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A virus survey of seed potato generation 4 and 5 crops, 2018

Fletcher JD

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EXECUTIVE SUMMARY

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A survey of seed, fresh and process potato crops in 2014 (Fletcher 2014) determined changes in the patterns of virus incidence compared to past surveys. *Potato virus S* (PVS) was the most widespread virus detected in 90% of crops, *Potato virus M* (PVM) and *Potato virus A* (PVA) were present in around one third of crops and *Potato virus Y* (strain PVY^{N}) present in 17% of crops. High incidences of these viruses, especially in some seed crops, were of concern to Potatoes New Zealand who felt further exploration of the problem was required. Of concern was the detection in this survey of a recombinant isolate of $PVY^{N:O}$ not previously found in New Zealand. In 2018, with the cooperation of growers and merchants, 43 seed generation 4 and 5 potato crops were surveyed from Canterbury, Manawatu and Auckland during January – March 2018.

The objectives were:

- To estimate the ranges of incidence of the potato viruses X, Y, S M, A and *Potato leafroll virus* (PLRV) within potato seed Generations 4, 5 and 6 compared to previous surveys
- To measure the relative proportions of potato virus Y strains Y^{N}, Y^{C} and Y^{O} within the seed crop population
- To determine the presence of any new recombinant strains of PVY in seed crops
- Where crops with low virus incidence are detected, key crop and seed management practices will be explored by consultation and discussion with those growers
- To make recommendations to improve virus health in seed crop production.

Incidences of all viruses were up from the last survey (Fletcher 2014). Some increases were marginal, such as PVX and PVY. PVY^{N} appears to be under a consistent level of control, likely because of high insecticide use to control tomato potato psyllid. (TPP). It is unfortunate that we were not able to determine if $PVY^{N:O}$ was still present in seed crops so further work on this will need to be done in the future. PVS continues to be widespread and at high incidence in over 50% of crops with, mechanical transmission is likely the primary cause of spread. It worth noting that 25% of crops did have PVS incidences below 10% and this is an indication that some growers are making a serious effort and having some success in minimising PVS incidence in their seed lines. PVM was more widespread, with more crops affected and at higher incidences. PVA, while only at low levels is more widespread, again possibly contained by insecticides and by the resistance of many cultivars. PLRV incidence increased after trending down in past surveys (Fletcher 1996;:2012; 2014). It is likely (as has happened in the past) that late aphid flights may have transmitted some PLRV to regrowth in seed crops.

Key points arising from discussions and communications concerning seed production were:

- Nuclear seed production — pre G1 mini tubers were produced under hygienic protected conditions well isolated from subsequent generations
- Seed storage —strict isolation and segregation of seed tubers from other potato generations while in cool stores
- Isolation of subsequent generations — the cleanest early generations were multiplied on land not previously used for potato production. Some seed crops were isolated from other potato production areas
- Whole seed preference — whole seed tubers planted to avoid unnecessary cutting thus reducing the risk of mechanical damage and virus transmission
- Seed cutting — if seed was cut strict sanitation of cutters with suitable disinfectants was undertaken. Attempts are being made to reduce or eliminate seed cutting
- Planting — sanitation between early generations. Some growers were using cleaned equipment to plant early generations to help maintain virus health
- Intensive insecticide spray programmes — planting with a tuber or in furrow treatment then spraying 7–10 days in order to further protect crops from both aphids and tomato potato psyllid. Careful use of differing mode of action chemicals every second or third spray. Chemicals were usually ground applied
- Early spray off — post certification early herbicide spray off with insecticide, monitoring for regrowth or missed plants then further follow up spray off .

Ideally earliest generation crops, especially generation 1 (G1) and generation 2 (G2) should be fully isolated from subsequent generations. Hygienic management of these crops sets the scene for what will follow. Separate storage of early generations also helps maintain high health. The move toward whole seed planting of varieties that are currently cut is commendable in that it removes one important aspect of seed damage.

Further areas to explore to sustain crop health are the use of barrier crops between generations, e.g. cereal strips laid down to slow and disrupt aphid/psyllid movement between plantings and to further expand glasshouse grown nuclear, G1 and G2 seed production in order to contract the seed production period from 5–6 generation down to 4 to 5.

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1 INTRODUCTION

A survey of seed, fresh and process potato crops in 2014 determined changes in the patterns of virus incidence compared to past surveys. *Potato virus S* (PVS) was the most widespread virus detected in 90% of crops and *Potato virus M* (PVM) and *Potato virus A* (PVA) were present in around one third of crops and *Potato virus Y* (strain PVY^{N}) present in 17% of crops. High incidences of these viruses, especially in some seed crops, were of concern to Potatoes New Zealand who felt further exploration of the problem was required. Of concern was the detection in this survey of a recombinant isolate of $PVY^{N:O}$, not previously found in New Zealand. In 2018, with the cooperation of growers and merchants, 43 seed potato crops were surveyed from Canterbury, Manawatu and Auckland during January – March.

The objectives were:

- To estimate of the ranges of incidence of the potato viruses X, Y, S M, A and *Potato leafroll virus* (PLRV) within potato seed Generations 4, 5 and 6 compared to previous surveys
- To measure the relative proportions of potato virus Y strains Y^{N}, Y^{C} and Y^{O} within the seed crop population
- To determine of the presence any new recombinant strains of PVY ($Y^{N:O}$) in seed crops
- Where crops with low virus incidence are detected, key crop and seed management practices will be explored by consultation and discussion with those growers
- To make recommendations to improve virus health in seed crop production.

2 METHODS

2.1 Virus survey

With the cooperation of growers and merchants, 43 seed crops were surveyed from Auckland, Canterbury and Manawatu during January – March 2018. The survey focussed on seed generations 4 to 6. Based on the method used in past surveys in each crop (Fletcher 1993; Fletcher et al. 1996), 100-leaf samples were randomly collected by the seed merchants or their representatives, usually in a 'W' pattern, cool stored and sent to Plant & Food Research, Lincoln. Serological assays were completed on each field sample for potato viruses X, Y, S, M, A and PLRV using samples grouped in 10. Any positive PVY groups were further tested serologically using monoclonal antibodies (MAbs) to PVY^N and a combination antibody to strains PVY^O and Y^C, by host inoculation to *Nicotiana tabacum* and molecular analysis (Ministry for Primary Industries, Auckland) to further confirm the strains of PVY. Virus incidence was estimated using tables (Fletcher 1996) derived using the formula of Gibbs and Gower (1962). Unlike the previous survey no differentiation of PVS strains was undertaken in this survey.

2.2 Low virus incidence crop practices

Merchants and seed growers were approached for further details on key practices undertaken to maintain good virus health.

3 RESULTS

3.1 Virus survey

Only seed from generations 4 and 5 were submitted for testing. Full survey results are presented in Table 1, which summarises the number of infected crops and the percentage incidences of potato viruses X, Y, S, M, A and PLRV detected in a survey of the 43 crops. Figure 1 presents a comparison of mean incidence of six viruses including the strain PVY^N from eight potato crop surveys completed over the past 27 years.

Table 1. Crops infected and estimated incidences (%) of potato viruses X (PVX), Y (PVY), PVY strain Y^N (PVY^N), S (PVS), M (PVM), A (PVA) and Potato leafroll virus (PLRV) detected in a survey of 43 seed potato crops from Auckland, Manawatu and Canterbury in 2018.

Cultivar	Gen	PVX	PVS	PVM	PVA	PLRV	PVY	PVYN	PVYo/c
'Innovator'	4	0	100	21	0	0	0		
'Innovator'	4	0	100	21	0	0	0		
'Innovator'	5	0	100	15	0	0	1		1
'Innovator'	4	0	100	2	0	0	0		
'Hermes'	5	0	7	0	0	0	0		
'Russet Bank'	4	0	100	0	0	0	0		
'Lady Rosetta'	4	0	100	1	0	0	0		
'Innovator'	4	0	100	2	0	0	1	1	
'Innovator'	4	0	100	1	0	0	0		
'Innovator'	4	0	100	100	0	0	0		
'Russet Burbank'	4	0	100	100	0	1	0		
'Russet Burbank'	4	0	100	15	0	2	1	1	
'Agria'	4	0	3.5	2	0	0	0		
'Agria'	5	0	3.5	0	0	0	0		
'Agria'	5	0	100	0	2	1	0		
'Moonlight'	4	0	5	0	2	0	0		
'Moonlight'	5	0	21	0	1	0	0		
'Moonlight'	5	0	7	0	0	0	0		
'Agria'	4	0	0	0	1	1	0		
'Russet Burbank'	4	0	100	0	0	3.5	0		
D4	4	0	0	0	0	3.5	0		
D4	5	0	7	0	2	3.5	0		
'Agria'	2	2	2	0	2	0	5	5	
'Agria'	4	0	3.5	0	0	1	0		
'Moonlight'	4	1	7	0	0	1	5	7	
'Moonlight'	4	2	7	0	1	1	3.5	3.5	
'Agria'	4	0	1	2	0	0	0		
'Moonlight'	5	0	100	21	0	0	0		
'Agria'	4	0	20.5	2	0	1	0		
'Agria'	5	0	7	3.5	0	1	0		
'Ranger Russet'	4	0	100	11	0	2	0		

Cultivar	Gen	PVX	PVS	PVM	PVA	PLRV	PVY	PVYN	PVYo/c
'Ranger Russet'	5	0	100	21	0	3	0		
'Moonlight'	4	0	3.5	21	0	0	0		
'Moonlight'	5	0	20.5	15	0	0	0		
'Innovator'	5	0	100	100	0	0	0		
'Moonlight'	5	0	11	3.5	0	0	2	2	
'Agria'	5	0	0	5	0	0	0		
'Lady Rosetta'	4	0	0	0	0	0	0		
'Ranger Russet'	4	0	100	20.5	2	0	9	7	2
Russet Burbank	4	0	100	100	1	0	2		2
'Innovator'	4 and 5	0	100	100	0	0	0		
'Russet Burbank'	4 and 5	0	100	100	0	0	0		
'Ranger Russet'	5	0	100	100	0	0	0		
T=43									
No. of crops inf.		3	39	27	9	14	9	7	3
% Crops infected		6.9 (7)	95.2 (95)	62.7 (63)	20.1 (21)	32.5 (33)	20.1 (21)	16.2 (16)	6.9 (7)
Range of incidence		0-2	0-100	0-100	0-9	0-3.5	0-9	0-7	0-2
	Crops with a virus incidence below 10%								

Survey results from 2018 are summarised in Table 1, with historical survey trends graphically summarised in Figure 1. From the survey, only one crop of 'Lady Rosetta' was found free of detectable virus, eight crops at 5% incidence or below and 11 crops at 10% incidence or below. PVS was at the highest incidence present in 91% of surveyed crops. PVS was detected throughout both generations and usually at high estimated incidence within the seed lines (0–100%), similar to the previous survey. Note: 100% equates to all 10 group samples testing positive, estimated percentage incidence within the crop will actually range between 20% and 100%. Only in three crops was PVS not detected.

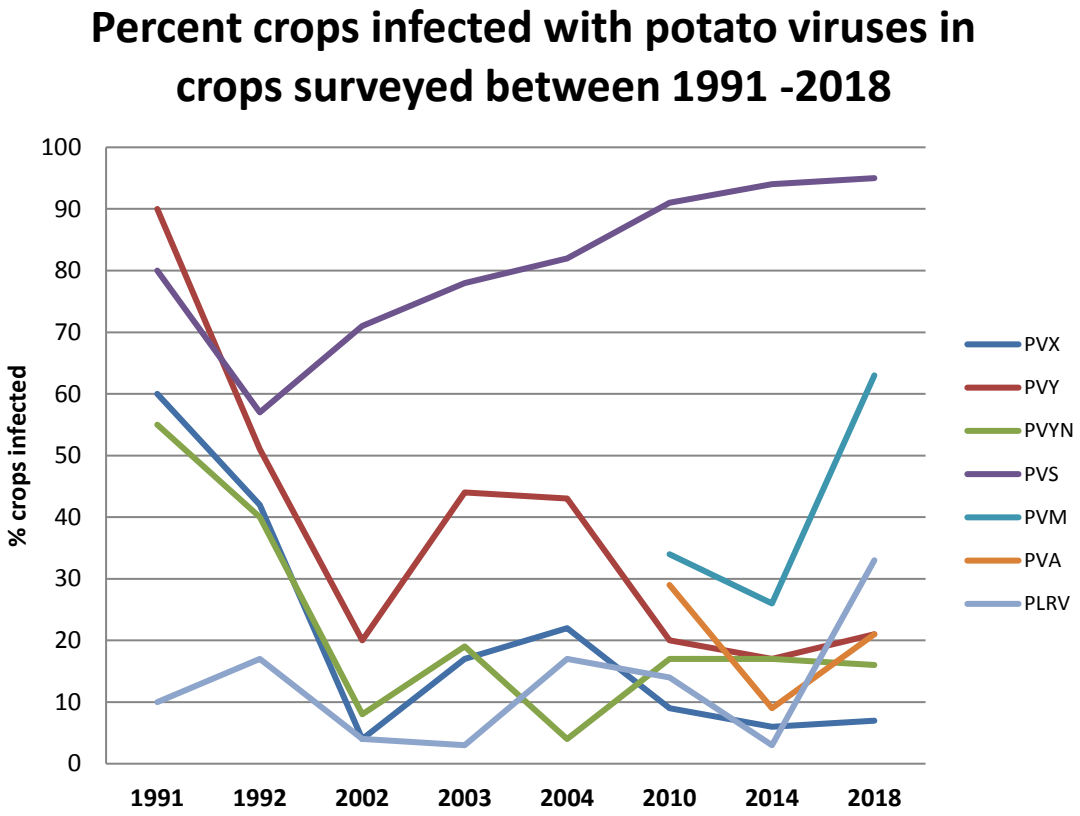

Figure 1. Percentage of potato crops infected with potato viruses PVX, PVY, PVY strain PVY^{N}, PVS, PVA, PVM and Potato leafroll virus (PLRV) from seven surveys completed over 27 years from 1991 to 2018.

PVM was next highest in presence in about 63% of crops, double that of the last survey (Fletcher 2014) and at a high incidence of up to 100% in a number of crops.

PVA was present in 21% of crops, more than double the previous survey albeit at a very low incidence within crops (0–2%).

PVX was present in three crops (7%), again at 1–2% incidence similar to the last survey.

Potato leafroll virus was detected in 35% of crops at up to 3.5% incidence, up considerably from the last survey, albeit at low incidence.

PVY was detected in 21% of crops, up a little from the previous survey with incidences within crops of up to 9%.

PVY^{N} was confirmed present with monoclonal antibodies as was PVY Y^{C} and PVY^{O}. Further sequencing by the Ministry for Primary Industries (MPI) only confirmed one sequence of PVY^{N}. Unfortunately purification quality was inadequate to further characterise all eight submitted isolates so examination for recombinant strains could not be completed. From the monoclonal data, incidence of PVY^{N} was 16%, similar to the 17% recorded in the previous survey, with Y^{C} and PVY^{O} at 7%.

3.2 Low virus incidence crop practices

Key points arising from discussions and communications concerning seed production were:

- Nuclear seed production — pre G1 mini tubers were produced under hygienic protected conditions well isolated from subsequent generations
- Seed storage —strict isolation and segregation of seed tubers from other potato generations while in cool stores
- Isolation of subsequent generations — the cleanest early generations were multiplied on land either not previously used for potato production over a 5 year rotation. Some seed crops were isolated from other potato production areas
- Whole seed preference — whole seed tubers planted to avoid unnecessary cutting thus reducing the risk of mechanical damage and virus transmission
- Seed cutting — if seed was cut, strict sanitation of cutters with suitable disinfectants was undertaken. Attempts are being made to reduce or eliminate seed cutting
- Planting — sanitation between early generations. Some growers were using cleaned equipment to plant early generations to help maintain virus health
- Intensive insecticide spray programmes — planting with a tuber or in furrow treatment then spraying 7–10 days to further protect crops from both aphids and tomato potato psyllid. Careful use of differing mode of action chemicals every second or third spray. Chemicals were usually ground applied.
- Early spray off — post-certification early herbicide spray off with insecticide, monitoring for regrowth or missed plants, then further follow up spray off.

4 DISCUSSION

Incidences of all viruses was up from the last survey (Fletcher 2014). Some increases were marginal such as PVX and PVY. It is encouraging that PVY and especially PVY^{N} appears to be under a consistent level of control, likely because of high insecticide use to control tomato potato psyllid. It is unfortunate that we were not able to determine if $PVY^{N:O}$ was still present in seed crops so further work on this will need to be done in the future. This strain is associated with the damaging tuber necrosis disease present in other parts of the world and was detected in a crop of 'Innovator' in the last survey. PVS continues to be widespread and at high incidence in over 50% of crops. As previously indicated in past reports, mechanical transmission is likely the primary cause of transmission. It is worth noting that 25% of crops did have PVS incidences below 10% and this is an indication that some growers are making a serious effort, and having some success, minimising PVS incidence in their seed lines. PVM was more widespread in incidence with more crops affected and at higher incidences. This virus is closely related to PVS with similar means of transmission. Yield losses from PVM are usually 10–20% although some virulent strains may cause more severe leaf deformation and lead to higher yield losses of up to 50% (INRA 2017). PVA, a virus related to PVY, while only at low levels is more widespread, again possibly contained by insecticides and by the resistance of many cultivars.

PLRV incidence was a surprise after trending down in past surveys and rarely being seen during inspections. It is likely as has happened in the past that late aphid flights may have transmitted some leafroll to regrowth in seed crops. It may pay to be vigilant with rogueing next season.

Crop practices which sustain low virus incidence should be no surprise to most seed growers as most try to undertake these. Isolation of generations especially early generations continues to be important. Ideally, earliest generations, especially generation 1 (G1) and generation 2 (G2) should be kept well away from any subsequent generation crops, preferably in isolation from any other potatoes. Hygienic management of these crops is paramount as they set the scene for what will follow. Separate storage of early generations also helps maintain high health. The move toward whole seed planting of varieties that are currently cut is commendable in that it removes one important aspect of seed damage.

Where close generation is unavoidable, generous row breaks are a fall back. In my opinion a single row break is not enough when a crop has reached full cover. A two row distance is better than one, and where feasible three is better than two.

A further area to explore sustain crop health might be the use of barrier crops between generations, e.g. cereal strips laid down to slow and disrupt aphid/tomato potato psyllid movement between plantings. A review of equipment hygiene practices is well worth a visit. Questions to consider might be: are you using cleaned planting equipment and bins, are you cleaning between planting blocks, are you moving from earliest to latest generations, are you attending to perimeter weeds and volunteers?

Long–term, a desirable goal might be to further expand glasshouse grown nuclear, G1 and G2 seed production in order to contract the seed production period from a maximum of 5–6 generation down to 4 to 5. This concept has often been discussed in the past and perhaps should be once again.

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