Aphid Transmitted Viruses of Potato

Introduction

Viruses are among the most economically important diseases of potato. Those transmitted by aphid vectors are the most prevalent and damaging to crops, accounting for almost 75% of potato virus disease intercepted. There are two groups of aphid transmitted viruses which affect potato which can be divided on the basis of their mode of transmission; these are Persistent and Non-Persistent. The only persistent virus affecting potato crops in the UK is *Potato leaf roll virus* (PLRV), commonly characterised as the name suggests by rolling leaves. Non-persistent viruses are also called the mosaic viruses as they cause a range of generalised mottles or mosaic symptoms in affected plants.

There are several non-persistent viruses, the most common and of greatest economic importance are the potyviruses (PVY strains, PVA, PVV) and less common are the carlaviruses (PVS and PVM). In each case the appearance and severity of symptom can vary depending upon virus, variety, and number of viruses affecting the plant. It is not uncommon to find more than one virus in a crop or even multiple viruses in the same plant.

Key Facts

- Aphid transmitted viruses are the major reason for crops failing seed certification
- Cause a range of haulm and tuber symptoms
- The potential yield loss may be up to 85% dependant upon potato variety and growing conditions
- Are grouped by mode of transmission, into Persistent and Non-Persistent
- Persistent viruses include PLRV
- Non-Persistent include the mosaic viruses PVY and PVA
- Viruses may be present alone or in combination resulting in varied symptoms
- Planting certified seed will help reduce the risk of virus inoculum on the growing crop
- If using home saved seed ensure this has been virus indexed to ensure that risk of virus inoculum is kept to a minimum

PLRV symptoms - Note characteristic rolling of lower leaves

Mosaic symptoms of PVY in Potato

Symptoms

Persistent Viruses - Potato leaf roll virus

Primary symptoms of PLRV arising from current season infection include the rolling of upper leaves and chlorosis (yellowing) or reddening. Secondary infection, i.e. that arising from an infected mother tuber, include stunting, chlorosis or paler colouration. Plants tend to Have an upright stiff growth habit and the characteristic

In the tuber, some varieties will exhibit net necrosis. This presents as brown flecking throughout the vascular tissue of the tuber. Net necrosis develops as a result of primary (in-season) spread of the virus. It is not seen in progeny of mother plants grown from infected tubers (secondary infection). The appearance of net necrosis is dependant upon timing of infection and varietal susceptibility. Not all varieties will exhibit this symptom when infected. However, some varieties, such as Russet Burbank, are susceptible and symptoms can be problematic where tubers are destined for chipping or processing.

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Original thinking... applied

Range of mosaic symptoms

Potato tuber necrotic ring disease

Non-Persistent Viruses

The most commonly occurring potato virus in the UK is PVY, with PVY strains accounting for approximately 30% of infections in potato crops. PVA accounts for approximately 20% of infections seen in the growing crop, however, PVA affects a limited range of varieties, with Estima, Desiree and Hermes the varieties most at risk from this virus. Dependant upon the type and strain of virus and the variety affected, mosaic symptoms can range from symptomless through mild mosaics with yellowing or generalised mottles to severe mosaics with growth malformations, bunching, twisting, crinkling, vein necrosis, leaf spotting or leaf drop. Viruses in combination can cause symptoms other than those linked with the individual viruses. For instance, PVA usually causes mild mosaic, as does PVX (a contact transmitted mosaic virus). However, in some varieties PVA and PVX in combination can cause "crinkle" where leaves have a rugose or "raspberry leaf" appearance.
The primary issue in tubers is a reduction in yield. However, virus load in a tuber in association with environmental effects can lead to severe cracking. One strain of PVY (PVYNTN) causes superficial rings and welts on tubers, also known as Potato tuber necrotic ring disease (PTNRD). The precise set of conditions necessary for the expression of PTNRD symptoms is elusive.

Biology

Effective management of virus cannot be achieved without an understanding of the relationship between the viruses and their vectors. There will be two patterns of transmission occurring in a growing crop regardless of virus type. Virus will enter the crop from external sources of inoculum. Simultaneously, any virus that is already present within the crop will act as a reservoir for further spread of virus both within the growing crop and to neighbouring crops.

Mosaic in a field plant, PVY in cv. diamond

Potato leaf roll virus, a persistent virus, is circulative i.e. it is carried in the mid-gut of the aphid and is injected into the phloem of the potato plant when the aphid feeds via injected saliva. Because the virus is within the circulatory system of the aphid, the insect remains infective throughout it's lifespan. This type of transmission requires a long feeding time to acquire the virus. A minimum of 10 to 20 minutes is needed for effective transfer from the plant to the aphid and a similar period of time to transmit the virus into a healthy plant. As a consequence of this, the aphid must remain on the plant for an extended period of time. This means that the two main potato colonising aphids, the Peach-potato aphid, *Myzus persicae*, and the Potato aphid, *Macrosiphum euphorbiae*, are the sole transmitters of PLRV in UK potato fields. Of these, *M. persicae* is the most efficient transmitter of this virus, with a potential to transmit PLRV approximately 10 fold that of *M. euphorbiae*.

Understanding transmission of non-persistent potato viruses is a little more complex. These viruses are carried on the stylet (feeding mouth parts) of the aphid. The virus particles are readily picked up and passed to healthy plants. This means that long acquisition periods are not required. An aphid could acquire virus particles in less than a minute. As an aphid passes through a crop it will make probe feeds. This allows the aphid to taste the plant, if it does not find the crop palatable it will move on and probe feed again. *Myzus persicae* (Peach-potato aphid) is the most efficient transmitter of non-persistent potato viruses. However, because of the short acquisition and transmission periods and the relatively low numbers of *M. persicae* by comparison to some of the less efficient vector species, it is suspected that non-colonising transitory aphids play a much greater role in the spread of non-persistent viruses. For this reason mosaic causing viruses have the potential to spread throughout a crop at a far greater rate than PLRV.

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Diagnosis

Testing for all of the above viruses can be carried out during the growing season using ELISA, an antibody based test. Fera has also developed a range of rapid serological based field kits for the diagnosis of mosaic causing potato viruses (available from Forsite Diagnostics www.forsitediagnostics.com). A range of serological and molecular tests are available through the Fera Crop Health services to confirm the causal virus of both haulm and tuber symptoms.

Field kits for confirmation of virus infection in potato

Control

Effective virus management is targeted at control of the virus vectors. Chemical control through the use of aphicides has reduced the incidence of PLRV in the crop to negligible amounts. Aphid control for virus management has a marked effect on the control of colonising aphids and therefore on management of PLRV. However, this does not mean that PLRV is a virus that can be neglected. Due to the biology of the virus and the vectors there are seasons where PLRV transmission is as great a threat to crops as the mosaic causing viruses. Further information on the activity of aphids in the growing season can be obtained through the Potato Council/Fera Aphid Monitoring Programme http://aphmon.csl.gov.uk.

Due to the transitory nature of the vectors of non-persistent aphid viruses chemical control has not had as great an effect upon mosaic virus management. Recent developments in spray efficacy aimed at anti-feeding mechanisms in aphids should go some way to redress this balance. Another way of reducing the risk from aphid transmitted viruses is to be aware of the susceptibility of varities to different the viruses.

Most varieties have a susceptibility to strains of PVY, especially PVYN. Varieties most susceptible to PVA infection are Estima, Desiree, Hermes, Red Pontiac and Russet Burbank. Estima is particularly susceptible to PVA in combination with PVV, Desiree and Red Pontiac to PVA infection in association to PVX. The best way to minimise the potential for spread of virus within a crop is to ensure the health of your seed potatoes. By buying quality certified seed potatoes there is an assurance of virus health status. This will prevent a reservoir of virus to further infect the growing crop and those surrounding it. If using home saved seed, ensure that the stock used has been submitted for tuber virus indexing to give an indication of virus health. Two comparable methods are currently in use at Fera for tuber indexing, the traditional growing-on test or a rapid molecular based method. Both methods give comparable results. Further information on these tests is available through Fera Crop Health services.

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