SASA
Helping Scotland Grow

SRUC

The James Hutton Institute

agrovista

McCain

SCOTTISH AGRONOMY LTD

PRE BASIC GROWERS ASSOCIATION

SPO
SEED POTATO ORGANISATION

BRITISH POTATO TRADE ASSOCIATION

Scottish Seed has an excellent reputation for high viral health

following

The Six Steps

will help ensure

Effective Virus Management in Seed Potato Crops

see overleaf for details

Keeping virus out of seed stocks requires an integrated approach with all the individual steps important in achieving the end result.

Maintaining the high standards of Scottish Seed is becoming more difficult as pesticide availability is reduced, changes occur to the pathogen, and climate change takes effect. Use the following **Six Steps** to ensure everything is being done to protect Scotland's reputation.

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 (high grade, low field generation) as possible.
• Avoid dual purpose crops – they are more exposed to infection and present challenges in formulating a legal and effective insecticide programme.
STEP 2: Remove virus infected plants
• Remove infected material before virus can spread.
• Rogue potato crops.
• Control volunteers.
STEP 3: Use resistant varieties, mitigate risks in susceptible varieties
• Use resistant varieties to potato virus Y (PVY) and potato leaf roll virus (PLRV).
• Target varieties with high virus propensity (Maris Piper, Maris Peer, Cara, Atlantic, *etc*…) with extra control measures.
• Isolate varieties with high virus propensity away from other seed crops.
STEP 4: Act on aphid monitoring information
• Get yellow water set up and operational early (before emergence). 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 insecticide programmes and other control measures.
• Inspect crops regularly.
STEP 5: Target your Spray Programmes
• Monitor aphid fights and target your applications.
• As soon as key aphids are flying, spray.
• Mineral oils can reduce virus acquisition and transmission when sprayed early and frequency.
• Continued over-reliance on pyrethroids is likely to result in further resistance shifts.
• Observe guidelines to ensure an effective, reliable, and legal programme is followed.
• Select sprays that will protect crops from both PVY and PLRV. Systemic insecticides can be very effective against PLRV, but they are not effective for PVY control.
STEP 6: Continue control measures until haulm is dead
• Bring crops down as early as you can – a shorter growing season means less exposure to virus transmission.
• Continue programmes until all green plant material has died.
• Prevent and control regrowth.

Example aphid and virus control programme

The below is a stylised seven-day programme. It will not be suitable for all situations but is nonetheless a useful example of how a programme should be constructed. **The first spray assumes crops to be between 30-50% emergence and early rosette stage.** Points to consider when devising a virus control programme are given on the following pages.

Table 1: Aphid and virus control programme for high-risk seed crops

Spray no.	Approx. timing	Comments	Spray
1	mid-June	Yellow water traps identify non-colonising and colonising aphids.	Mineral oil, e.g. Cropspray 11-E @ 4 L/ha in 200 L + Teppeki @ 0.16 kg/ha
2	mid-June + 7 days	Yellow water traps identify non-colonising and colonising aphids.	Mineral oil, e.g. Cropspray 11-E @ 4 L/ha in 200 L
3	late June. (Expected to be tuber initiation.)	Yellow water traps identify non-colonising and colonising aphids.	Pyrethroid, e.g. Sven (esfenvalerate) @ 200 ml/ha + InSyst @ 0.25 kg/ha
4	early July	Yellow water traps identify non-colonising and colonising aphids.	Pyrethroid, e.g. Sven @ 200 ml/ha.
5	mid-July	Yellow water traps identify non-colonising and colonising aphids.	Pyrethroid, e.g. Sven @ 200 ml/ha + Teppeki @ 0.16 kg/ha
6	Mid-July + 7 days	Yellow water traps identify non-colonising and colonising aphids	Pyrethroid, e.g. Sven @ 200 ml/ha
7	Late-July (before 31st July)	Yellow water traps identify non-colonising and colonising aphids	Pyrethroid, e.g. Hallmark Zeon 75 ml/ha + InSyst 0.25 kg/ha.
8	August	Yellow water traps identify non-colonising and colonising aphids	Pyrethroid, e.g. Hallmark Zeon 75 ml/ha.

Source: Scottish Agronomy Ltd

A virus control programme: restrictions and considerations

Where it is necessary to adapt the programme on the previous page, the following points should be considered to ensure programmes comply with regulatory restrictions while delivering the greatest benefit.

- Mineral oils are most effective when applied at early growth stages, with evidence suggesting that they should be applied from 30% emergence if non-colonising aphids are present – table 5 gives an indication on how seasonal variations can influence performance.
- Mineral oils rely on covering new foliage growth with a thin film of oil. Frequent application, every three days in very high-risk situations, may be appropriate.
- **IMPORTANT - LATEST NEWS: Emergency authorisation granted for mineral oil application in 2024.** Mineral oil Olie H (Certis Belchim). See here for further details https://hcpltd.org/wp-content/uploads/2024_00418_app-Olie-H-Seed-potato.pdf (Plant Protection Products Regulation No 1107/2009)
- Pyrethroids are permitted throughout crop growth with restrictions on the number of sprays per season (see table 4). However, they should not be relied upon if Peach-potato aphids or Willow-carrot aphids are present as these species are likely to be resistant.
- Pyrethroids, where effective, can deliver rapid knock-down of aphids and act as a deterrent to aphid probing of treated leaves, thus reducing the risk of virus being acquired and transmitted. However, detrimental effects on aphid predators should be taken into consideration.
- Pyrethroid use should be targeted to the period after tuber initiation where **non-colonising** aphid species are present that are likely to be sensitive. Where required, applications should be every seven days.
- Systemic products should be applied to control **colonising** aphid species, especially Peach-potato aphid and Potato aphid when recorded as present through monitoring systems or observed in the crop. Applications should be repeated at 14-day intervals where necessary and if permitted.
- Systemic products must not be used in consecutive applications. Products should be alternated with those belonging to a different mode of action group to minimise resistance risk.
- **Programmes must continue until haulm is completely dead at the end of the season**. Pay particular attention to any regrowth.
- Label recommendations for all products must be followed. These label recommendations include restrictions aimed at preventing resistance development.

Dual purpose crops: The production of seed tops is not recommended. The extended growing season increases the risk of aphid infestation and virus spread. Furthermore, pesticide application restrictions limit the ability to properly protect these crops from virus ingress.

Viruses and their transmission

Potato viruses are transmitted by a range of vectors including aphids, nematodes and fungi. In 2023, 98% of the virus found in symptomatic potato plants were aphid-transmitted viruses.

The aphid-borne viruses of concern fall into two groups: **persistent** viruses, such as *Potato leaf roll virus* (PLRV), and **non-persistent** viruses, such as *Potato virus A* (PVA), *Potato virus V* (PVV) and the most common non-persistent form of virus, *Potato virus Y,* variants of which include PVY^{O}, PVY^{N}, and PVY^{NTN}.

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 PLRV is then delayed for several hours as the virus passes through the digestive system of the aphid and then enters its saliva ready for transmission to occur. Consequently, **only potato colonising aphids transmit PLRV**. Once the virus has been acquired by an aphid, it remains infective for the rest of its life.

The **non-persistent** viruses such as **PVY**, **PVA** and **PVV** are acquired rapidly when an aphid feeds on an infected plant. These viruses are carried on the aphid's mouthparts and can be passed on to another plant within a few minutes during feeding or plant probing. Consequently, winged aphids which briefly probe plants to determine whether they are suitable hosts and then move onto another plant, have the potential to spread viruses quickly within a crop. These winged aphids may be one of many species of **non-colonising** or **colonising aphids** commonly found in potato crops.

Aphids as virus vectors

Once any of the aphids listed in table 2 appear in local water traps or suction traps, there is risk of virus transmission, and aphid management programmes should start.

Table 2: Key aphid species which can transmit virus (ranked according to the relative efficiency by which they are able to transmit virus). Those highlighted (in orange) are potato colonisers and can transmit both PVY and PLRV; resistance to pyrethroids has been identified in species highlighted in bold.

Species	Common Name	PVY transmission (REF*)	PLRV transmission (REF*)
Myzus persicae	**Peach-Potato Aphid**	1.00	1.00
Acyrthosiphon pisum	Pea Aphid	0.70	
Sitobion avenae	Grain Aphid	0.60	
Cavariella aegopodii	**Willow-Carrot Aphid**	0.50	
Aphis nasturtii	Buckthorn-Potato Aphid	0.40	0.25
Rhopalosiphum padi	Bird Cherry-Oat Aphid	0.40	
Metopolophium dirhodum	Rose-Grain Aphid	0.30	
Brachycaudus helichrysi	Leaf-Curling Plum Aphid	0.21	
Aulacorthum solani	Glasshouse and Potato Aphid	0.20	0.1 – 0.3
Macrosiphum euphorbiae	Potato Aphid	0.20	0.15 - 0.89
Myzus ascalonicus	Shallot Aphid	0.20	
Myzus ornatus	Violet Aphid	0.20	
Rhopalosiphoninus latysiphon	Bulb and Potato Aphid	0.20	0.3
Hyperomyzus lactucae	Currant-Sowthistle Aphid	0.16	
*Aphis fabae***	Black-Bean Aphid	0.10	0.3 - 0.56
Brevicoryne brassicae	Cabbage Aphid	0.01	

* The transmission efficiency for aphid species is used to calculate a potential transmission risk and is expressed as a relative efficiency factor (REF). The efficiency of transmission of *Myzus persicae* is nominally set to a REF of 1 and REFs for other species are calculated relative to this. This table represents average data (PVY) or from a range of sources (PLRV). Some differences can occur with different virus/aphid combinations. ** Recently reported as a potato colonising aphid.

Varieties and virus interactions

Varietal resistance to viruses

Resistance varies between varieties. **Some are highly resistant to certain viruses and do not express symptoms or become sources of infection. Others can be symptomless, but still serve as reservoirs of infection**. Unfortunately, resistance to one form of virus does not indicate reliable resistance to another.

The resistance score for most varieties – rated from 1 (highly susceptible) to 9 (highly resistant) – can be found in the 'Potato variety database' (https://potatoes.agricrops.org/). These figures indicate the proportion of daughter tubers that can be expected to be infected with virus at end of the growing season, **not the severity of symptoms**.

Caution: Changing viruses
Depending on when a variety was entered for NL testing, a rating for virus resistance may not be available, or it may refer to resistance to strains of PVY which were prevalent at the time but are less widespread now. Varieties with high resistance ratings (7 or higher) can only be considered as a low risk for the strain of virus for which they were tested.

Symptoms of virus

Some varieties are known to be susceptible to virus but do not display clear symptoms (e.g. Estima). This is referred to as virus tolerance, (sometimes termed 'honesty' of virus expression) and is largely dependent upon the virus strain and environmental conditions. There is no exhaustive source of information on virus tolerance for the main varieties grown.

The term 'varietal propensity' is used to describe whether virus symptoms observed within a variety are above or below the average observed across the whole Scottish seed crop. The variety propensity score for PVY, PLRV or PVA can be used to risk assess different varieties. Full details on varietal propensity can be found at https://www.sasa.gov.uk/seed-ware-potatoes/virology/varietal-propensity-virus-infection.

For those varieties with a high propensity, additional control measures may need to be implemented. Reduction in field generations may be appropriate for these varieties. A variety's propensity/strong association to virus infection is given in table 3.

Table 3: Varieties with high propensity/strong association with virus species

PVY	PLRV	PVA
Maris Piper	Maris Piper	Hermes
Cara	Cara	Desiree
Desiree	Maris Peer	Russet Burbank
Atlantic	Kingsman	Estima
Maris Peer	Daisy	Galactica
VR808	Banba	Golden Wonder
King Edward	Slaney	Cabaret
Charlotte	Russet Burbank	Casablanca
Slaney	Golden Wonder	Cara
Ivory Russett	Sunset	
Marvel	Belmonda	
Wilja	Hermes	
Valor	Markies	
Duke of York	Elland	
Harmony	Estima	
Golden Wonder		

Source: SASA, Scottish Government; 2023 data

From left to right: King Edward infected with PVY^{O}; Harmony infected with PVY^{N} and Marfona infected with PVY^{N}.

Pre-season actions: Seed quality and crop location

The focus should be on isolating crops from both internal and external sources of virus. Adjacent fields should be checked for the presence of groundkeepers and action taken as appropriate.

Sources of aphid transmitted potato viruses
Infected seed planted in the field
Infected neighbouring ware or seed crops
Potato groundkeepers in potato and non-potato crops
Potato dumps where there is haulm growth

Nearby ware crops should be as free from virus as possible: the use of untested home-saved seed to grow ware will increase the risk. Preventing haulm growth on dumps is essential. To

reduce in-crop sources of virus, use high quality virus-free seed. If it is your own seed, you will know what level of virus it may or may not contain. If brought in, then buy from trusted suppliers and ask for reassurance that the crop was free from virus infection.

Crops in which virus was identified in the preceding season, even at low levels, should be isolated from other stocks and managed as being at high risk of virus transmission.

Surrounding crops with cereals, wildflower mixes or any other green crop could provide a barrier (purge strips) to incoming non-colonising aphids, as they land, probe and effectively "cleanse" the virus from their stylet. When using this technique ensure that the area planted is green when the potato crop emerges.

Wildflower mixes are most likely to provide a source of aphid predators to help control colonising aphids later in the season. However, understanding of and evidence-based guidance covering the efficacy and practical application of 'purge' strips and wildflower mixtures remains limited.

Seed tuber testing

Tubers can be tested for virus before planting if there is a risk of infection. Tuber samples must be representative of the stock tested and randomly selected, preferably from the field (individual plants) before harvest. The results should be interpreted with an understanding of the confidence limits associated with such samples. The following provide a tuber testing service.

SASA: https://www.sasa.gov.uk/diagnostics/virus-testing

FERA: https://www.fera.co.uk/crop-health

NIAB: https://www.niab.com/services/laboratory-niab-labtest/potato-disease-testing/potato-virus-testing

Early season actions: Remove reservoirs of infection

If there is any virus present in your crop, it will become a significant source of disease once aphids enter the crop. Thorough roguing of infected plants and groundkeepers at an early stage – as early in the growth of the crop as practical – and before aphid vectors are flying is essential to reducing sources of infection.

Roguing of groundkeepers from non-potato crops, and potato plants exhibiting virus symptoms from nearby ware is also a component of virus management in seed potatoes.

Keep inspecting crops throughout the season and removing any infected plants as symptoms appear.

Identification of virus symptoms in seed potatoes is a skilled operation, roguers should attend a suitable training course. Contact heather.bruce@sac.co.uk for more information.

Effectiveness of roguing

Where PVY was observed by inspectors in the 2020 crop, it was six times more likely to be seen in the 2021 daughter crop than in crops where PVY had not been found the previous season. For PLRV it was seven times more likely. Effective roguing breaks this cycle.

Removal of isolated plants in early generations is especially important and requires patience, skill and training.

Straw mulches

The use of straw mulches which cover bare soil during early crop growth, in combination with other control measures, principally early mineral oil applications, can reduce virus transmission. They are most likely to be effective during seasons where aphid flights are early as they are ineffective after canopy closure. The technique can be used in all crops but is probably most appropriate for high grade FG 1 to FG3 seed crops.

Mid-season actions: Utilise aphid forecast information

Before the season starts

The SASA aphid forecast indicates that first catches at Dundee and Edinburgh are expected on 24th and 27th May respectively – 17 days earlier than average for both locations. This early flight combined with the late planting means many crops will face the risk of virus transmission from the moment they emerge.

These forecasts indicate an earlier than average start to aphid migration. For more information on aphid predictions visit https://www.sasa.gov.uk/wildlife-environment/aphid-monitoring/aphid-predictions.

This information clearly gives the first indication of a high-risk season and should focus seed growers' minds; particularly on measures to control virus spread early in the season.

Similar predictions are available for some non-colonising aphids, such as the cereal aphids. Visit https://ahdb.org.uk/aphid-forecasts for more detailed information.

During the season

Aphid movement throughout the season can be monitored from the UK network of aphid suction traps which report their weekly findings on the following sites (freely available).

SASA: http://www.sasa.gov.uk/wildlife-environment/aphid-monitoring/aphid-bulletins (signup for weekly updates); and Rothamsted Research https://insectsurvey.com/aphid-bulletin.

This information should be used as an early warning system for general areas (ca. 80 km around the suction trap). Monitoring throughout the season enables growers to understand the continuing threat in the area. Interpretation of the data is provided by SASA on its website.

These early warnings should be complemented by use of the FERA network of aphid yellow water traps (https://aphmon.fera.co.uk/). This is the most directly relevant source of information to identify local movements and hotspots of activity. See box right for details of important changes for the 2024 season.

Important: Yellow water traps 2024

Aphid monitoring has been identified as a key priority by the industry. As a result, an open Scottish Aphid Monitoring Network of yellow water traps (YWT) will be operated by growers in 2024 and co-ordinated by FERA. Results will be openly available through the SASA website https://www.sasa.gov.uk/seed-ware-potatoes/virology/aphid-monitoring-network and the weekly email bulletin. 45 funded traps will be available for the 2024 season; alternatively, individuals may wish to purchase traps directly from FERA https://content.fera.co.uk/aphid-monitoring. All trap operators are encouraged to make their data openly available through both FERA and SASA websites to provide a more powerful tool to themselves and the rest of the industry.

Traps should be present in crops from **before emergence** to ensure they are operating during the critical early stages of crop growth. The traps should be emptied weekly and sent for analysis. Note: It can be over a week between an aphid being caught and the result being reported.

Mid-season actions: Target spray programmes

Aphid management programmes

The use of plant protection products has an important role to play in managing the spread of virus. However, applications will only be effective as a part of a fully Integrated Pest Management (IPM) strategy (as outlined in this document).

Information on the resistance of aphids to pesticides is published by the Insecticide Resistance Action Group (IRAG) here: https://ahdb.org.uk/irag.

The most effective, approach to manage resistance is to minimise insecticide use by following appropriate threshold guidance and using IPM programmes, including cultural, namely

resistant varieties, buffer strips and mulches, and chemical forms of control. There is not a single solution; it is about assembling complementary actions.

Pyrethroids resistance

Reliance on pyrethroid products needs to be reduced. For many years, pyrethroids (esfenvalerate and lambda-cyhalothrin, see table 4) have been used in Great Britain as the main pesticide to control non-persistent virus spread. They have historically provided a rapid 'knockdown' of non-colonising aphids and prevent spread of PVY strains.

However, **pyrethroid resistance** in some aphid species is widespread (see box right) and these active substances are now at risk of withdrawal. Testing of aphids for resistance is complex and relies on either live samples or detailed genetic understanding. Many species of aphid are not regularly tested for resistance and as such the extent of the issue could be underestimated. Pyrethroid use also has a detrimental effect on beneficial insects, which may contribute to the control of aphid populations.

Pyrethroids: Latest from IRAG

- Peach-potato aphids with high levels of pyrethroid resistance continue to dominate across the UK.
- Two species of non-colonising aphids, Grain aphid and Willow-carrot aphid with moderate levels of resistance are present in the UK.
- Other species have not been tested, so resistance status is unknown.

Systemic (translaminar) products

Systemic insecticide products (see table 4) are taken up by leaves and ingested by aphids as they feed. These will help to manage populations which may slow the spread of disease but will not stop it. They are of limited value in controlling non-persistent viruses. Instead, these products are recommended for the control of colonising aphids and should be effective in the control of PLRV.

Application should be made as necessary in response to information from aphid trapping services and the presence of aphids in the crop. Where a risk of aphid infestation is identified, products should be applied at 14-day intervals, providing all the statutory label restrictions allow. Where any 'seed tops' are marketed as ware then the crop must be treated as a ware crop when planning insecticide use.

Why has PLRV increased in recent years?

Our understanding of why this is happening is poor. Changes to climate and aphid populations clearly have a role.

However, insecticides should be effective. It is important for insecticide programmes to continue until the haulm is dead as virus transmission can occur late in the season.

Table 4: Insecticide active substances approved for use on seed potato crops

Aphicide group	Active substance (example Product)	Max no. of applications per product	Comments
Pyrethroid	Esfenvalerate (Sven)	4	• Widespread resistance, especially in Peach-potato aphid (*Myzus persicae*) and Willow-carrot aphid (Cavariella aegopodii); moderate resistance in Grain aphid (*Sitobion avenae*). • Knockdown activity. • At risk of withdrawal.
Pyrethroid	lambda-cyhalothrin (Hallmark Zeon)	4	
Neonicotinoid	acetamiprid* (Insyst)	2 (1 on ware)	• Translaminar activity. • Minimum interval 21 days between sprays. • Earliest application after tuber initiation (BBCH 40). • Latest application 31st July. • Insyst label states to protect non-target insects/arthropods respect an untreated buffer zone of 5 meters to non-crop land. • Pre-harvest interval 7 days. • Use early in the season to reduce resistance risk.
Pyridine carboxamide	flonicamid# (Teppeki)	2	• Use of this product in potatoes (including seed) is approved by CRD but not supported by manufacturers due to potential residue issues and is therefore applied at the grower's risk. • Do not use oil-based adjuvants in a tank mix with flonicamid to ware crops or if you intend to sell tops. • Minimum interval 21 days between sprays. • Translaminar activity. • Not to be used in consecutive sprays. • Pre-harvest interval 14 days.
Tetramic acid	Spirotetramat (Movento)	4	• Translaminar activity. • Not to be used in consecutive sprays. • Application only after flowering (in those varieties which produce flowers). • Pre-harvest interval 14 days.

It is recommended that you check with your customer before use of this product.

Mineral oils

Experience in the UK and abroad strongly indicates that mineral oils can reduce the transmission of non-persistent viruses.

The control achieved is variable (and dependent upon seasonal conditions and aphid activity). There are no mineral oil products approved as Plant Protection Products (PPP) in the UK. However, some products are available as spray adjuvants which must be used with an approved PPP such as an insecticide, fungicide, or herbicide.

Newman Crop Spray 11E can only be applied up to tuber initiation. Visual crop effects have occasionally been seen when used in bright sunny days with high ambient temperatures, where there is a lack of agitation in the spray tank, overlaps with the sprayer and during periods of very rapid haulm growth. **Fungicides to avoid tank mixing with mineral oil include; Shirlan/Nando/Volley/Tizca (fluazinam), Zorvec Endavia, Ranman Top and Electis 75WG (zoxamide).**

Emergency Authorisation has just been granted for mineral oil Olie H (Certis Belchim) application in 2024 following a request by HCP on behalf of SPO. Olie-H is an emulsifiable concentrate formulation containing 794 g/L paraffin mineral oil. This offers the use of a mineral oil beyond tuber initiation in seed potatoes for non-persistent aphid-vectored viruses.

There is currently very little information on the physical and biological compatibility of late blight fungicides and product mixtures with Olie H, it will be safer during the the seed inspection period to apply Olie H as a separate application pass to fungicides, to minimise potential visual phytotoxicity symptoms. Olie-H is best used as part of an integrated virus reduction programme, along with translaminar and systemic insecticides such as Insyst and Teppeki.

See here for further details of the Olie H emergency approval (Plant Protection Products Regulation No 1107/2009) https://hcpltd.org/wp-content/uploads/2024_00418_app-Olie-H-Seed-potato.pdf. Stewardship is a requirement of the emergency approval: recording of applications timings and growth stage and any adverse effects must be done.

- Maximum individual dose 6.25 L/Ha
- Minimum water volume 200 – 400 L/Ha
- Maximum 6 applications from BBCH 40 i.e. tuber initiation until harvest, 1 day PHI.
- First application from BBCH 40 (tuber initiation)
- Spray interval 7 days between applications
- 18m buffer from surface water
- 3 star drift reduction nozzles must be used
- Use period between 23rd May and 31st August 2024
- Always apply to a dry leaf
- Avoid spraying in the heat of the day

As table 5 indicates, the success of mineral oil Newman Crop Spray 11E in reducing the transmission of aphid-borne virus is often season dependant. Nor are mineral oils sufficient at controlling colonising or non-colonising aphids alone but must be used in combination with systemics and other forms of control. In 2021, high numbers of Potato aphid through the season were not effectively controlled by mineral oil [1]. In 2022, both Grain aphid and Rose-grain aphid were flying after tuber initiation. The use of systemic insecticides alone provided poor control of PVY [2]. This justifies the use of pyrethroids after tuber initiation if non-

colonising aphids are found to be flying in to crops and known to be controlled by pyrethroids at field rates (or alternatively use of Olie H).

Table 5: Mineral oil has been found to be effective in reducing the transmission of aphid-borne viruses, but success is often season-dependant.

	PVY infection after harvest		Average control over two years
	2021	2022	
Untreated	40%	67%	
Straw mulch only	24%	35%	45%
Experimental programme (Cropspray 11E applied over 8 weeks)	38%[1]	31%	31%
Managed programme (no pyrethroids and no Cropspray 11E after T1)	18%	48%[2]	42%

Source: Scottish Agronomy Ltd, Pittenweem 2021 & 2022.

- Early application of mineral oils is required to be effective. In trials, initial applications have been made from 30% emergence if aphids are present.
- Mineral oils need to cover the foliage to be effective. In some high-risk situations and during rapid canopy expansion, spray intervals have been reduced to three days to ensure good coverage.
- Mineral oil adjuvants are **not compatible with all plant protection products** (including some blight fungicides) and advice on compatibility must be obtained before use.
- Application of mineral oils can have detrimental effects on foliage (transient local necrosis). While this has not been considered a hindrance to crop inspection, avoid applying mineral oils one to two days before the inspection.

Illustration of suggested control measures to improve virus health of seed potatoes: