Why it matters keeping deciduous trees free from scheme viruses.

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Patho Solutions, South Africa

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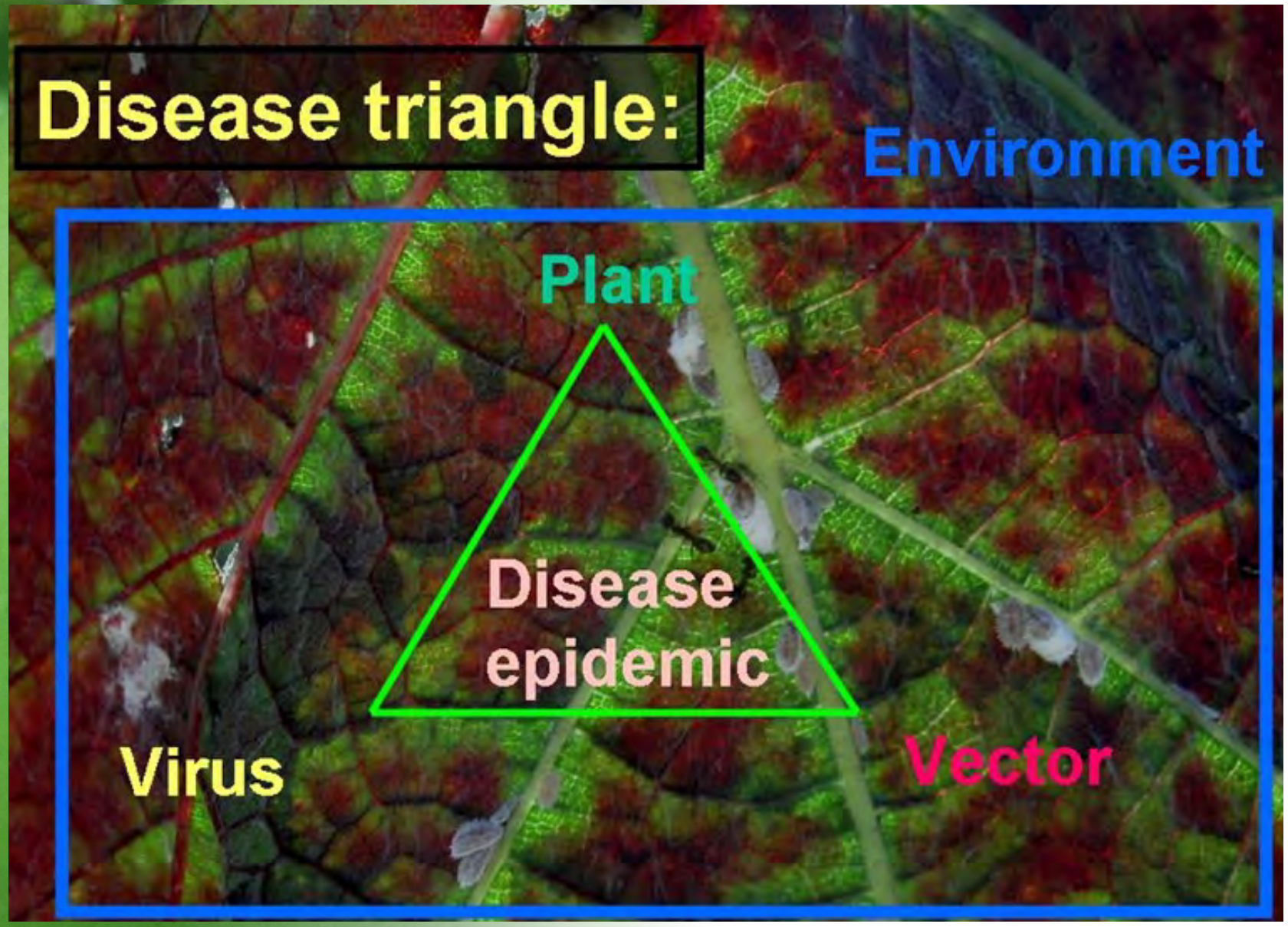
HORTGRO
Growing Fruit IQ

To control a virus diseases, it is important to understand its epidemiology.

Disease triangle

Determine weaknesses amongst the components interacting in the disease.



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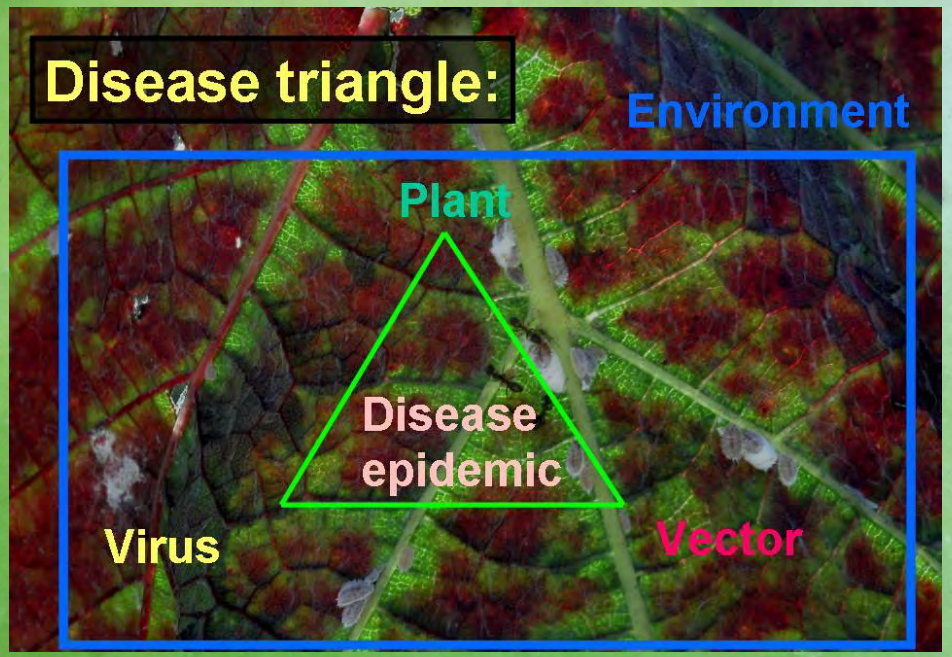
Virus Control strategies

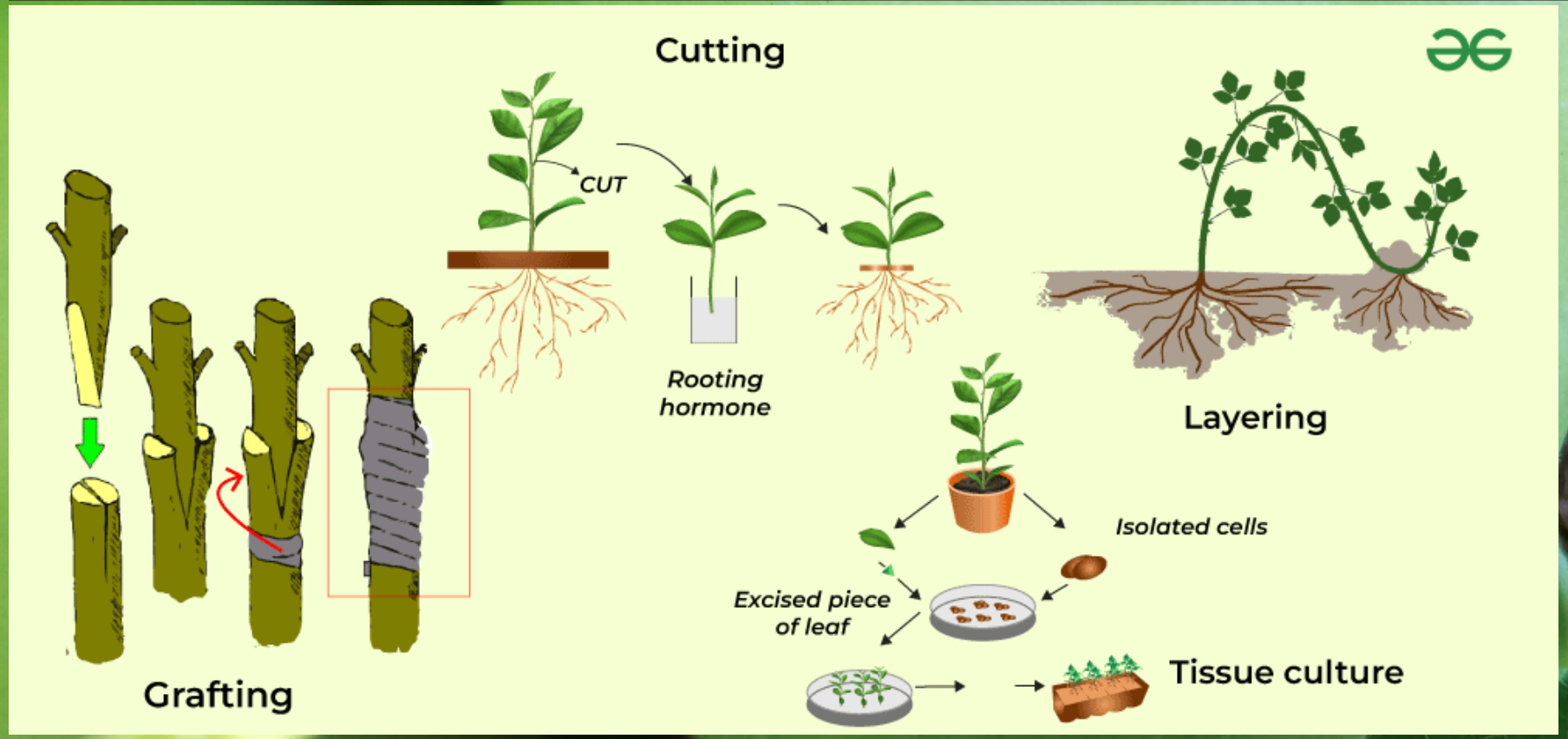


Control Strategies

- **Vector control**
- **Resistant cultivars**
- **Eliminate/Reduce sources of virus.**
- **Modify environment**

In vegetatively propagated crops (including stone and pome fruit) the presence of viruses in planting material play a major role in the epidemiology of the diseases they cause.

Most, if not all the progeny plants being infected by the virus.



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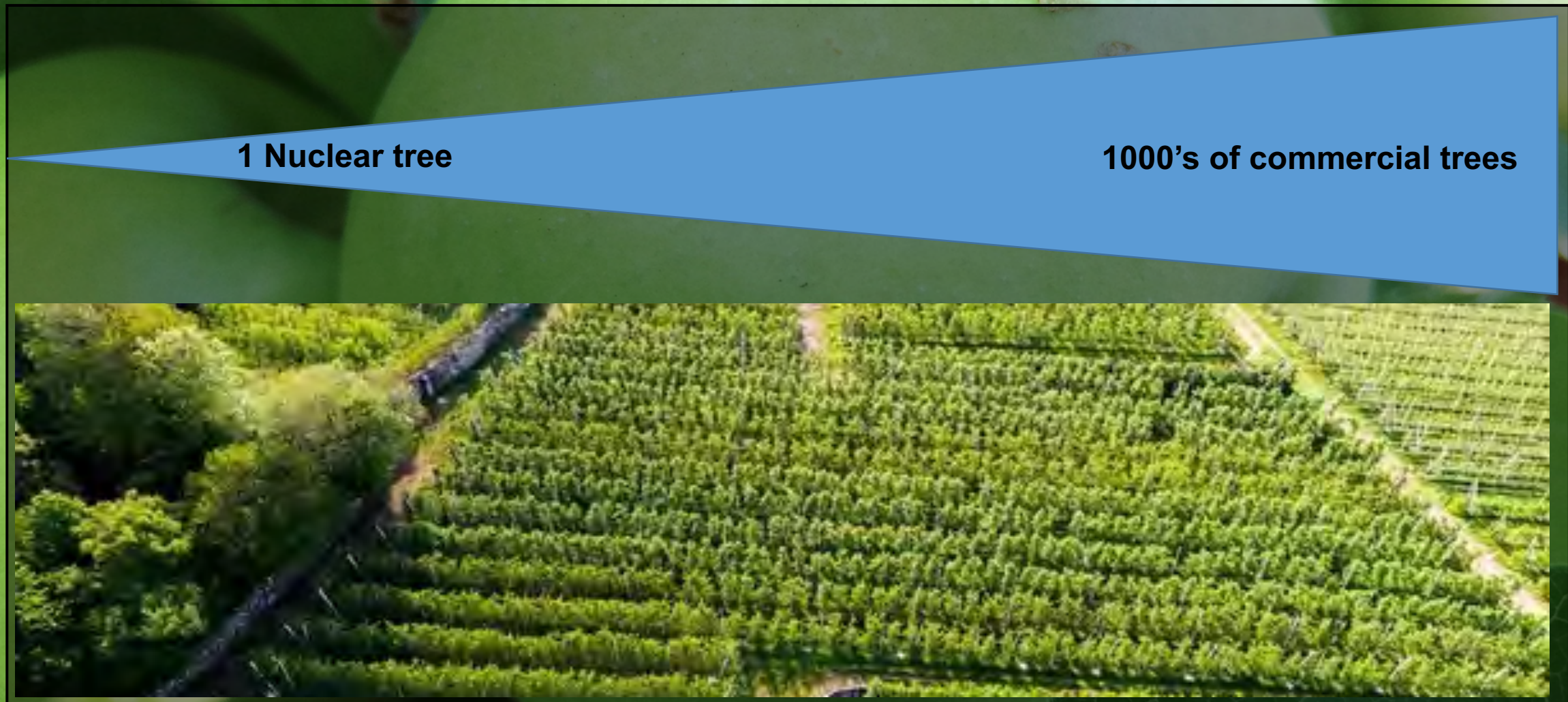
Viruses in starting (or “nuclear”) material results in thousands of infected progeny plants.

Even small adverse effect of viruses important under these conditions.



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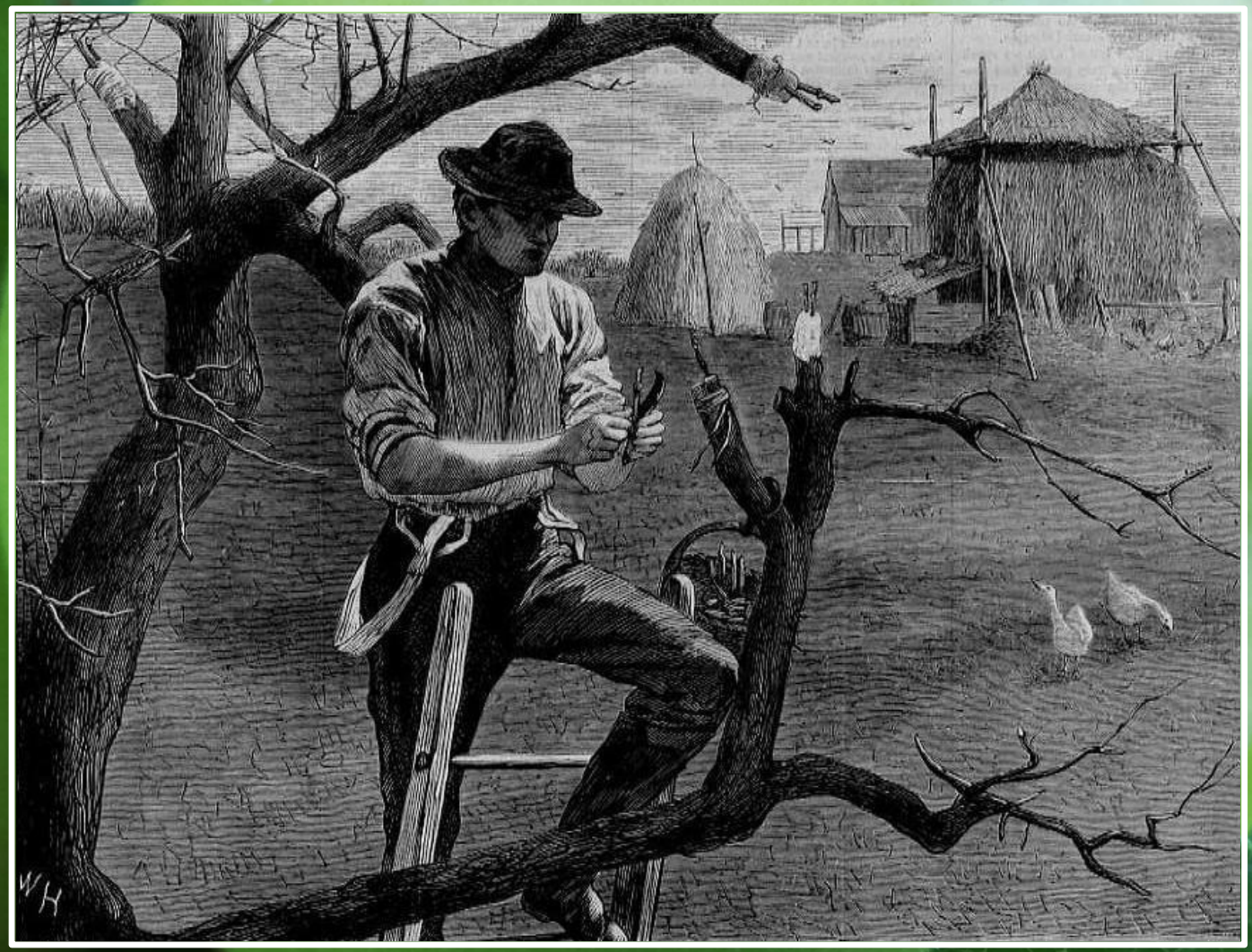
Vegetative propagation of Apple and Pears is more than 150 years old.



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Propagation of Pome and Stone fruit is almost exclusively by vegetative propagation in modern times .

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All viruses are transmitted by grafting of infected material.

Scion material (fruit bearing cultivar) grafted onto rootstock (desirable horticultural properties e.g. disease resistant).

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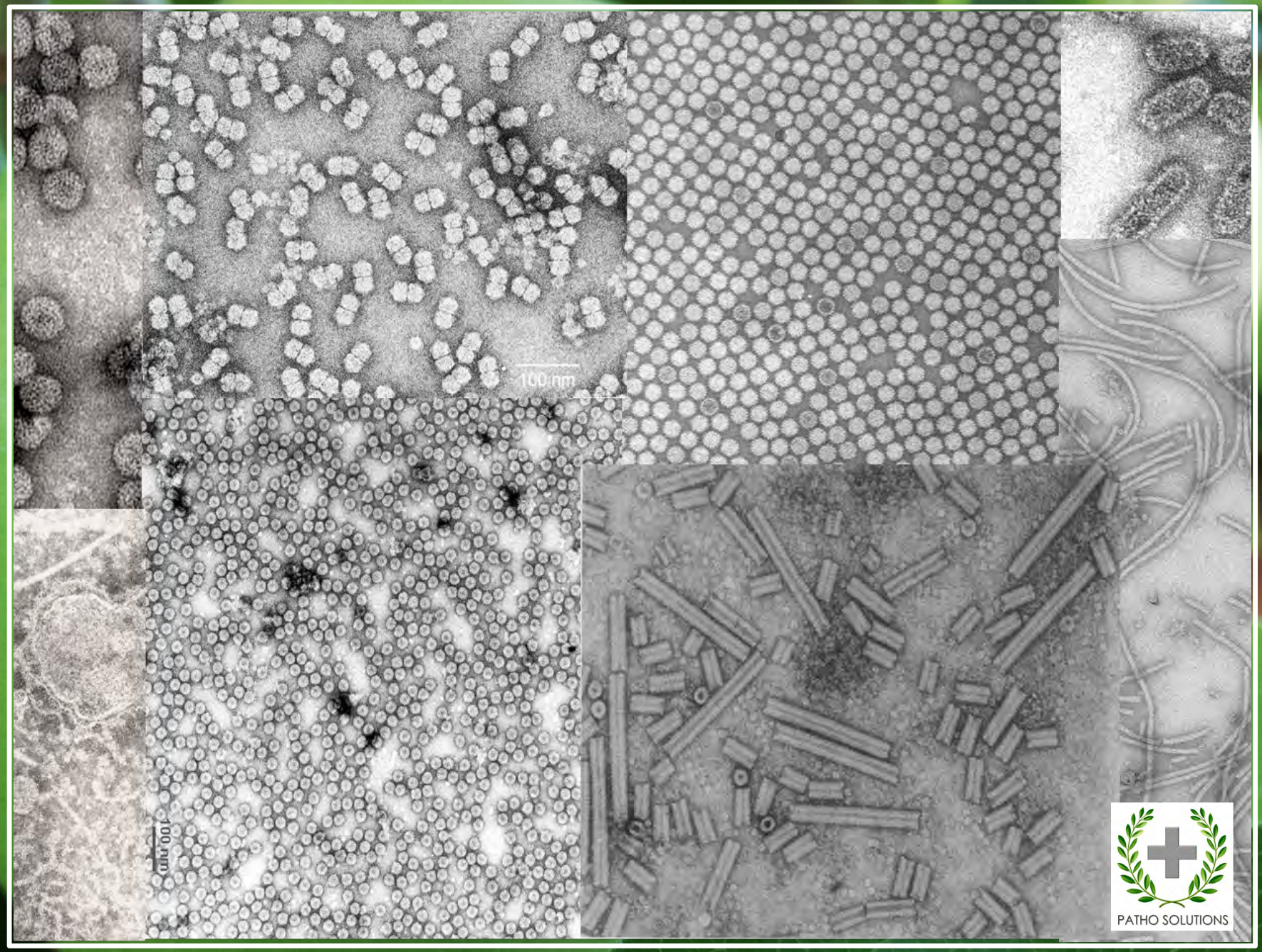
Must have a “virus elimination step”, (seed or other), or starting with clean material -have accumulation of viruses in cultivated Apples and Pears.

Will also often results in mixed infections of multiple viruses.



What are the “scheme” viruses:

Pome fruit:

- Apple stem pitting virus (ASPV)
- Apple stem grooving virus (ASGV)
- Apple chlorotic spot virus (ACLSV)
- Apple mosaic virus (ApMV)

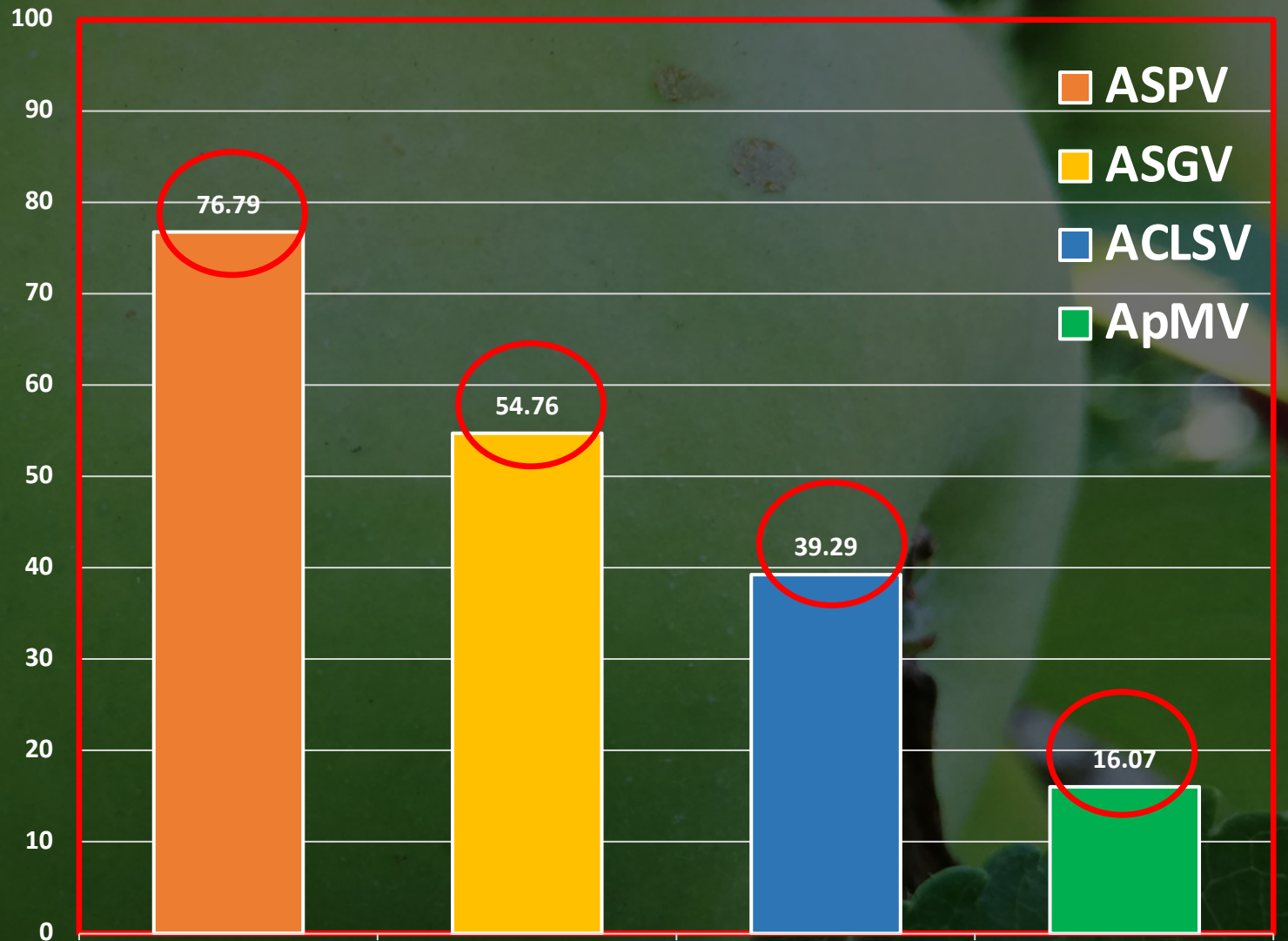
Stone fruit:

- ASPV
- ASGV
- Prune dwarf virus (PDV)
- Prunus necrotic ringspot virus (PNRSV)

Percentage of Apple orchards (n = 168) infected by scheme viruses.

What is the situation in South Africa?

Recent survey in **apples** for scheme viruses.
1008 trees tested in 168 orchards in five major production areas.



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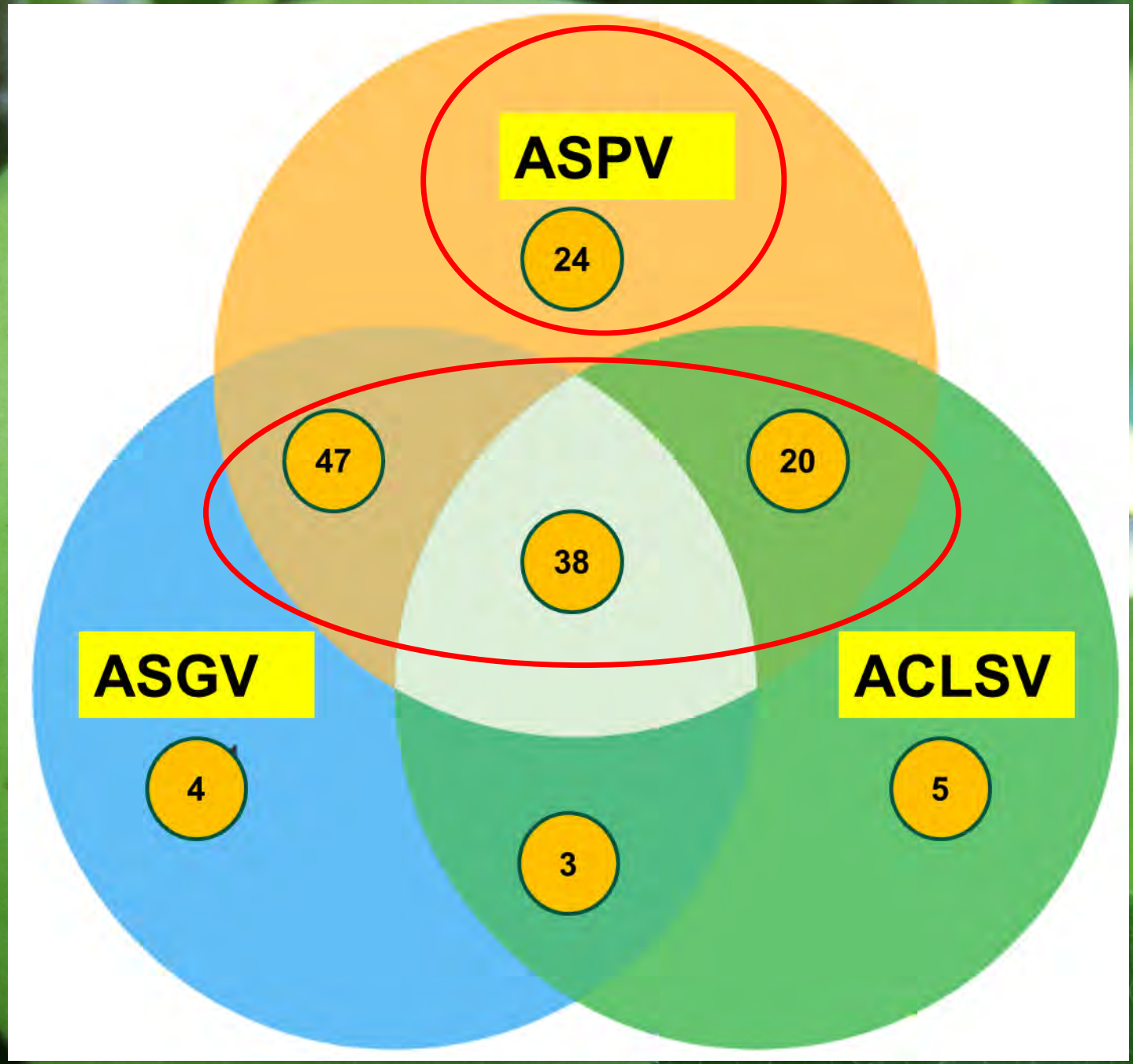
Results of a recent survey in apples.

Number of orchards tested with specific combinations of ASPV, ASGV and ACLSV.



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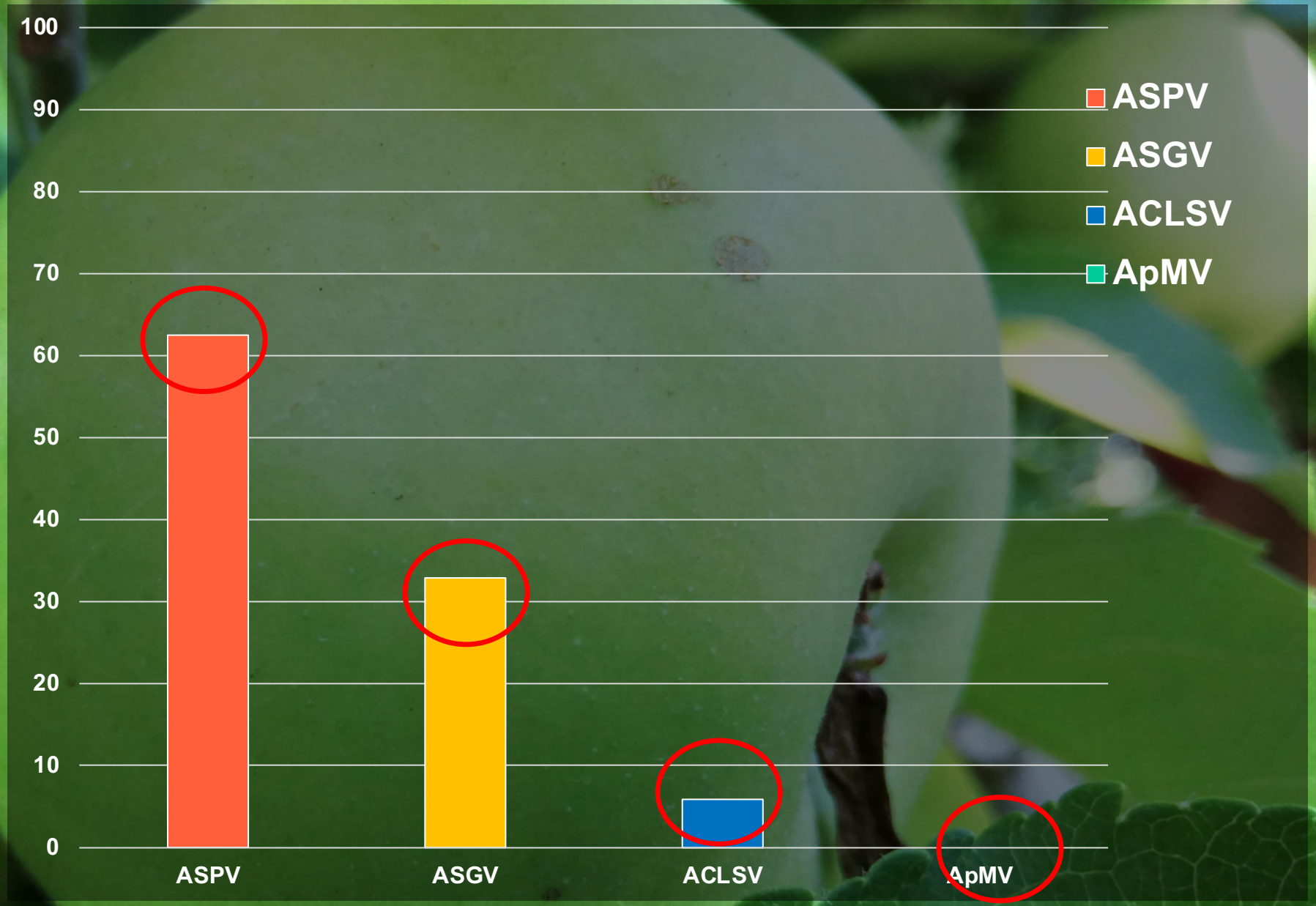
Results of a recent survey in pears (962 trees tested in 152 orchards in 5 major production areas).

Percentage of orchards (n = 152) infected by scheme viruses.



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Transmission properties of scheme viruses

Mode of transmission	Virus					
	Pome fruit		Stone fruit			
	ASPV	ASGV	ACLSV	ApMV	PDV	PNRSV
Vegetative propagation	yes	yes	yes	yes	yes	yes
Grafting	yes	yes	yes	yes	yes	yes
Seed transmission	no	yes (low)	no	no	yes	yes
*Vector	no	no	no	no	Thrips?	Thrips?
Pollen Transmission (Horizontally)	no	no	no	no	yes	yes
Pollen Transmission (Vertically)	no	no	no	no	yes	yes
Mechanical transmission	experimentally	experimentally	experimentally*	experimentally*	*experimentally	yes
Field spread	root grafting	root grafting	root grafting	root grafting	yes	root grafting

*inefficient experimental mechanical transmission with sophisticated buffers

Planting material

In field (re-infection)

Planting material

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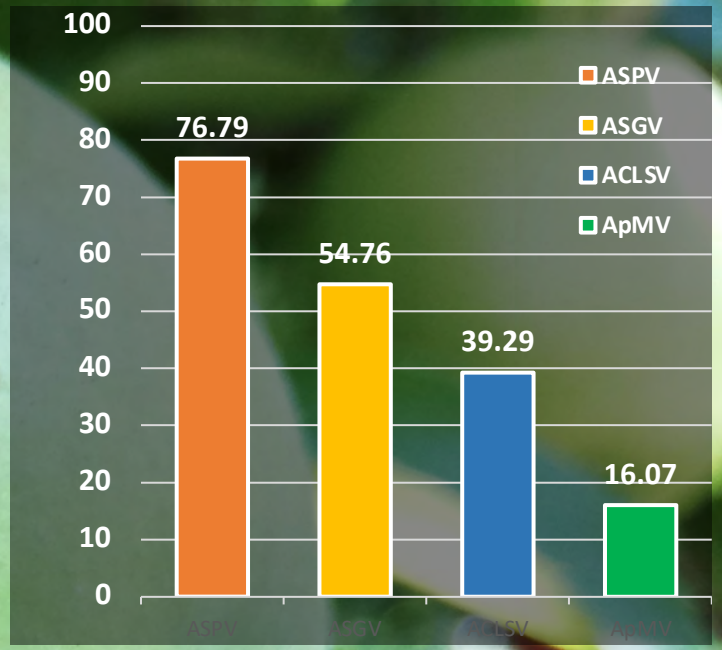
Mode of transmission	Virus			
	Pome fruit			Ston
	ASPV	ASGV	ACLSV	ApMV
Vegetative propagation	yes	yes	yes	yes
Grafting	yes	yes	yes	yes
Seed transmission	no	yes (low)	no	no
*Vector	no	no	no	no
Pollen Transmission (Horizontally)	no	no	no	no
Pollen Transmission (Vertically)	no	no	no	no
Mechanical transmission	experimentally	experimentally	experimentally*	experimentally*
Field spread	root grafting	root grafting	root grafting	root grafting



Incidence of scheme viruses in pome fruit probably solely due to use of infected planting material.

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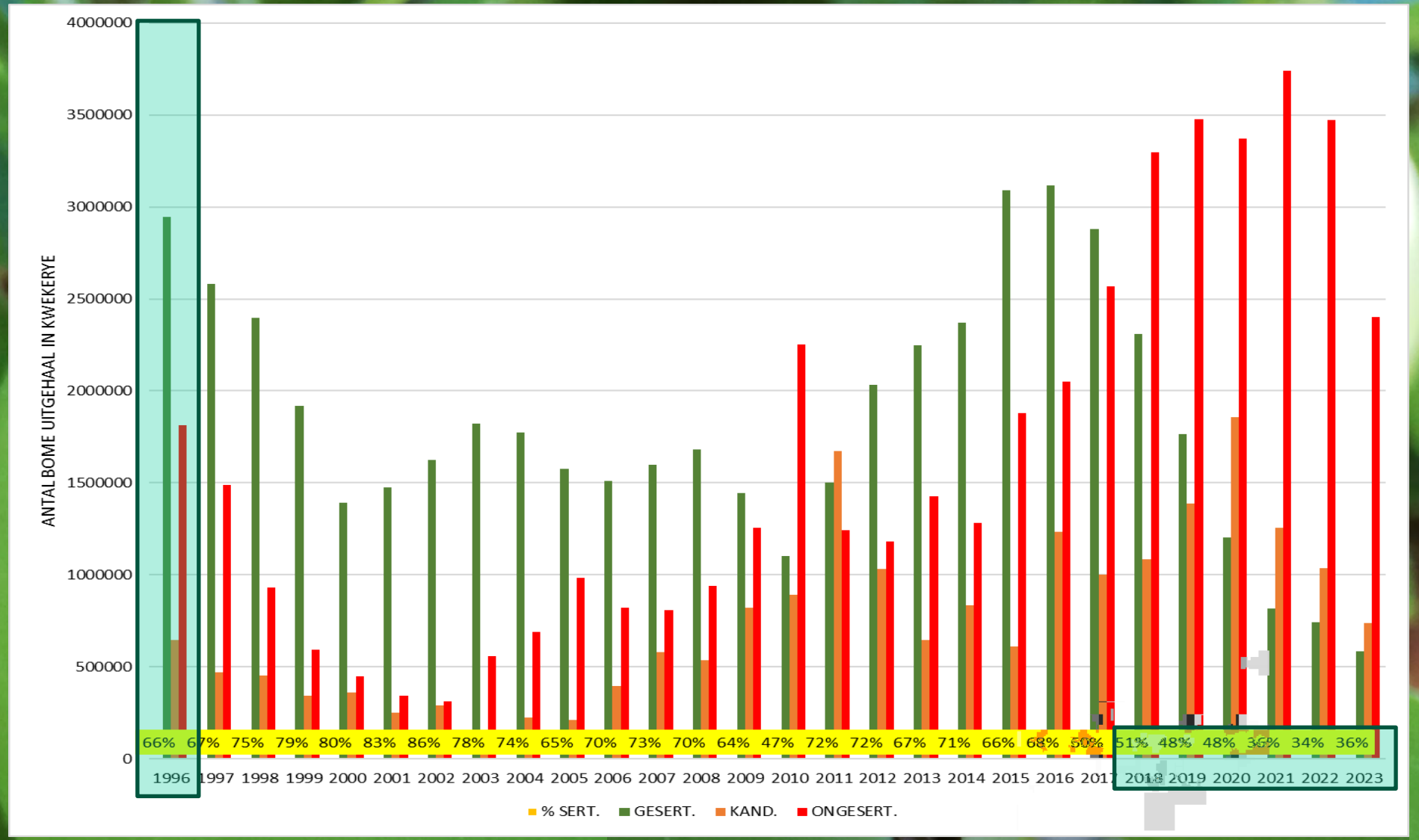
Uptake of certified planting material is extremely poor.



Graph, courtesy of Rachel Kriel PlantSA.

spvidpa
SAGTEVRUGTEPLANTVERBETERINGSVERENIGING
DECIDUOUS FRUIT PLANT IMPROVEMENT ASSOCIATION

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Irony: Because most pome fruit viruses lack a vector, control by planting healthy plant material will eliminate these viruses from the industry (as done for apple rubbery wood disease in the UK)

Ensure have virus-free nuclear material of scions and rootstocks. Do this by:

1) selection of virus free material or
2) subject starting material to virus-elimination processes.

No need for further tests downstream, if grafted material all traceably derived from nuclear material.

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Mode of transmission	Virus					
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*inefficient experimental mechanical transmission with sophisticated buffers

Not as simple with the stone fruit. Besides starting with virus-free nuclear material of both scions and rootstocks will also have to do downstream tests for PDV and PNRSV unless propagation done in isolated budwood parks. Will also require control at grower level.

What are the effects of the scheme viruses (ApMV and the so-called “latent viruses”, ASPV, ASGV, ACLSV) on apples?

Table 1
Yield reduction effects on apple production due to viral diseases

Apple Cultivars	Virus strain	Yield reduction (%)	References
Golden delicious	Apple mosaic virus (AMV)	46	Baumann and Bonn (1988)
	AMV, rubbery wood disease agent (RW)	21–67	Baumann and Bonn (1988)
Golden delicious	RW	46	Wood (1978)
Golden delicious	Apple stem grooving virus (ASGV), apple stem pitting virus (ASPV) & apple chlorotic leaf spot virus (ACLSV)	12	Meijnske et al. (1975)
Golden delicious	ASGV, ASPV & ACLSV	30	van Oosten et al. (1982)
McIntosh	AMV	9	Zawadzka (1983)
McIntosh	RW	8	Zawadzka (1983)
Red delicious	AMV	42	Zawadzka (1983)
Red delicious	RW	20	Zawadzka (1983)

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This means if you start a new orchard with infected planting material you have these yield reductions from the start and you wouldn't even know it (all trees infected similarly).

https://upload.wikimedia.org/wikipedia/commons/4/4d/Young_apple_trees_bearing_fruit_-_geograph.org.uk_-_1476095.jpg

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“Latent viruses” ASPV, ASGV and ACLSV often associated (often graft incompatibilities).

Apple topworking disease associated with ACLSV
Malus prunifolia var. Ringo (Image T. Ito)

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ASPV, ASGV and ACLSV also associated with specific diseases (often graft incompatibilities).

ASGV; Associated with necrotic grooves at the graft union of rootstock budded with Virginia Crab

Courtesy: Luca Monducci (Università di Bologna)

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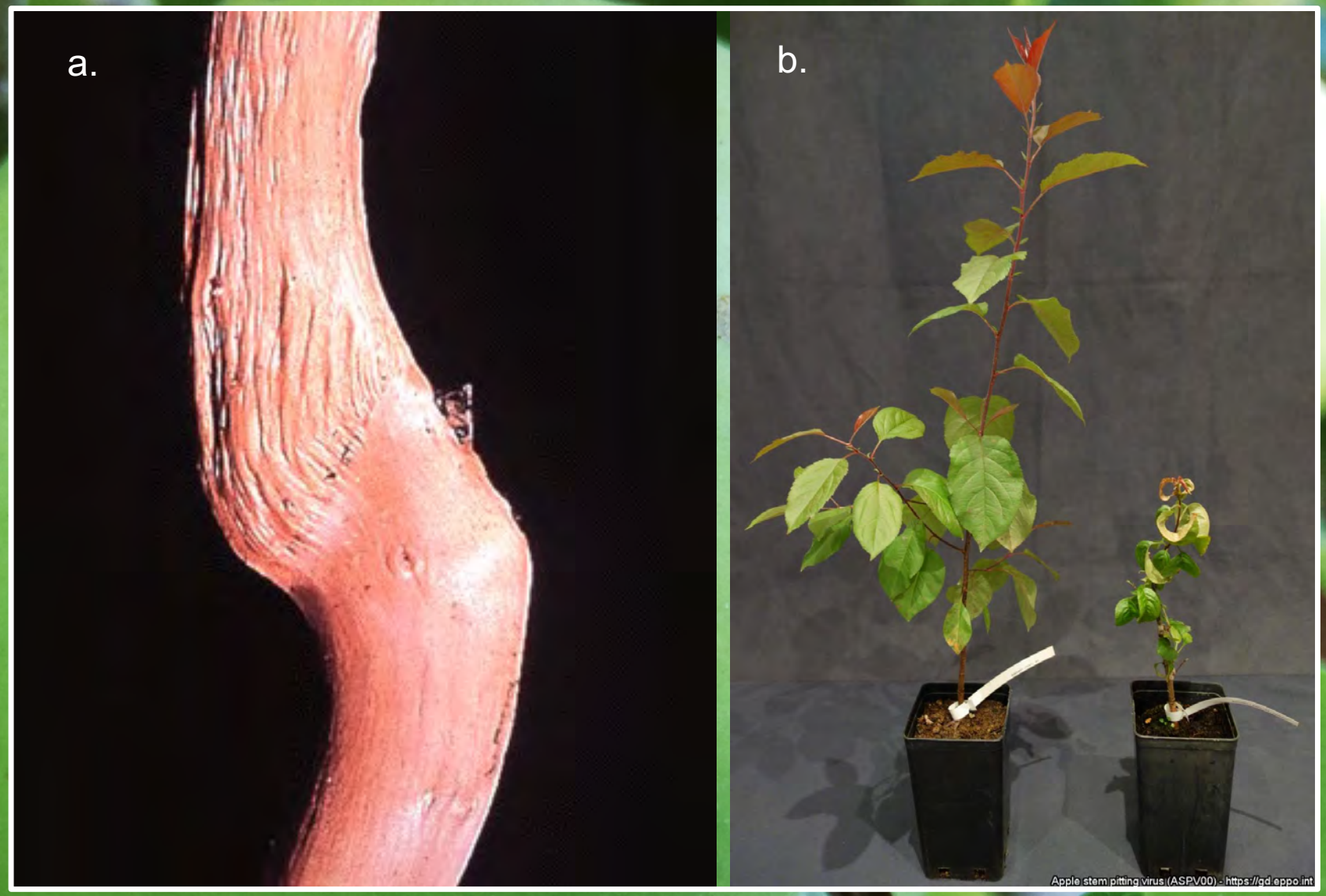
ASPV, ASGV and ACLSV also associated with specific diseases (often graft incompatibilities).



ASPV; a. Stem pitting on Virginia crab above the graft union, b. Healthy and ASPV infected “Radiant” saplings

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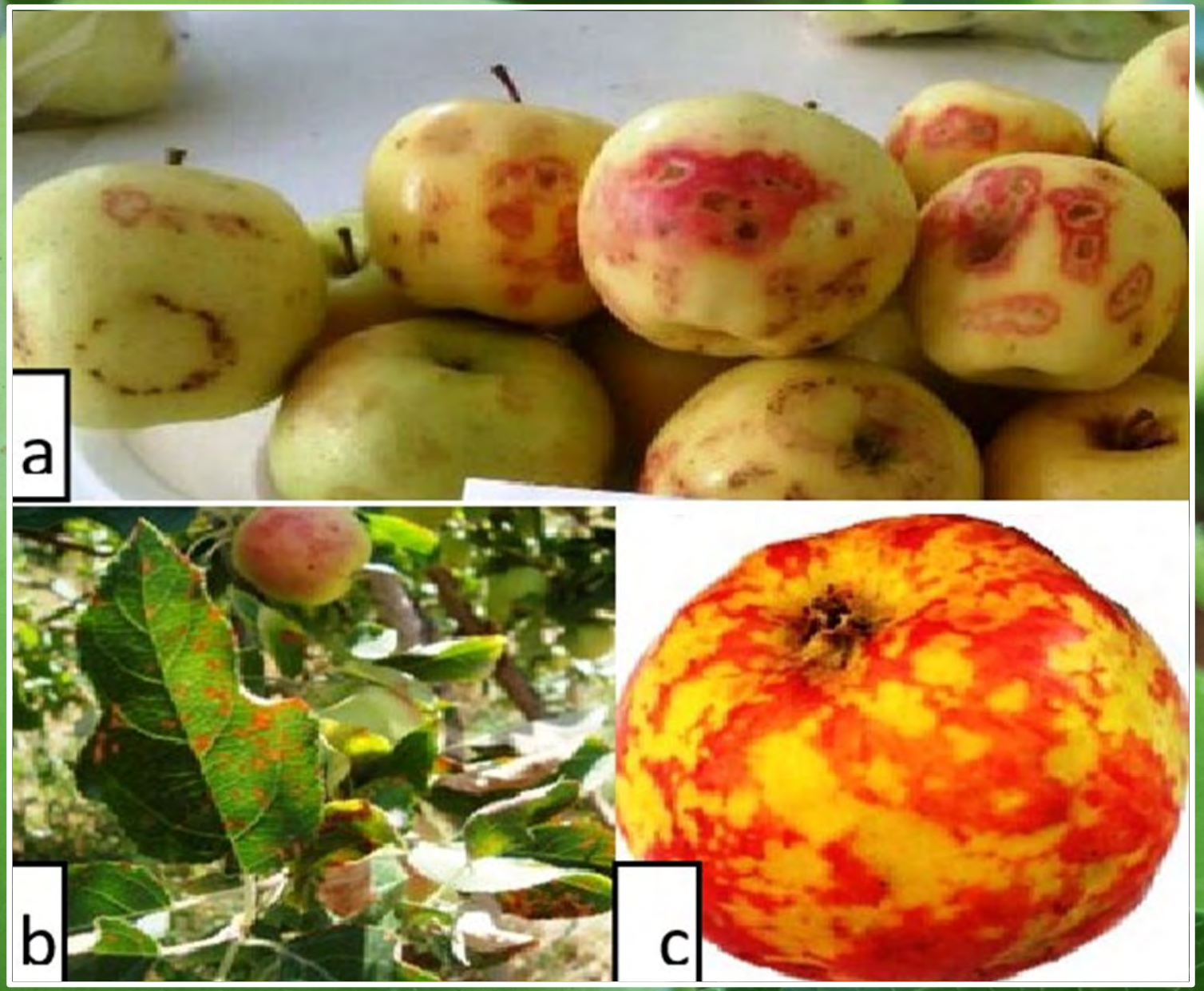
ACLSV on apples (fruit symptoms)



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ASPV on pears (fruit symptoms)

ASPV; Possible association with stony pit symptoms of Bosc pears.

Images by Bester and Maree.

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Have not done a survey of stone fruit in South Africa to assess the nature and extent of virus problems.

The presence and symptoms of Plum viroid 1 (Bester and Maree) are well documented.

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PDV and PNRSV in Stone fruit.

PDV: bud take reduction: 40-50% if either rootstock or scion infected.
Causes significant losses in almond, peach and sweet cherry.

PNRSV causes serious diseases in nurseries, reduced bud take, tree survival, uniformity, death of buds and shoots, reduced growth of fruit (10-30%), reduced fruit yield (20-60%), and delay in fruit maturity.

Peach trees infected with PDV and PNRSV together have bark splitting, increased sucker production and can have yield reductions of 38% to 60% in susceptible cultivars.

Certification in other countries?

Most countries with an active Pome or Stone fruit industry have certification schemes (e.g. Canada, USA, Australia, EU, Netherlands, France, Germany, UK, Italy, Spain, Hungary)

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Australian Pome Fruit Improvement Program Ltd.

Nursery Tree Specifications & Tree Types Description

This tree specification and tree types description is provided to assist those involved in the Australian pome fruit industry to establish a reference standard for nursery trees. ***(The rootstock/scion combination is also essential in this process and needs to be arranged directly between the grower and the nursery tree supplier)***

General Requirements

Suppliers growing and providing apple trees for Australian Orchards shall ensure that each tree that is delivered is:

- Produced from bud and graft wood from trees that are virus tested for and free of the following viruses, apple stem-pitting virus, apple stem-grooving virus, apple mosaic virus & apple chlorotic leaf spot virus. Rootstocks used in the production of the nursery trees are to come from production areas that have been indexed for the above viruses.

Oregon State, USA

- For *Malus*, *Pyrus*, *Cydonia*, and *Chaenomeles* we test for latent viruses:
  - *Apple chlorotic leafspot virus* (ACLSV)
  - *Apple stem grooving virus* (ASGV)
  - *Apple stem pitting virus* (ASPV)
- For Prunus, we test for:
  - *Prunus necrotic ringspot virus* (PNRSV)
  - *Prune dwarf virus* (PDV)

Certification in other countries….

European Union:

Table 1 Viruses and other pathogens of varieties and rootstocks of almond, apricot, peach and plum occurring in the EPPO region and requiring testing in the certification scheme

	Prunus amygdalus (almond)	*Prunus armeniaca* (apricot)	*Prunus persica* (peach)	*Prunus domestica*, *Prunus insititia* and *Prunus salicina* (plum)	*Prunus besseyi*, *Prunus cerasifera*, *Prunus davidiana* and interspecific hybrids
Viruses					
Apple chlorotic leaf spot trichovirus (ACLSV)	×	×	×	×	×
Apple mosaic ilarvirus (ApMV)	×	×	×	×	×
Cherry green ring mottle foveavirus (CGRMV)			×		
Myrobalan latent ringspot nepovirus (MLRSV)				×	×
Plum pox potyvirus (PPV)	×	×	×	×	×
Prune dwarf ilarvirus (PDV)	×	×	×	×	×
Prunus necrotic ringspot ilarvirus (PNRSV)	×	×	×	×	×
Strawberry latent ringspot nepovirus (SLRSV)			×		
Tomato black ring nepovirus (TBRV)	×				

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Must control scheme viruses.

Should be expanding viruses tested for within the scheme.

Apple rubbery wood disease (apple rubbery wood virus 1, ARWV-1 and ARWV-2 associated with this disease)

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Scheme viruses should include recently discovered Apple rubbery wood 2 found in South Africa (Bester and Maree).

ARWD (associated with ARWV-1 and -2) largely eliminated in UK from apples via certification.

Malus domestica 'Lord Lambourne' infected with Apple rubbery wood agent

Image by: Paul Martens

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New virus/viroids.
Plum viroid 1 (Bester and Maree).

Control of this viroid largely made possible by traceability inherent in certification scheme.

Introduction of NGS testing on nuclear material.

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Dankie!

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