms the basis of the following sections[1].

Although primarily aimed at seed growers, much of the information is also relevant to ware producers.

Step 1 | Isolate crops from sources of infection

- Sources of infection include infected seed planted in a field, other potato crops, potato volunteers, and uncontrolled growth in potato dumps.
- The first step to control is to place crops away from these sources.
- Use as healthy seed as possible.

For transmission to occur both aphids and virus infected plants must be present. If crops are isolated (i.e. by distance) from potential sources of infection, risk of transmission is decreased. If seed with very low levels (or ideally nil) virus infection is planted, the risk of within-field spread is decreased.

The most important potential sources of infection include other potato crops, uncontrolled groundkeepers, and growth in unprotected potato dumps. Nearby potato crops (both seed and ware) should be as free from virus as possible. In practice this will mean discussions with neighbouring growers. At the very least, knowledge of where other local crops are likely to be sited will aid field selection for seed crops.

[1] https://www.sasa.gov.uk/sites/default/files/The%20six%20steps%20to%20effective%20virus%20management%20in%20certified%20or%20home%20saved%20seed.pdf

Input seed is the most important determinant of virus levels in nearby crops. Ware crops grown from farm-saved seed potatoes of high field generation that have not been tested for virus levels are likely to increase risk of virus being present.

If a seed stock is known or suspected of harbouring virus infected tubers (for example following a tuber test or from growing crop inspections) then great care should be taken in its management. Such stocks should be geographically isolated from other crops and should be managed appropriately.

Fields that are directly adjacent to planned seed potato crops should be assessed for the presence of groundkeepers, and these should be controlled if found.

Isolation is particularly important for high grade seed crops, and for varieties that have a high virus propensity (see step 3).

There is some evidence that surrounding potato crops with "buffers" of either non-host crops (i.e. cereals) or by mixes of plant species that increase biodiversity. Non-host buffers are helpful against non-persistent viruses, as aphids probing these plants before entering a potato crop may "cleanse" their mouthparts and thus loose infectivity.

To be effective, such crops/strips must be well developed before the potato crop emerges.

Plant mixes ("wildflower strips") can encourage insects that predate aphids and may reduce pressure in the crops they surround. This technique is likely to be helpful later in the growing season and additional measures will be needed in early canopy development. Evidence for the most effective deployment of wildflower strips is limited, but the best mix may not be the same as that needed for pollinator encouragement (though there is some overlap).

Step 2 | Remove virus infected plants

- Remove infected material before virus can spread.
- Rogue potato crops.
- Control volunteers.

Potato plants infected with viruses with a crop, or close to a crop will act as a significant source of infection once aphids are present. Physical removal by roguing is not only important to achieve grades with the SPCS, but it is also a very effective disease control measure – if roguing begins early.

If infected material can be removed before vectors are present in significant numbers, the transmission cycle can be broken. Roguing out of infected plants at early field generations is especially important, as incidence of infection will increase down the multiplication chain.

There are limitations to roguing – primary (within season) infection can be difficult or impossible to detect, depending on when infection occurs. Some varieties may be asymptomatic for certain strains.

Roguing is a skilled job, as symptoms of viral infection can be subtle and can vary according to variety and viral strain present. SASA provide comprehensive training courses for their crop inspectors and have demonstration plots of symptomatic varieties. SRUC provide a longstanding roguing course open to candidates who work in or who are seeking employment within the potato industry.

Step 3 | Use resistant varieties and mitigate risks in susceptible varieties.

- Use resistant varieties.
- Target varieties with high virus propensity with extra control measures.
- Isolate varieties with high virus propensity.

Potatoes varieties vary a great deal in their resistance to different viruses. Some varieties do not display symptoms and do not become sources of infection. For the most up-to-date information on varietal resistance, consult the UK potato varieties database[2]. Although these rating provide a useful guide, the complexity of viral strains means that, practically for PVY, they cannot wholly be relied upon.

Some varieties can become infected with virus and do not display symptoms but can act as sources of virus to neighbouring crops. Such varieties are colloquially referred to as "dishonest" varieties. There is no comprehensive list, but the variety Estima is a well-known example. Viral strain and environmental conditions also play a large part in the development of asymptomatic infections.

[2] https://potatoes.agricrops.org/

SASA collect very detailed data on viral faults within the SPCS, and it is therefore possible to rank varieties on their viral propensity[3] . Varieties with a high propensity display symptoms at above average incidence compared to the Scottish seed potato crop as a whole.

If a variety with high virus propensity is grown, then additional control measures will be needed – for example they should be propagated for fewer field generations and planted well away from known sources of infection.

Table 2. Varieties with high virus propensity (2022 data, SASA, Scottish Government).

PVY	PLRV
Maris Piper	
Cara	
Maris Peer	
Slaney	
Golden Wonder	
Atlantic	Kingsman
VR808	Daisy
King Edward	Banba
Charlotte	Russet Burbank
Ivory Russett	Sunset
Wilja	Belmonda

Step 4 | Act on monitoring information

- Check suction trap and yellow water trap data regularly.
- Anticipate aphid flights in your area based on this information.
- Act on information – use it to inform spray programmes and other control measures.

Monitoring and forecasting systems are in place that allow growers to make informed and timely decision about aphid management. The key information is when are important aphid species flying and in what numbers.

The first indication of when problem aphids, such as the peach-potato aphid (Myzus persicae) may be flying is provide by forecasting from the Rothamsted Insect Survey Aphid Forecasts. These are based on temperatures during January and February. These forecasts are not a substitute for in-season trapping data but they can give a broad indication on when control measures need to be in place.

Weather forecasts can provide a good general indication of likely aphid activity, but in-season the most reliable indicated is direct trapping. There is a network of UK wide suction traps administered by Rothamsted Research and SASA. Weekly reports are available during the growing season[4]. Growers should monitor the reporting from their nearest suction trap to gain information on regional virus pressure.

At a more local level, yellow water traps (YWT) can be purchased from providers such as FERA. Cost of purchase usually includes counts and species identification for a set number of catches. At time of writing a fixed number of traps are supported financially by the industry. Purchase of a trap allows access to data for the whole network.

YWTs provide the best source of locally relevant information – it is important to consider aphid catches not just for traps placed in a grower's own fields, but also those in the local area. There is a slight time lag between trapping period and data availability, so this must be factored into management decisions.

Place YWTs within the crop (not to the side) and adjust high so that it is level with canopy as it develops. Traps should be placed before crops emerge as aphid-virus pressure in the early stages of crop growth are of particular importance.

[3] Propensity = % of diseased crops of variety divided by % of diseased crops of all varieties)

[4] https://insectsurvey.com/aphid-bulletin

Step 5 | Used targeted spray programmes

- Use plant protection products when problem aphids are flying.
- Be aware of resistance issues in some actives.
- Ensure programmes cover the full growing season.

There are several plant protection products that can be helpful in the management of aphid vectored virus but their use is only effective as part of an integrated pest management (IPM) approach.

It is also important to remember that control programmes need to manage the threat from non-persistent viruses (PVY) and persistent viruses (PLRV)

The number of insecticides approved for use against aphids in potato crops in the United Kingdom has declined in recent years, and there are significant resistance issues amongst some aphid species to some insecticide classes, particularly the pyrethroids.

Pyrethroids

Pyrethroid insecticides (esfenvalerate and lambda-cyhalothrin) have been the mainstay of control programmes for a number of years. They result in rapid insect paralysis or "knock-down" which is particularly useful as a defence against PVY transmission as this virus is transmitted very rapidly by transient aphid populations. However, resistance is known in populations of peach-potato aphid (*Myzus persicae*), grain aphid (*Sitobion avenae*), and willow-carrot aphid (*Cavariella aegopodii*). The resistance status of many other aphid species is not known or regularly monitored.

Pyrethroids are fairly broad-spectrum insecticides and as such may negatively affect insects which are natural enemies of aphids. Pyrethroids may still have a useful role to play in controlling non-persistent viruses as long as they are not over-used and attention is paid to which species of aphid are present.

Translaminar insecticides

The other insecticides which are currently approved for use in potato crops (acetamiprid, flonicamid, and spirotetramat) are generally classed together as "translaminar insecticides" because they all have some degree of mobility with the plant. However, they have distinct modes of action and different use restrictions. These insecticides work chiefly against aphids that feed on treated leaf material, and thus are less effective against non-persistent viruses (as transmission may occur before aphid mortality). They are, however, very useful against non-persistent viruses where control of colonising aphids is a key objective. Statutory labels should be followed when using such products, but a protection period of 14-days is often cited.

Applications of translaminar insecticides should begin once colonizing aphids are found in local yellow water traps or if the risk is judged as high based on suction trap data. At time of writing there is no evidence in the UK of resistance against these products amongst key aphid species, but resistance is known in other parts of Europe.

If applications are made to ware crops, take note that different label conditions apply in some products (e.g. Incyst has a maximum of 1 application in ware, but 2 in seed).

Table 3. Plant protection products that can be used for aphid control in potato crops. CHECK LABELS BEFORE USE as additional restrictions apply. Obtain a recommendation from a BASIS qualified advisor.

Active Ingredient	Example Products	Maximum Applications	IRAC Group[5]
Esfenvalerate	(Sven, Gotcha, etc.)	4	3A (pyrethroid)
Lambda-cyhalothrin	(Hallmark, Kusti, etc.)	4	3A (pyrethroid)
Acetamiprid	(Incyst)	2 (1 on ware)	4A (neonicotinoid)
Flonicamid	(Teppeki)	2	29 (pyridine carboxamide)
Spirotetramat	(Movento)	4	23 (tetramic acid)

[5] https://irac-online.org/

Oils

There is very strong evidence from both the UK and abroad that oils (mineral or paraffinic) can help to reduce the spread of non-persistent viruses in potato crops. As with several other methods outline in this technical note, control is dependent on seasonal conditions and is often partial. However, evidence from field trials is that regular oil applications are generally more effective that routine pyrethroid treatments at reducing PYV spread. Integrated approaches that include oils, insecticides, and other measures such as straw mulching often produce the best levels of control.

In the UK, oil products are only available as adjutants and so must be applied with an approved plant protection product. In potatoes this is likely to be one of the insecticides mentioned above or with a fungicide applied for control of late blight (caused by *Phytophthora infestans*), however not all plant protection products are compatible with oil adjutants so seek advice before application. Oils are also generally not legal to apply past tuber initiation (unlike in other jurisdictions).

In field trail work a strategy of very early oil applications (beginning at 30% crop emergence) with regular top-ups (every 7 days, reduced to every 3 in some circumstances) has proved the most effective approach in the absence of colonising aphids – the regular applications are to ensure good coverage of foliage.

There have been documented phytotoxic effects (“scorch” - transient localised necrosis) from use of oils in some varieties and environmental conditions. Producers should be aware of this, and if crops are to be inspected as part of the SPCS a consultation with the inspector may be prudent.

Step 6 | Continue control measures until haulm is dead

- Continue programmes until all green plant material has died
- Prevent and control regrowth.

Late season transmission of virus by aphids is a possibility. Haulm destruction in potato crops can be protracted in some seasons and with some varieties. Until potato haulm has completely died there is a risk. It has also been demonstrated experimentally that virus transmission to daughter tubers is possible from regrowth.

Timely haulm destruction is an important control measure – limiting the length of the growing season decreases exposure to aphid vectored viruses. Although this may slightly limit yield, this is more than out weighted by the risk reduction. For this reason, “dual-purpose” crops (with both seed and ware fractions) are discouraged.

Regrowth, which can sometime occur after mechanical flailing should be avoided (through appropriate nitrogen fertiliser management) or controlled if it occurs.

When planning plant protection programmes, ensure that the cover the full growing season. Protection should continue until haulm destruction is complete.

Other measures

Use of straw mulches (typically at 5 t/ha) pre-emergence can reduce virus transmission in combination with other control measures (i.e. oils, insecticides, etc.). Producers are experimenting with dyes, meshes/crop covers, and pheromone-based products. Although promising we currently lack information on best practice for these approaches.

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