POTATO VIRUS Y

- flattening the disease curve

- By **Dr Nigel Crump**

The COVID-19 global pandemic means we are all aware of the need to suppress disease by "*flattening the curve*". That is, stopping the spread of COVID-19 throughout the population. It is now common to hear about the use of laboratory testing to identify known cases of COVID-19 in the population. We even understand the importance of genomic sequencing to identify the various strains of COVID-19, including delta.

The management of Potato Virus Y (PVY) shares similarities to COVID-19. Actions taken by the Australian Seed Potato Industry Certification Authority (AuSPICA) have resulted in the successful "flattening of the curve" for PVY and provided assurance of "clean" certified seed potatoes.

Just like COVID-19, PVY has several strains such as PVY^{O}, PVY^{C} and PVY^{N}. Around the world PVY is evolving and new strains of PVY are being discovered using genomic sequencing.

PVY is vectored by aphids feeding in the potato crop and PVY can be spread with infected seed lots.

SEED POTATO CERTIFICATION AND PVY

Potato seed certification programs aim to prevent or limit initial levels of virus in potato seed. Consistent with certified seed programs around the world, the Australian seed certification schemes limit the number of times a seed lot can be recertified to a maximum of five generations. The initial G0 minituber seed stocks are derived from pathogen-tested tissue culture material known to be free from virus (Figure 1).

PVY SYMPTOMS

Symptoms of PVY can vary across different potato varieties. In some varieties, the virus may show no visible symptoms. Alternatively, symptoms can range from very mild mosaic leaf yellowing to plant death or tuber necrosis. The impact of infection is therefore an interaction between potato cultivar and strain of PVY (Figure 2).

PVY STRAINS IN AUSTRALIA

Historically, Australia reported the PVY strains PYV^{O}, PVY^{N}, PVY^{C}, PVY^{Z} and PVY^{D} (1,2,3). A more recent study has shown Australian isolates belonged to the PVY^{NTN} strain. Sequence analysis of the whole genomes of three isolates suggested a single introduction of the PVY^{NTN} strain to Australia (4). PVY^{NTN} produces mild symptoms in potato, making them more difficult to manage through visual inspections. In addition to reducing yield, necrotic isolates may also cause external and internal

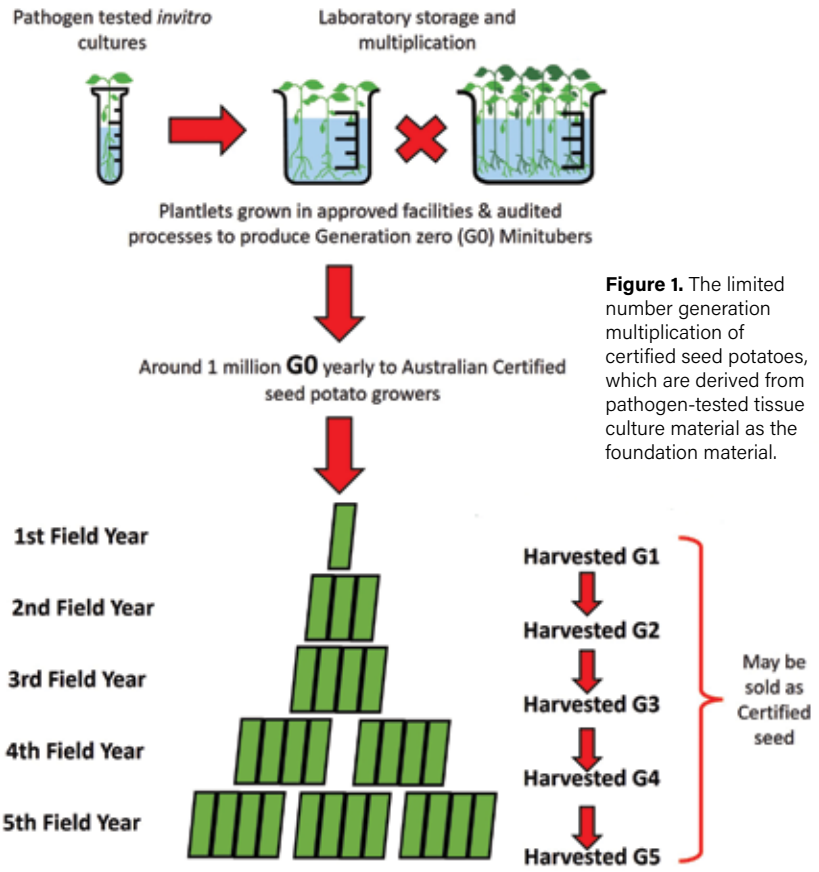

Figure 1. The limited number generation multiplication of certified seed potatoes, which are derived from pathogen-tested tissue culture material as the foundation material.

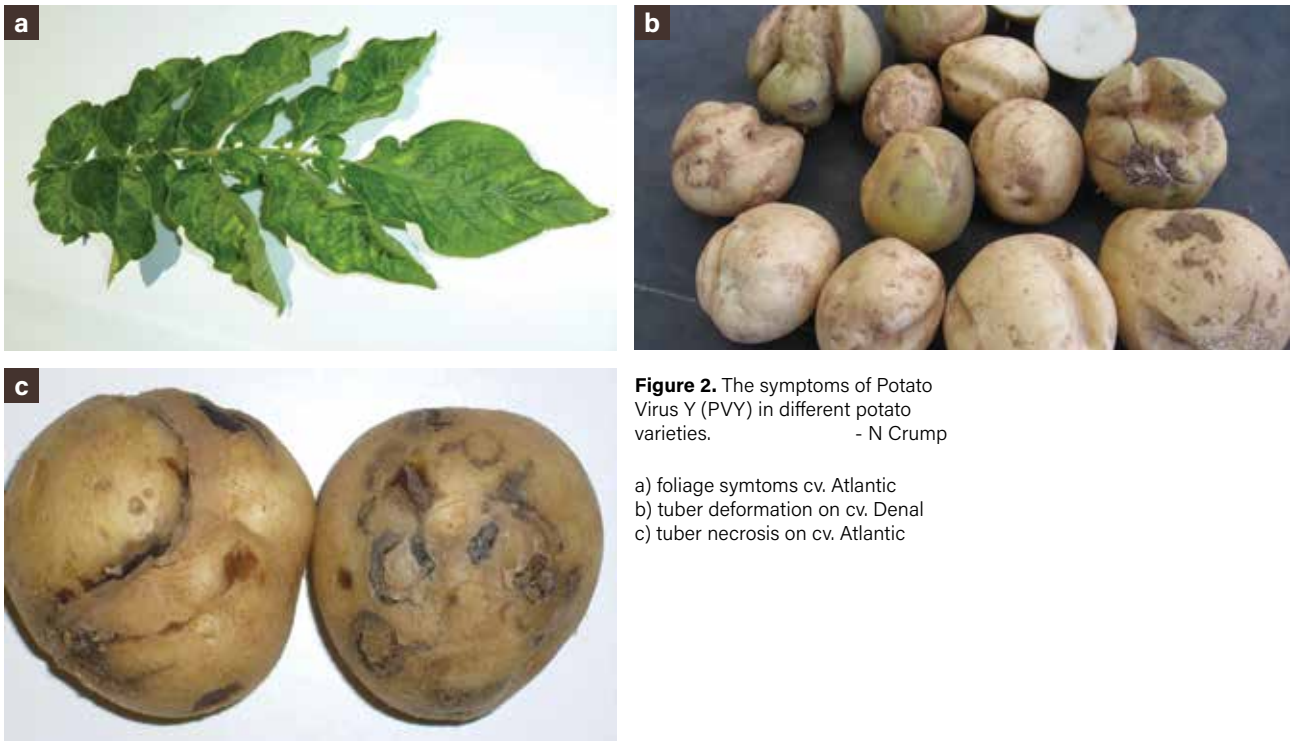

Figure 2. The symptoms of Potato Virus Y (PVY) in different potato varieties. - N Crump

a) foliage symtoms cv. Atlantic
b) tuber deformation on cv. Denal
c) tuber necrosis on cv. Atlantic

damage in tubers of susceptible cultivars, which is known as potato tuber necrotic ringspot disease (PTNRD).

PVY COST TO POTATO PRODUCTION

PVY is a potyvirus that causes significant economic loss in yield and quality of potatoes worldwide. A study in the US found that for every 1% of PVY in the seed, the yield of the subsequent crop was decreased by 0.18 t/ha, as PVY decreased marketable yield and tuber size (5).

In the US state of Idaho, which produces about 7.1m tonnes of potato worth US$1b annually, the losses due to PVY were valued at US$34m (6). It was estimated that 10% PVY infection in seed could decrease commercial crop returns by US$225–300 per hectare depending on the market sector.

In Australia, there has been no economic study on PVY. However individual crop losses of up to 90% have been reported when crops were grown from seed with high levels of PVY. If not effectively managed, PVY will have significant economic impact on the Australian potato industry.

FLATTENING THE CURVE ASSOCIATED WITH PVY

Until recently, seed potato crops were entirely assessed for PVY symptoms using visual inspections during the growing season. This became problematic as PVY strains that have very mild or no symptoms in foliage can therefore be missed by visual inspection.

In 2010, AuSPICA introduced mandatory leaf testing of all seed stocks, including all generations of certified seed potatoes that were issued with official certification labels. This involved the collection and laboratory testing of over 17,000 samples of leaves annually from around 2000 ha of seed crops throughout Victoria, South Australia and Northern New South Wales. This large surveillance program supplements the visual inspection of seed crops for certification, and – importantly – identifies seed lots that have shown no visual symptoms of PVY. The plants showing no symptoms can act as a reservoir for PVY to carry over between seasons.

The PVY surveillance program conducted by AuSPICA has been successful in mitigating the risk of PVY in certified seed potato crops. We have reduced the amount of seed crop rejection due to viruses, which includes PVY, from 7% in 2010/11 to 0.3% in 2021 (Figure 3). This surveillance has resulted in the flattening of the curve associated with PVY. This provides the Australian potato industry with high-quality certified seed that has the potential to achieve maximum yield and quality, without the adverse impact of Potato Virus Y.

SUCCESS IN RELATION TO THE SUPPRESSION OF PVY

Significant effort has been made by the entire seed potato industry to reduce PVY to extremely low levels. This should be celebrated by the whole industry. The use of laboratory diagnostics to support certification provides verification as to the quality of certified seed crops, especially in relation to PVY. Seed buyers have

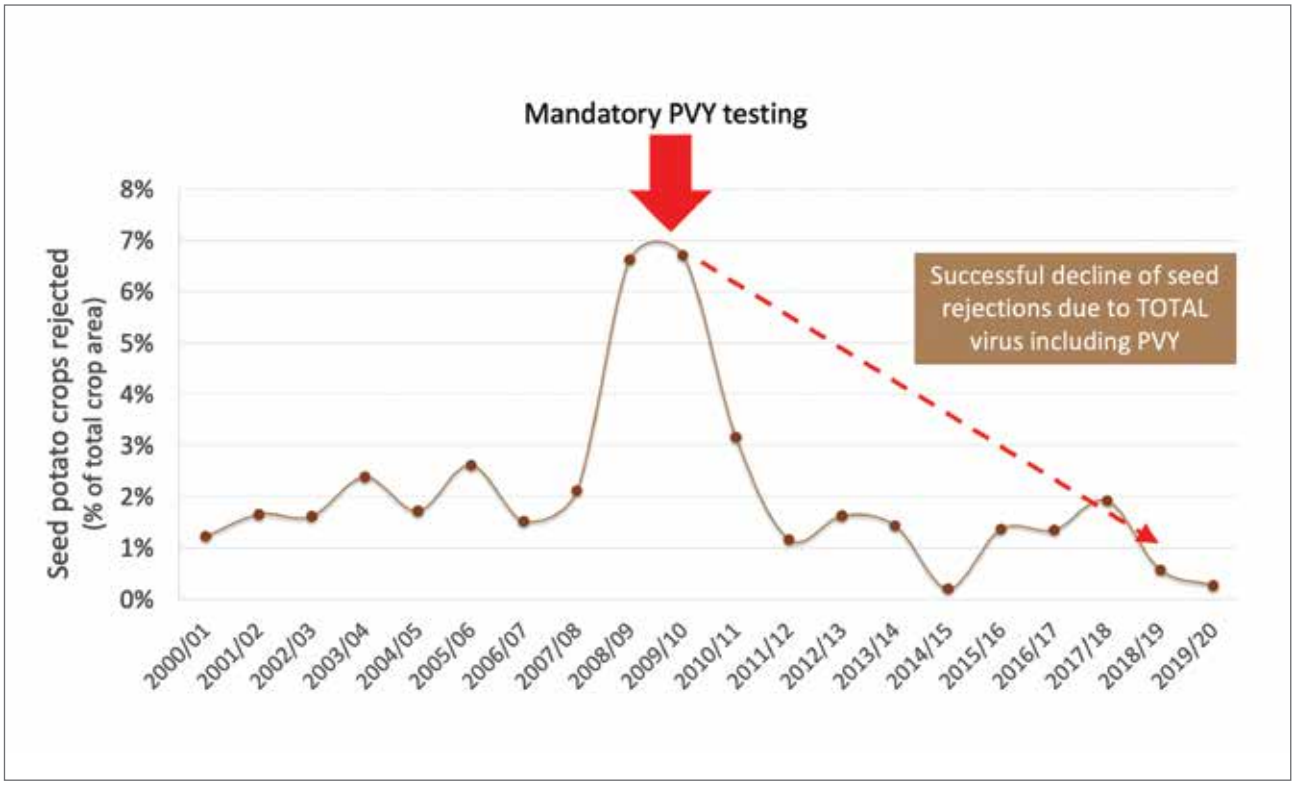

Figure 3. Crop rejection due to presence of viruses (including PVY) as a percentage of the total crop area submitted to the AuSPICA seed potato certification scheme, from 2000 to 2021.

confidence in the extremely low levels of PVY in certified seed potatoes. Certified seed producers have greater awareness of PVY and have adopted integrated management strategies to mitigate PVY in seed crops.

NEW DIRECTIONS

AuSPICA has now adopted DNA-based diagnostics to detect PVY in potato leaves and tubers to ensure high-throughput testing capacity and more affordable tests are available.

New technology is available to sample insect populations and determine the presence of known insect vectors of PVY. This technology will provide growers with more information about the movement of aphids that can spread PVY and allow for more informed management decisions.

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