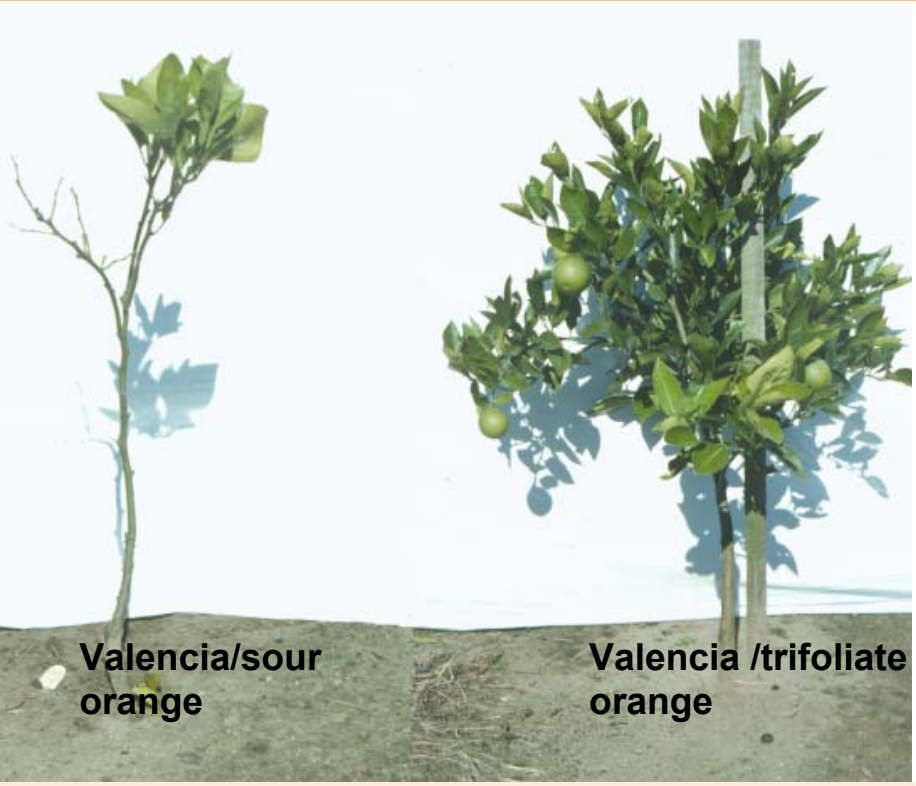
ROOTSTOCKS – DISEASE CONSIDERATIONS

ROOTSTOCKS – DISEASE CONSIDERATIONS: tristeza quick decline



CTV <u>and</u> *Toxoptera citricida* probably introduced on budwood or trees from China or South Africa before 1870, as Sydney nurserymen couldn't use CTV-susceptible stocks eg Seville orange after that time. USE OF CTV–TOLERANT ROOTSTOCKS

Seville orange used as a R/S in the establishment of inland irrigation districts at Mildura, Renmark ≈ 1900, as CTV-free budwood from California was propagated.
Aphids and CTV did not become a problem until 1940's.

ROOTSTOCKS – DISEASE CONSIDERATIONS: *Phytophthora*

1860-1870: Root rot in orchards around Sydney.

By 1942: At least 50% of orchards in MIA had gone out of production due to Phytophthora root rot.

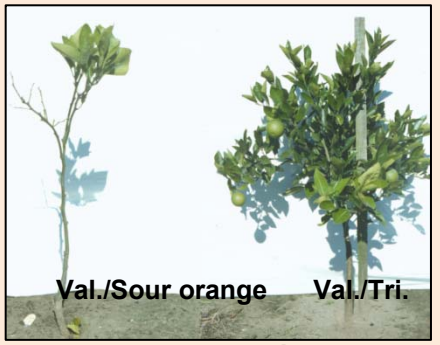
In field inoculations at Leeton, trifoliata and Carrizo citrange were found to be resistant.

>1950's: Exocortis problems in trees on *P.trifoliata.*

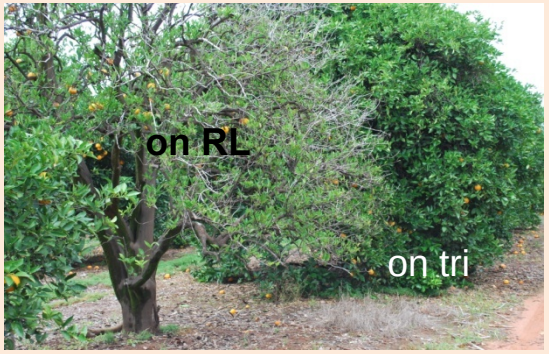
Required Attributes for Citrus Rootstocks under Australian Conditions

Essential:

- Tolerance to tristeza virus
  - quick decline, stem pitting



- Tolerance to Phytophthora root and collar rots



- Good good fruit quality and horticultural performance

HORTICULTURAL INCOMPATIBILITY (not virus)

Yellow ring at the bud union of Eureka lemon on *Poncirus trifoliata.* Extent and severity of tree decline is correlated with tree vigour.

HORTICULTURAL INCOMPATIBILITY (not virus)

Yellowing and decline of Chinese low acid orange on *P. trifoliata,* with yellow ring at bud union.

Imperial mandarin on Troyer citrange without (left) and with (right) a sweet orange interstock.

AUSTRALIAN ROOTSTOCK BREEDING PROGRAMMES

- Search for a ***Phytophthora*** **resistant rootstock compatible with Eureka lemon** begun by FT Bowman in 1945 and resulted in the **Benton citrange** (*P. trifoliata* x Ruby Blood sweet orange).
- J Cox continued a programme of hybridisations to find **better rootstocks for lemons and mandarins** (1959-1978) resulting in the **Cox hybrid** (smooth seville x *P. trifoliata*), also compatible with Eureka lemon. Some hybrids are still under evaluation.
- A CSIRO rootstock breeding programme in 1968-72 aimed to produce **dwarfing rootstocks**, while the crosses made in the 1980's aimed to incorporate **salt tolerance** to other characters.

DEFINITIONS re *Phytophthora*

(Erwin & Ribeiro, 1996)

- ***Immunity:*** no infection occurs even under high pathogen pressure
- ***Resistance:*** ability of the host to hinder development of the pathogen
  - ❖ **Specific resistance** = vertical resistance: race specific; single gene interactions between plant and host
  - ❖ **General resistance** = horizontal or field resistance

Regeneration of RL roots after Phytophthora attack.

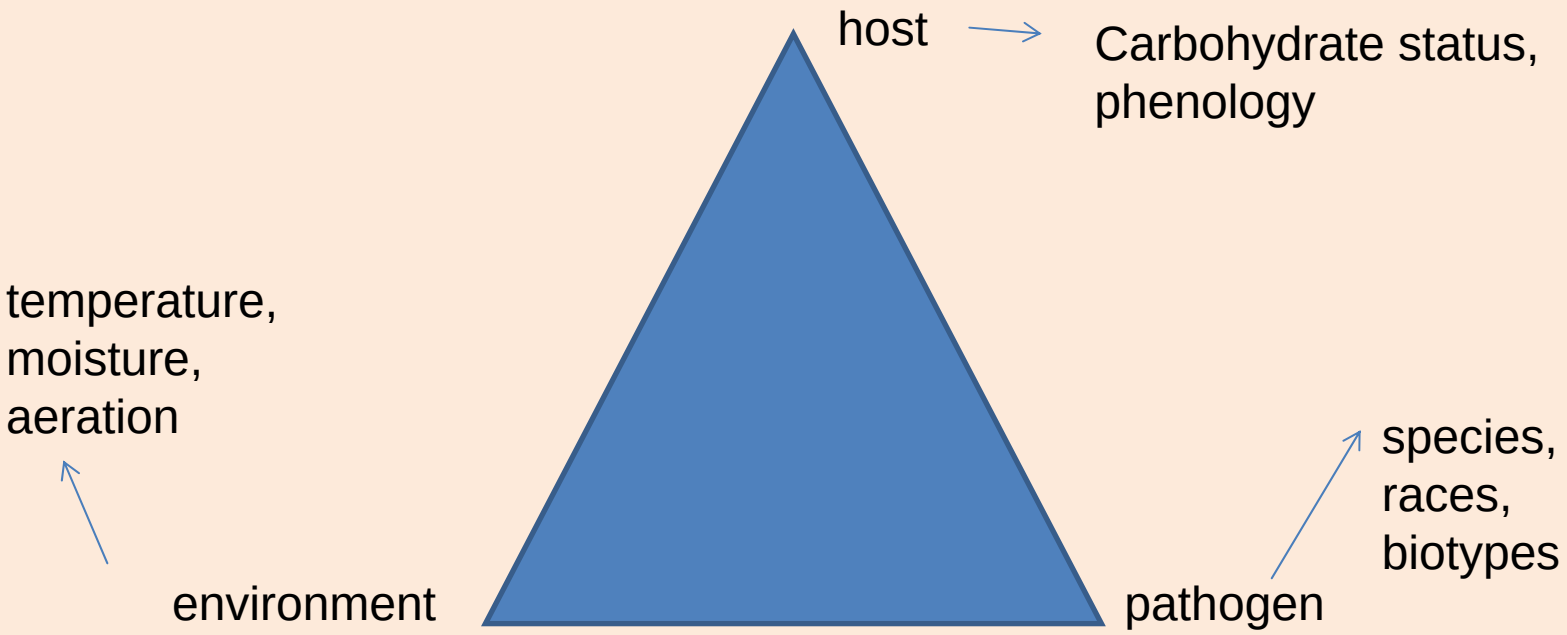
= ***tolerance***

=capability of host to prevent, reduce,or delay the development of pathogen

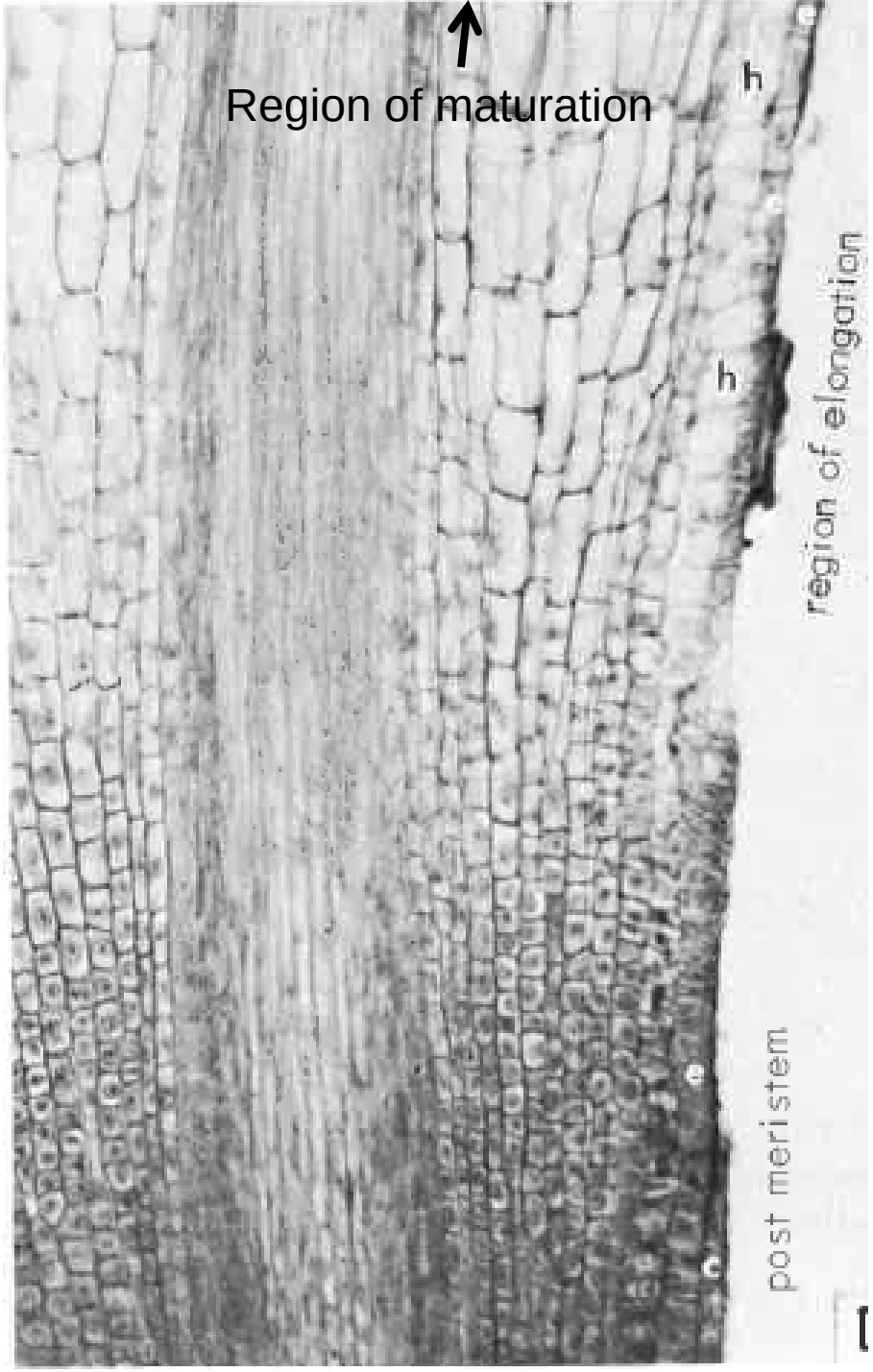
and/or

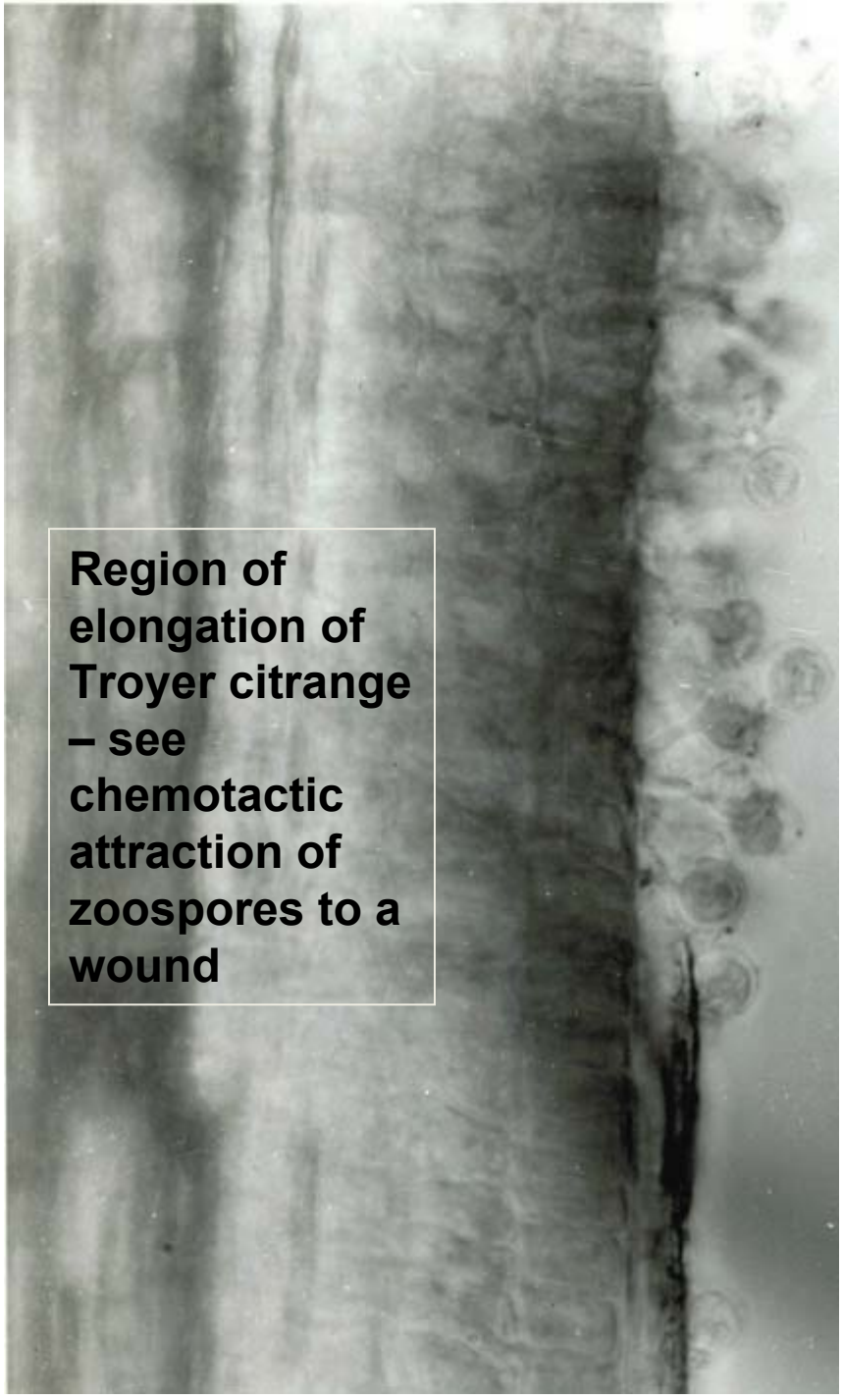
ability to overcome the effects of root rot after soil conditions become unfavourable to **Phytophthora.**

- Disease outcome is determined by the three-way interaction of the pathogen, the plant, and the environmental conditions (an interaction known as the **disease triangle**).



- **Host resistance is most successful if regulation of irrigation and soil drainage are also practiced**

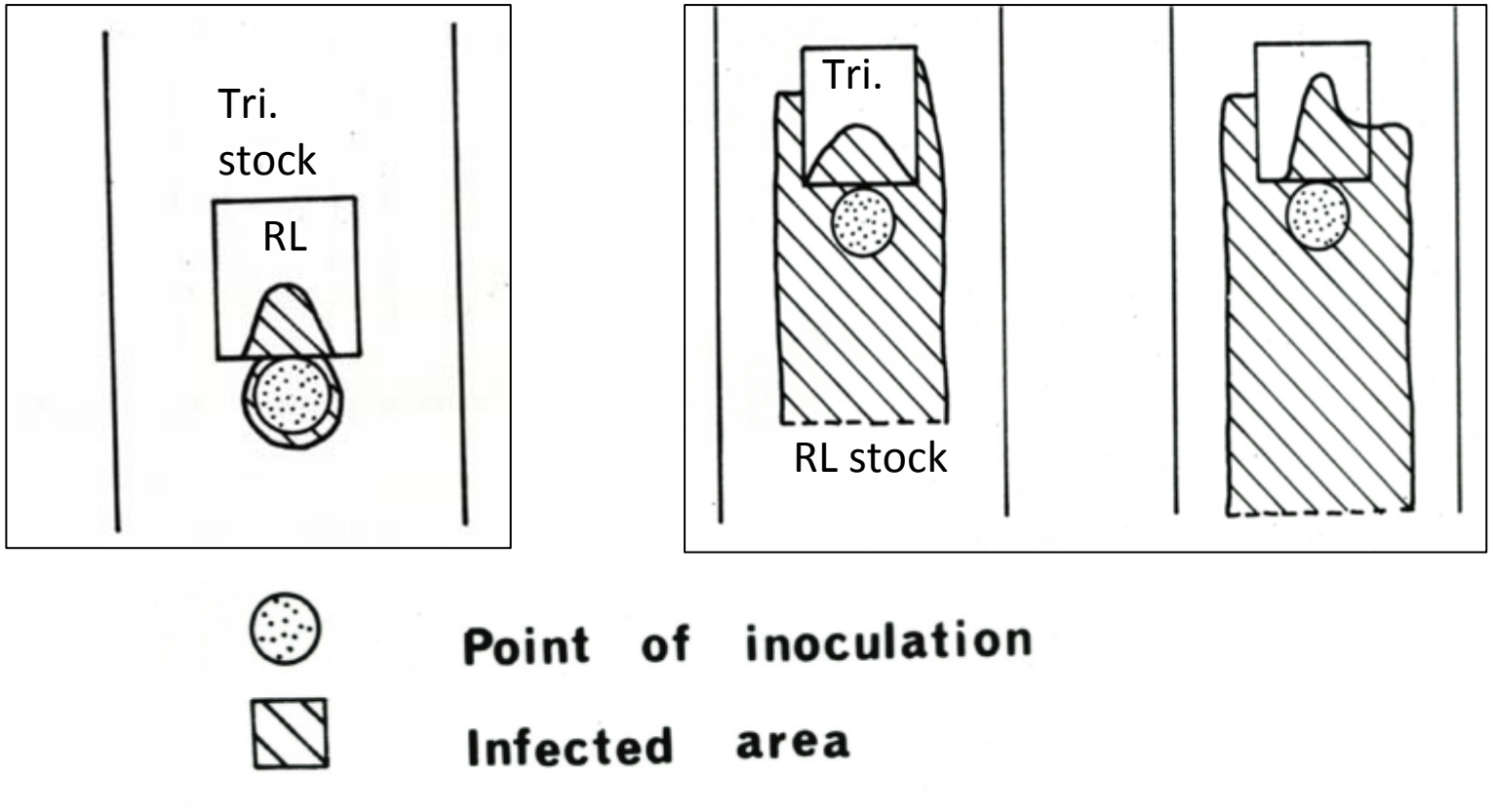


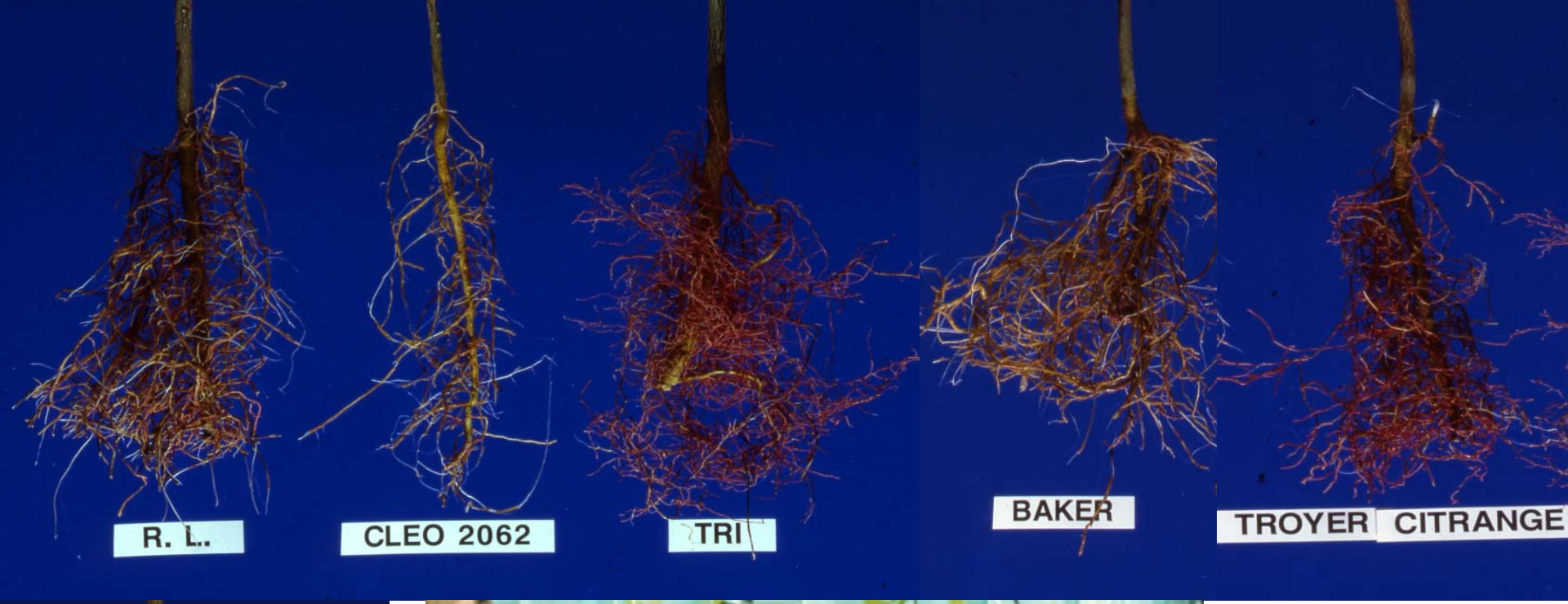


Region of elongation of Troyer citrange – see chemotactic attraction of zoospores to a wound

The resistance or susceptibility of a citrus rootstock is modified by the scion

eg a sweet orange stock will be more susceptible to root rot with a lemon scion than with a Valencia orange scion.





Zoospore infection in aerated nutrient solution

Collar rot inoculations

Type	Lesion Length (cm)
P. trifoliata 22	0
P. trifoliata Flying Dragon	0.2
Benton citrange	0
Nelspruit hybrid 639	0.31
Cleopatra mandarin	1.2
C. volkameriana	1.71
McKillops RL	2.53
Sweet orange	3.93

This is a hybrid from the CSIRO rootstock breeding programme for salinity tolerant rootstocks.

Seedlings grown in soil infested with *P. citrophthora*:

rough lemon and sweet orange on left; tri. on right.

ROOTSTOCKS	PHYTOPHTHORA TOLERANCE	TRISTEZA TOLERANCE
ROUGH LEMON	4	1
SWEET ORANGE	5	1
P. TRIFOLIATA	1	1
TROYER CITRANGE	2	1
CORRIZO CITRANGE	2	1
BENTON CITRANGE	2	1
CLEOPATRA MANDARIN	3	1
RANGPUR LIME	4	1
SOUR ORANGE	3	5
SMOOTH SEVILLE	3	4
C. MACROPHYLLA	3	4
C. VOLKAMERIANA	4	1
SWINGLE CITRUMELO	2	1

1 = BEST OF ROOTSTOCKS LISTED

PONCIRUS TRIFOLIATA

- **GOOD POINTS**

✓ **Preferred stock for heavy soils and replant sites**

✓ **Highly resistant to CTV, *Phytophthora* and citrus nematode**

✓ **Tree size small to medium**

✓ **Very good fruit quality; mid-late**

✓ **Shallow rooting but high fibrous root density**

- **BAD POINTS**

- **Prone to "Sudden Death"**
- **Incompatible with Eureka lemon**
- **Intolerant of highly acid and highly alkaline soils**
- **Poor drought tolerance**
- **Low tolerance to salt**

(3 exceptions among Chinese tri's)

ROOTSTOCKS SUGGESTED BY MARTINEZ FOR OPEN HYDROPONIC SYSTEM : AUSTRALIAN RESULTS

C. volkameriana is similar in behaviour but superior to Rough lemon? More tolerant of *Phytophthora.*

C. macrophylla *(alemow)* is very sensitive to stem pitting strains of tristeza virus and is not recommended for Australia. High early yields; mediocre fruit quality.

Rangpur lime is highly susceptible to *Phytophthora;* salt and drought tolerant, large trees, large mediocre fruit. High early yields.

ROOTSTOCKS – DISEASE CONSIDERATIONS:tristeza stem pitting

Eureka/RL

/macrophylla

Somersby

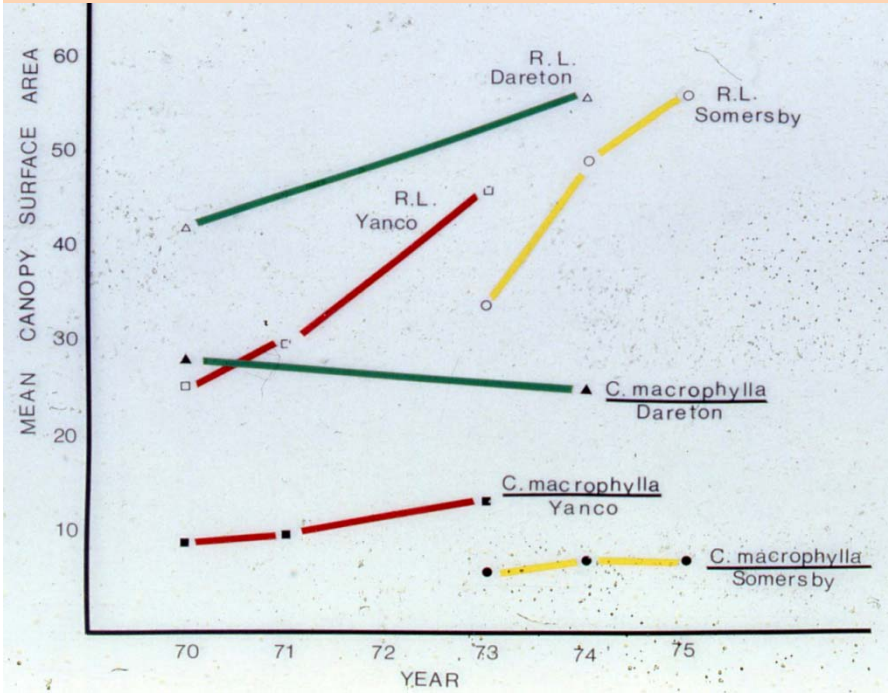
/macrophylla

/RL

Dareton

FACTORS CONTRIBUTING TO SUCCESS/FAILURE OF *C. macrophylla* IN AUSTRALIA:

- Nursery trees grown in a screenhouse free of aphids? Or in field subject to infection of CTV by aphids?
- Scion variety carrying strains of CTV which would pit *C.macrophylla*?



IMPORTATION OF POTENTIAL ROOTSTOCKS

1.overseas breeding programmes

2.centres of origin of commercial citrus (China & Vietnam)

2. Project objectives: Collect native citrus germplasm in China and Vietnam

Evaluate the disease and salinity tolerance of these rootstocks

Evaluate their horticultural potential as rootstocks in Australia

P. trifoliata variants from China

Collecting native citrus in mountainous areas of Vietnam →

VARIATION IN SALT EXCLUSION BY CHINESE *PONCIRUS TRIFOLIATA* VARIANTS

(SYKES' DATA)

Experimental conditions:

Genotype	Leaf chloride (% DW)
Zhi #5	0.69
Zhi 78-85	0.82
Zhi 84-75	0.80
Lunan zhi	2.73
Bapi zhi	1.28
Rangpur lime	1.21
Williams tri	2.22
LSD	0.42

NEW SALT EXCLUDING GENOTYPES IDENTIFIED: Sykes' results

CODE	NAME	Cl^-	Na^+
CO113	Gulin jinqianju	excluder	intermediate
CO116	Zhuhongju	excluder	excluder
CO118	Caoshi xiangju	excluder	excluder
CR143	Goutoucheng A-E	excluder	intermediate
CR166	Small leaf	excluder	excluder
CR171	Donghu no. 1-2	intermediate	excluder
CR175	No. 5	excluder	excluder
CR177	78-85	excluder	excluder
CR179	84-75	excluder	excluder
No. 22		accumulator	excluder
Donghu no. 1-1		accumulator	excluder
Donghu no. 1-2		intermediate	excluder
Fuming		accumulator	accumulator
Minneola tangelo x Tanghe #6 5-1		-	intermediate
Minneola tangelo x Donghu 7-5		-	intermediate

SUDDEN DEATH


Fig. 1.3a


Fig. 1.3c

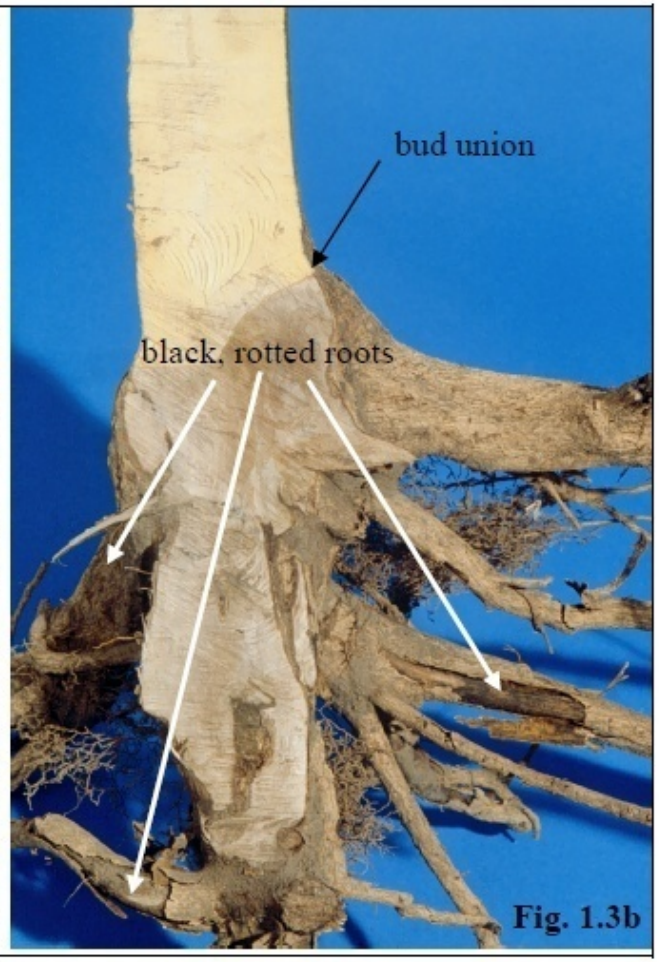
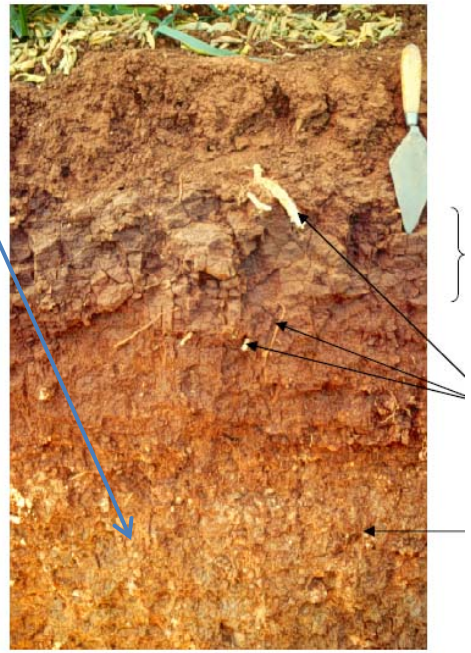


Fig. 1.3b

BLOCKS WITH SUDDEN DEATH ARE SUBJECT TO TEMPORARY WATERLOGGING AND POOR AERATION

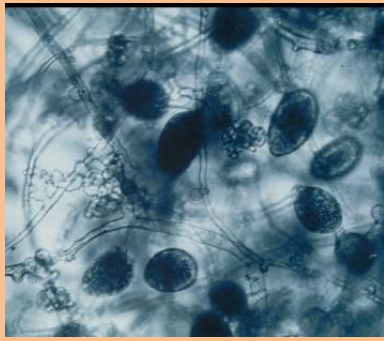
	Healthy sites	Sudden Death sites
Soil pit description	Soils dark reddish brown with only a few reddish yellow mottles.Soil colour shows no visual symptoms of previous waterlogging.	Soils paler and duller in colour especially in subsoil with frequent red, yellow and orange mottles. Soil colour shows evidence of previous waterlogging events and iron re-oxidation. Subject to waterlogging and poor soil aeration.
Soil texture	Clay loam to light clay topsoil	Medium to heavy clay topsoil
Porosity (air/water)		Wetter & less aerated in the root zone. Pores become filled with water after rainfall or irrigation and do not drain, with subsoil becoming anaerobic.
Soil compaction		Contributing to poor internal drainage of soil profile, leading to waterlogging through perched water tables.
Soil chemical factors	Nitrate higher	Ammonium and nitrite nitrogen higher



Description of soils from sudden death and healthy sites (Shearman, 2006)

Phosphonates (Phosphorous acid compounds)

Suggested modes of action:



- **Direct inhibition of Phytophthora** (growth rate, inhibiting sporulation and zoospore release)
- **Stimulating host defences**
- **Mixed**: effect of phos. on Phyt. causes release of stress metabolites from fungus which triggers active defense

Mode of action may be dependant on concentration of phosphonate in citrus (Afek & Sztejnberg 1989):

low – host defense mechanism;
high – as a fungicide.

Young mandarin trees in SA had leaf burn and reduced growth from 20% potassium phosphonate at 2L/100L (SA results).

16-09-08
Phytophthora affected tree—dying
Sprayed with phosphorous acid (Agrifos 600)

14-10-08
(28 days later)
Same tree showing rapid recovery

Miles, Qld.

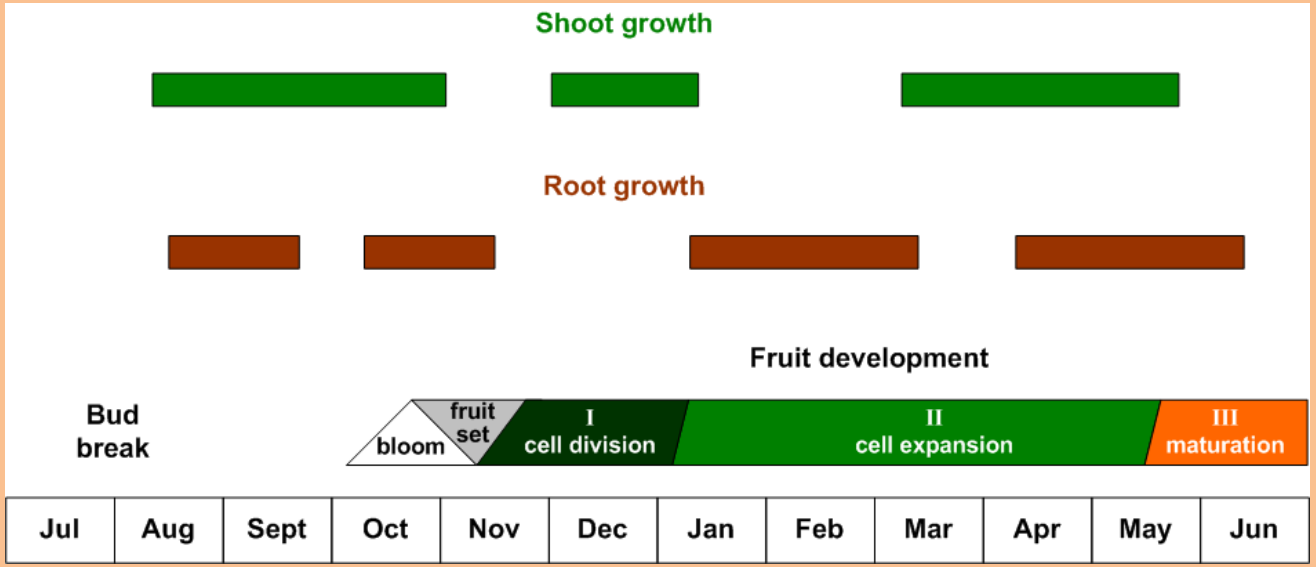
Phosphonates (Phosphorous acid compounds)

1. Phosphorous acid (Phi) can be absorbed through leaves and roots but cannot be used directly as a nutrient source.
2. Efficacy may depend on healthy root to shoot balance at time of application.
3. Since phosphites are systemic and very stable in plants, they should not be applied frequently.
4. Activity of Phi is affected by pH, temperature and nutrients.
5. Phi has a deleterious effect on P-deficient plants.
6. Direction of movement driven by source-sink pathways.

Phosphonates (Phosphorous acid compounds)

7. **Best time to apply is during the flush of root growth:**

Ex Treeby



8. **Resistance of *Phytophthora* spp. to Phi can develop.**

9. **MRL for phosphorous acid/phosphonate in Australia is 100 mg/kg, but other countries have no limits.**

CITRUS REPLANT PROBLEMS

∞ soil

∞ previous crop eg virgin soil, grape, citrus

- **Proposed causes:**
  - ? Organic toxins
  - ? Nutritional deficiencies/excesses
  - ✓ Deterioration in soil physical properties
  - ✓Microorganisms
    - Build-up of Phytophthora
    - Build-up of nematodes
    - Other microorganisms
      - change in microbial flora

Beneficial microorganisms which stimulate plant growth, solubilise phosphates, produce growth hormones, are antagonistic to plant pathogens etc. eg mycorrhizae

Microorganism with no effect on plant growth.

Microorganisms which inhibit plant growth.

Weak pathogens that extend the injury in a damaged root eg *Pythium*

Plant pathogens eg *Phytophthora*

Means of alleviating the replant problem:

- ❑Fallow/cover cropping
- ❑Soil fumigation
- ❑Deep ploughing
- ❑**Change rootstock (citrange to tri)**

HORTICULTURAL INCOMPATIBILITY DUE TO VIRUS IN SCION WOOD :

Exocortis is principally a problem of infected scions on *P.trifoliata* stocks.

Citrus tatter leaf virus in scion causes severe decline on susceptible rootstocks (eg. *P. trifoliata*, citranges and Swingle citrumelo).

HORTICULTURAL INCOMPATIBILITY DUE TO VIRUS IN SCION WOOD

This yellow ring at the bud union of Nagami cumquat on *Poncirus trifoliata* is due to Citrus Leaf Blotch Virus carried in scion budwood.

This yellow ring and overgrowth at the bud union of declining Navelina on Swingle citrumelo may be due to virus.

ENSURE YOUR NURSERYMAN USES HEALTHY BUDWOOD FROM AUSCITRUS

Summary of the Health Risks in Reworking Citrus: tristeza

Tree to be topworked		Mode of grafting	Grafting wood			
Scion	Rootstock		Orange	Mandarin	Grapefruit	Lemon
Valencia or Navel	*P. trifoliata*, citrange	into scion	S_1	S_1	NR	NR
Valencia or Navel	RL, sweet orange	into scion	S	S	NR	NR
Valencia or Navel	*P. trifoliata*, citrange	into rootstock	S_1	S_1	S_1	S_1
Valencia or Navel	RL, sweet orange	into rootstock (scion completely removed)	S	S_2	NR	NR
Mandarin	*P. trifoliata*, citrange	into scion	S_1	S_1	NR	NR
Mandarin	*P. trifoliata*, citrange	into rootstock (scion completely removed)	S_1	S_1	S_1	S_1
Mandarin	RL, sweet orange	into scion	S	S	NR	NR
Mandarin	RL, sweet orange	into rootstock (scion completely removed)	S	S_2	NR	NR
Grapefruit (with stem pitting)	*P. trifoliata*, citrange	into scion	NR	NR	NR	NR
Grapefruit (with stem pitting)	*P. trifoliata*	into rootstock (scion completely removed)	S_1	S_1	S_1	S_1
Grapefruit (with stem pitting)	*P. trifoliata*, citrange	into scion	NR	NR	S*	NR

NR = not recommended; S = satisfactory; S1 = satisfactory only if grafting wood is free of exocortis and tatter leaf virus; S2 = do not rework Rough lemon (RL) to Ellendale, Satsuma or Imperial.