INTRODUCTION

BACKGROUND

Protecting seed crops from the various aphid-borne potato viruses is essential to maintain the quality of Scottish seed potatoes. There are various sources of virus that aphids pick up the virus from, and these include:

- The mother seed stock – i.e. the seed crop planted in the field
- Other seed and ware crops in proximity to the crop
- Groundkeepers/volunteers in potato and non-potato crops
- Potato dumps where haulm growth is present

Aphids will acquire virus from the above sources and both non-potato colonising and potato colonising aphids play a significant role in virus transmission.

There are two groups of aphid-borne viruses that are of concern in seed potatoes; persistent viruses (such as potato leaf roll virus - PLRV) and non-persistent viruses (e.g. potato virus Y – PVY\textsuperscript{O}, PVY\textsuperscript{N}, potato virus A – PVA, potato virus V – PVV).

The persistent virus PLRV resides in the phloem sap of plants and is acquired from infected plants by aphids feeding on the plants and ingesting sap. The ability of an aphid to transmit the leafroll virus is then delayed for several hours because the virus has to pass through the digestive system of the aphid and enter its saliva before transmission can occur. Consequently only potato colonising aphids will be transmitting PLRV. Once the virus has been acquired by an aphid, it remains infective for the rest of the aphid’s life.

The non-persistent viruses PVY\textsuperscript{O}, PVY\textsuperscript{N}, PVA and PVV are rapidly acquired when an aphid feeds on an infected plant because these viruses, which reside in the epidermal cells of plants, are carried on the aphid mouthparts. Non-persistent viruses can be passed on to another plant within a few minutes during aphid feeding. Consequently, winged aphids which briefly probe plants to determine whether they are suitable host-plants and then move onto another plant, have the potential to spread these viruses quickly within the crop. These winged aphids may be non-potato colonising or potato colonizing aphids, and several non-potato colonising aphid species are involved in PVY virus transmission.

REMOVING SOURCES OF VIRUS

Growing seed crops in an environment in which all sources of aphid-borne viruses are kept to a minimum is a key consideration in the production of healthy seed potatoes. This includes sources within the seed crop as well. High quality virus-free seed should be sourced to minimise the risks of spread from infected plants within the crop, supported by roguing of any virus infected plants and groundkeepers at an early stage – preferably by the beginning of June before some of the non-potato colonizing aphid vectors of non-persistent virus are flying. Risks from outwith the crop should be addressed by attempting to isolate seed crops from potential external sources of virus, and by minimising the sources of virus available for aphids to pick virus up from. Adjacent fields should be checked for the presence of infected groundkeepers/volunteers and action taken as
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appropriate. Neighbouring ware crops should be as free from virus as possible - the use of untested home-

served seed to grow ware can increase the risk. Preventing haulm growth on dumps is also important in limiting

the opportunities for flying aphids to pick up virus and carry it into seed crops.

Roguing of groundkeepers/volunteers from non-potato crops, and potato plants exhibiting virus symptoms from

ware and seed crops is an essential component of virus management in seed potatoes – aphids have to pick

up virus from somewhere.

INFORMATION ON APHIDS

The cumulative appearance of aphids throughout the season can be monitored from the Potato Council

network of aphid water traps (http://aphmon.fera.defra.gov.uk/) and the UK network of aphid suction traps at

the following links:-

http://www.rothamsted.ac.uk/insect-survey/bulletins

http://www.sasa.gov.uk/wildlife-environment/aphid-monitoring/aphid-bulletins

This information can be used as an early warning system for general areas and growers are encouraged to

use data from both the water traps and the suction traps to gauge the threat from aphids and virus in their

area.

Aphids that carry and transmit non-persistent viruses include non-colonising as well as potato-colonising

species, and they can acquire and transmit virus to potatoes if they land and probe on a potato leaf without

producing colonies on the leaf. These non-colonising aphids include the bird cherry–oat aphid, the grain aphid,

the rose–grain aphid, the apple–grass aphid, willow–carrot aphid. The aphids that can colonise and multiply on

potatoes include the peach–potato aphid, potato aphid and glasshouse–potato aphid.

Consequently, the numbers of key aphids caught in the aphid water traps and suction traps should be used as

a guide to the risk of aphid movement into potato crops, and the beginning of the aphicide treatment

programme should be based on the appearance of the key aphids below, rather than specific potato–colonising

aphids.

KEY APHIDS

Once any of the following aphids begin to appear in local water traps or suction traps then there is risk of

transmission of non-persistent viruses.

- **Myzus persicae** - Peach–potato aphid
- **Acrystosiphon pisum** - Pea aphid
- **Rhopalosiphum padi** - Bird cherry–oat aphid
- **Aphis nasturtii** - Buckthorn–potato aphid
- **Metopolophium dirhodum** - Rose–grain aphid
- **Brachycaudus helichrysi** - Leaf-curling plum aphid
- **Rhopalosiphoninus latysiphon** - Bulb and potato aphid
- **Myzus ornatus** - Violet aphid
- **Myzus ascalonicus** - Shallot aphid
- **Macrosiphum euphorbiae** - Potato aphid
- **Aulacorthum solani** - Glasshouse–potato aphid
- **Hyperomyzus lactucae** - Currant–sowthistle aphid
- **Aphis fabae** – Black bean aphid
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- *Sitobion avenae* - Grain aphid
- *Brevicoryne brassicae* - Cabbage aphid
- *Cavariella aegopodii* – Willow-carrot aphid

Note that those in **bold** are the aphid species that can colonise potatoes, but all the aphids listed above can transmit non-persistent viruses.

### APHICIDE TREATMENTS

There are now several aphicides that can play a role in virus management in seed potato crops (see Table). However, peach–potato aphids resistant to pirimicarb and pyrethroid aphicides (cypermethrin, esfenvalerate, and lambda-cyhalothrin), are now in the majority in Scottish potato and vegetable crops, so correct choice of aphicide is crucial to minimise the risk of aphicide-resistant aphids developing on crops and consequently transmitting virus. A spray programme that alternates differing chemical groups (and in a tank-mix when potato-colonising aphids appear) is recommended to minimise the transmission of virus by aphids, and reduce the risk of resistance.

Use of products containing pirimicarb should be avoided on potato and vegetable crops to reduce the selection pressure on peach-potato aphids developing resistance to this active ingredient. Alternatives to pirimicarb are the neonicotinoids; acetamiprid, thiacloprid and thiamethoxam (only two treatments of which can be applied in a season on seed potato crops), and the non-neonicotinoids; flonicamid and pymetrozine.

There is evidence that the use of mineral (e.g. Cropspray 11E, Nufarm Cropoil) and vegetable oil (e.g. Headland Fortune), alone or in a mixture with some aphicides reduces the transmission of non-persistent viruses. Reliance on mineral/vegetable oil alone as an aphicide would be at growers risk. Note that mineral/vegetable oils are not compatible with the potato blight fungicides Ranman Top, Shirlan, or the aphicide Biscaya. Trials have demonstrated that the mixture of oils with the blight fungicides Invader, Percos and Revus improved levels of blight control.

- Mineral/vegetable oil can be applied alone (until peach-potato aphids appear) or with a pyrethroid (see below) up to tuber initiation (Cropspray 11E, Headland Fortune) or up to harvest NuFarm Cropoil.
- A rapid knock-down pyrethroid component (*lambda-cyhalothrin, esfenvalerate or cypermethrin*) is recommended before peach-potato aphids appear as the chemical has a rapid kill of aphids and also acts as a deterrent to aphid probing of treated leaves, thus reducing the risk of virus being acquired and transmitted. This aphicide specifically targets the transmission of non-persistent viruses (i.e. PVY*N*, PVY*O*, PVA, PVV). When peach-potato aphids appear on crops, relying on pyrethroid aphicides alone is not recommended, as these aphids may well be resistant to this group of aphicides.
- A translaminar component (*acetamiprid, pymetrozine, flonicamid, thiacloprid, thiomethoxam*) which is taken up by the leaf and kills aphids that feed on the leaves is recommended, particularly when potato-colonising aphids appear. Use of *pirimicarb* is however discouraged, due to issues with resistance.
## VIRUS MANAGEMENT IN SEED POTATOES

The following aphicides are approved for use on seed potato crops:

<table>
<thead>
<tr>
<th>Aphicide group</th>
<th>Active ingredient(s)</th>
<th>Products</th>
<th>Max No. of applications of each product</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pyrethroid</td>
<td>esfenvalerate</td>
<td>Barclay Alphasect, Clayton Cajole, Clayton Slalom, Clayton Vindicate, Sumi-Alpha, Sven</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Do not use alone for peach-potato aphid control due to limited efficacy and resistance issues</strong></td>
<td></td>
</tr>
<tr>
<td>Pyrethroid</td>
<td>cypermethrin</td>
<td>Afrisect 10, Cetan 100 EC, Cyper 100, Cyperkill 10, Cythrin 500 EC, Landgold Cyper 100, MAC-Cypermethrin 100 EC, Permasect C, Sherpa 100 EC, Supasect, Syper 100, Toppel 100</td>
<td>-</td>
</tr>
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</tr>
<tr>
<td>Carbamate</td>
<td>pirimicarb</td>
<td>Aphox, Agrotech Pirimicarb 50 WG, Arena, Clayton Pirimicarb 50, Hockley Pirimicarb WG, Milentus Pirimicarb, Phantom, Pir 50, Pirimate, Pirimate 500, Pirimex 50 WG, Pirimicarb 50, Reynard, RouteOne Primro 50 WG, Standon Pirimicarb 50</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Avoid due to limited efficacy and resistance issues</strong></td>
<td></td>
</tr>
<tr>
<td>Neonicotinoid</td>
<td>thiamethoxam*</td>
<td>Actara, Leptom 250 WDG</td>
<td>2 (1 on ware)</td>
</tr>
<tr>
<td>Neonicotinoid</td>
<td>acetamiprid</td>
<td>Insyst</td>
<td>2 (1 on ware)</td>
</tr>
</tbody>
</table>
**VIRUS MANAGEMENT IN SEED POTATOES**

<table>
<thead>
<tr>
<th>Neonicotinoid</th>
<th>Aphicide</th>
<th>Crop Protection Tolerance</th>
<th>Application Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>thiacloprid</td>
<td>Biscaya, Pintail, Scabiya, Standon Zero Tolerance, Zubarone</td>
<td>2 (1 on ware)</td>
<td></td>
</tr>
<tr>
<td>Azomethine</td>
<td>pymetrozine*</td>
<td>Plenum WG, Quorum</td>
<td>3 (2 on ware)</td>
</tr>
<tr>
<td>Pyridine carboxamid</td>
<td>flonicamid</td>
<td>Teppeki, RouteOne Ski</td>
<td>2</td>
</tr>
<tr>
<td>Oil</td>
<td>Mineral oil</td>
<td>Cropspray 11-E*, Headland Fortune*, NuFarm Cropoilb</td>
<td>aUnlimited up to tuber initiation, bUnlimited</td>
</tr>
</tbody>
</table>

* Do not use during flowering

No more than two applications of a neonicotinoid product (thiamethoxam, acetamiprid, thiacloprid) to be applied in a season

Of the aphicides listed above, thiamethoxam, acetamiprid, pymetrozine, flonicamid and thiacloprid are the only products to which peach–potato aphids have not shown any resistance, so they are an essential component of an anti-resistance strategy against this aphid, and should be used when peach-potato aphids have been found in aphid traps.

Aphid monitoring surveys in peach orchards in France and Spain have revealed that some populations of the peach-potato aphid (*Myzus persicae*) have developed high levels of resistance to neonicotinoid insecticides. To reduce the risk of resistance arising in the UK it is recommended that no more than two applications of a neonicotinoid product (thiamethoxam, acetamiprid, thiacloprid) should be applied over a season to an individual seed crop.

**THE FIRST APHICIDE TREATMENTS**

The first treatments should begin when **key aphids** (see those listed in the Table earlier) appear in traps or on the crop. Growers should regularly check the aphid trap websites listed above for the presence of the key aphids in local water traps and suction traps.

Note that it is predicted that the first catch of peach-potato aphids in the Dundee aphid suction trap is 15th June, and at Gogarbank (Edinburgh) on 10th June. These predicted dates are very much dependent on what the weather does over the next few weeks.

Non-colonising aphids such as the cereal aphids may appear in early-mid May.

Mineral and vegetable oils have been shown to be effective at reducing virus transmission, and can be used alone or mixed with pyrethroid aphicides (which increases the level of protection of virus transmission), but note that the use of these oils is at growers risk.
The pyrethroid aphicides can be used alone (or with mineral/vegetable oil) up to the point when potato-colonising aphids appear on crops or in traps, after which they should be used in a programme every 7 days, with a tank-mix of thiamethoxam, acetamiprid, pymetrozine, thiacloprid or flonicamid every 14 days. It is recommended that pirimicarb is not used on seed potato crops to avoid increasing the prevalence of MACE resistance in peach-potato aphids.

As thiamethoxam and pymetrozine cannot be used during flowering, these products in mixtures with pyrethroids should be used before/after flowering. At any stage of the crop flonicamid, thiacloprid, and acetamiprid can be applied preferably in tank-mixtures with lambda-cyhalothrin/esfenvalerate/cypermethrin. Bear in mind that no more than two applications of a neonicotinoid product (thiamethoxam, acetamiprid, thiacloprid) should be applied over a season to an individual seed crop.

Treatments should be maintained at 7 day intervals (pyrethroid ± oil) with pyrethroid + thiamethoxam, acetamiprid, pymetrozine, thiacloprid or flonicamid at 14 day intervals, and continue until burning down. Beware of any regrowth after burning down as this may be attractive to aphids and potentially infected with virus, so aphicide treatments on regrowth are recommended.

WARE CROPS

Virus management on ware crops is generally not necessary unless the ware crops are sited near to seed crops where they may act as a source of both virus and aphids. The removal of virus affected plants is recommended, and aphid control is suggested once aphids begin to appear. On ware crops isolated from seed crops, aphid control is only necessary when aphid numbers on the crop show a significant increase between two monitoring dates; e.g. 4 per leaf on one day and 12 per leaf the following date of monitoring. If aphid numbers remain relatively static or low then no treatment is necessary. Any of the aphicides listed above can be used on ware crops, but it is preferable to avoid use of pirimicarb or pyrethroid insecticides on ware crops due to aphicide resistance in peach-potato aphids.

SUMMARY

- Early roguing (by early June) of potato plants exhibiting virus symptoms from ware and seed crops, and groundkeepers from non-potato crops is an essential component of virus management in seed potatoes.
- This information can be used as an early warning system for local areas, and growers are encouraged to use data from both the water traps and the suction traps to gauge the threat from aphids and virus in their area.
- Aphicide treatments should begin when key aphids are found in traps, and continue every 7 days until burning down of the crop.
- When peach-potato aphids appear in traps or crops, include thiamethoxam, acetamiprid, pymetrozine, thiacloprid or flonicamid in your programme every 14 days.