

Understanding Bacterial Diseases and Tree Health Issues



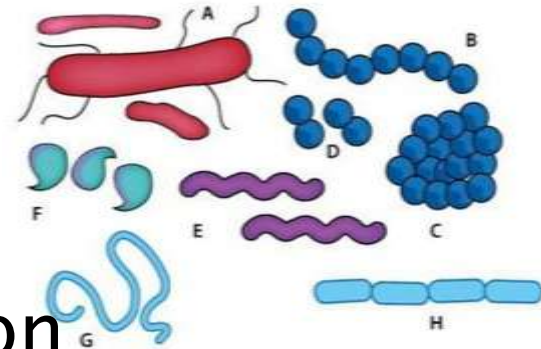
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DPI, Knoxfield, Victoria

Hortexpo, Tasmania 5 August 2009

Simple yet complex bacteria

- * Single cells, various shapes
- * Very small: 1- 5 micron in length
- * Abundance: 40 million/g soil
- * Rapid multiplication by cell division
- * Aggregate into colonies, biofilm
- * Sensing environmental and biochemical changes, resting phase, spore phase
- * Pathogens, saprophytes, antagonists, antibiotic producers
- * Same genus as human or animal pathogens
e.g. *Bacillus*, *Pseudomonas*, *Clostridia* spp.



How do bacteria cause diseases?

- * Cell death - die-back, cankers, spots & specks, blotches, scabs
- * Water soaking - cell leakage
- * Growth regulators – galls, growth disruption
- * Soft rots – Breaks down substrates & cells



Citrus canker



Pierce's disease



Erwinia carotovora

Potato soft rot



Olive knot

How do bacteria cause diseases

- * Toxins – necrosis, halos



Tomato speck

- * Systemic spread
- * Blocks the xylem - wilt
- * Blocks the phloem

Gummosis



Fire blight

Aggie-horticulture



MSU

Trunk injury

Bacterial Blossom Blast - Pomefruit



Bacterial blast



Symptoms can be similar to fire blight

Not Pear Decline

- * Caused by a phytoplasma, an exotic disease
- * Leaf curl, reddening
- * Very small, no cell wall
- * Lives in the phloem
- * Vector: pear psyllid



Bacterial canker on cherries



- * **Cankers,**
- * **Gummosis**
- * **Shoot die-back (scion)**
- * **Dead buds**
- * **Blossom blast**
- * **Leaf spots**
- * **Tree death**



Gummosis

Caused by injuries -

Diseases, mechanical, chemical, cold, insect

Fungal infection

- *Cytospora*

- Brown rot

- *Phytophthora*

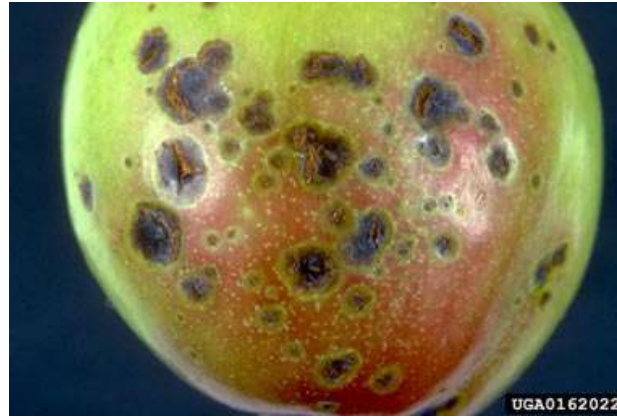
Bacterial infection

- bacterial canker

- bacterial spot



Bacterial Spot - *Xanthomonas arboricola*

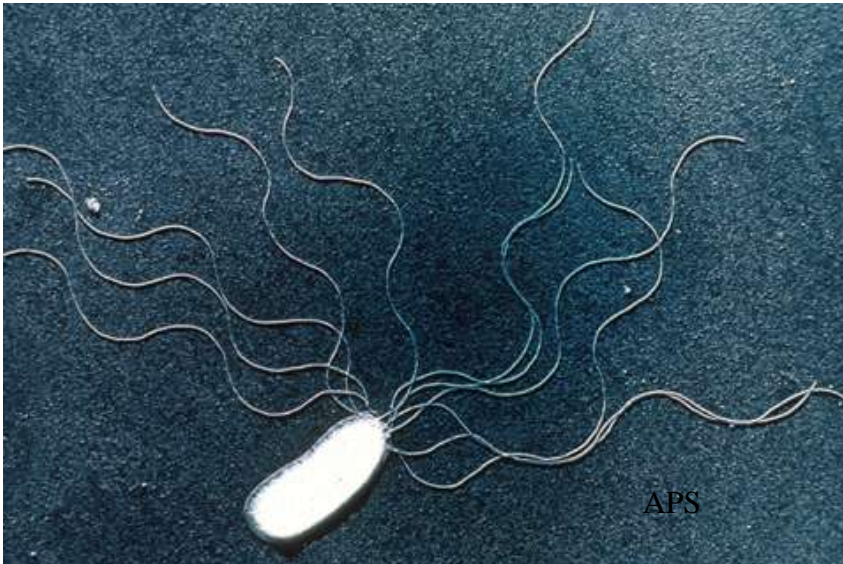


- * Warm, moist conditions
- * Stem cankers
- * Fruit loss
- * Bud scar infection



Pseudomonas syringae

- * Bacterial blast, blossom blast, 'syringae', 'pear decline'
- * Bacterial canker (stonefruit, cherry)
- * Population doubles every 2 - 4 hours
- * More than a million cells per lesion



Flagella – 'tails' help cells to move



Blue fluorescent pigment

Bacterial blast, bacterial canker

- * Cold, wet conditions
- * Wide spread, wide host range
- * Good coloniser of plant surfaces
- * Grows well in nutrient rich substrate, e.g. nectary
- * Produces plant toxin (halo, necrosis)
- * Produces a plant growth hormone (IAA)
- * Spread by rain, wind, insects, infected budwood, contaminated tools
- * Cankers or old infection as inoculum source
- * Systemic spread (bacterial canker)
- * Promotes ice-nucleation - frost injury - Why?

Frost Injury

- * Supercooling of tissues
- * Healthy tissues freeze at $-6\text{ }^{\circ}\text{C}$
- * Healthy tissues + ice nucleation active bacteria freeze at -1 to $-2\text{ }^{\circ}\text{C}$
- * Micro ice crystals grow
- * Freezing and thawing
- * Intercellular leakage
- * Systemic movement
- * Multiplies rapidly at warm temperatures



Frost ring



Blossom blast

Impacts of bacterial blast

Flower and fruit loss

Up to 40 - 70% loss of flowers
on trellis blocks



Downgrade of fruit quality

Up to 11% of remaining fruit
are diseased & misshapen fruit

⇒ rejected

Low 'pack-outs'

Only 6 - 12 % of fruit set in
October



Decline in pear tree productivity

- * Reduced productive life of trees
- * Small leaf clusters & poor tree growth
- * Cankers & non-productive limbs



Managing bacterial blast

- * Reduce inoculum
- * Good spray coverage
- * Prune out diseased branches
- * Renewal pruning
- * Better tree nutrition
- * Manage risk of frost, esp. early and sensitive cultivars - Corella pears



Managing bacterial canker

- * Limit surface wetness
 - Avoid splashing onto branches
 - Adjust sprinkler height
 - Promote quick drying,
 - Wide crouch angle
- * Minimise injury, sunburn
- * Hygiene
 - Remove dead twigs
 - Remove and burn infected wood (when possible)
 - Leaf fall protection, dormant season clean up
- * Quick healing of wounds
 - Prune in dry weather



Chemical control

Copper-based bactericides

- * Copper oxychloride (e.g. Brycop, Coppox, Coppurite, Neoram, Oxydul)
- * Copper hydroxide (e.g. Blue Shield, Champ Dry Prill, Kocide Blue, Blue-cop, Flo-Bordo)
- * Tribasic copper sulphate (e.g. Cuprofix Disperss, Tri-base Blue)
- * Cuprous oxide ('red copper' e.g. Flocop, Nordox 500, Norshield)
- * Bordeaux mixture (copper sulphate + calcium hydroxide)

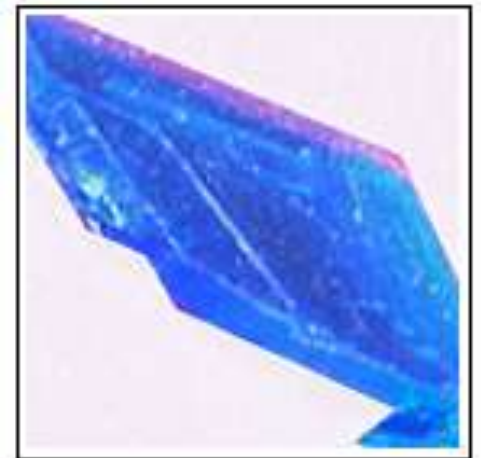


Copper sulphate crystal

Efficacy of copper sprays

- * Free copper (Cu) ions
 - Move to site of action within bacterial cells
 - Very small quantity (50 **ppb**) of free copper ions kills sensitive cells
- * Particle size
 - < 1 micron (1/1000 diameter of a hair)
- * Tenacity – rain fastness, formulation
- * Not systemic

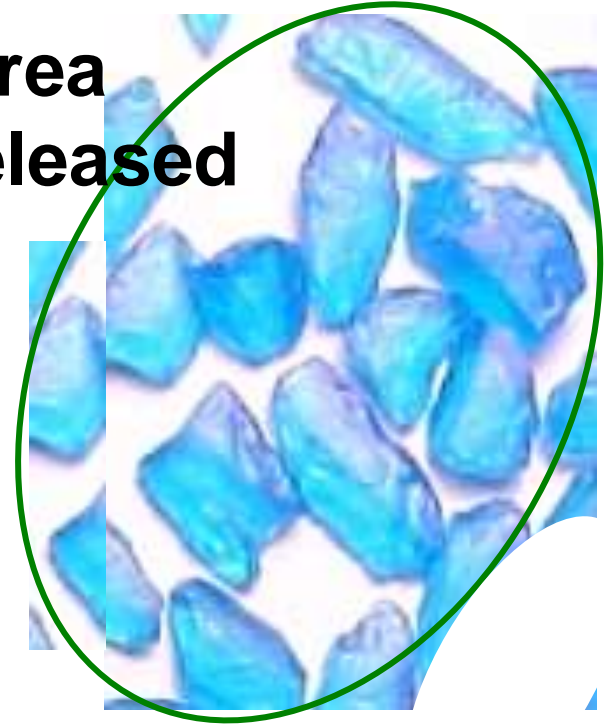
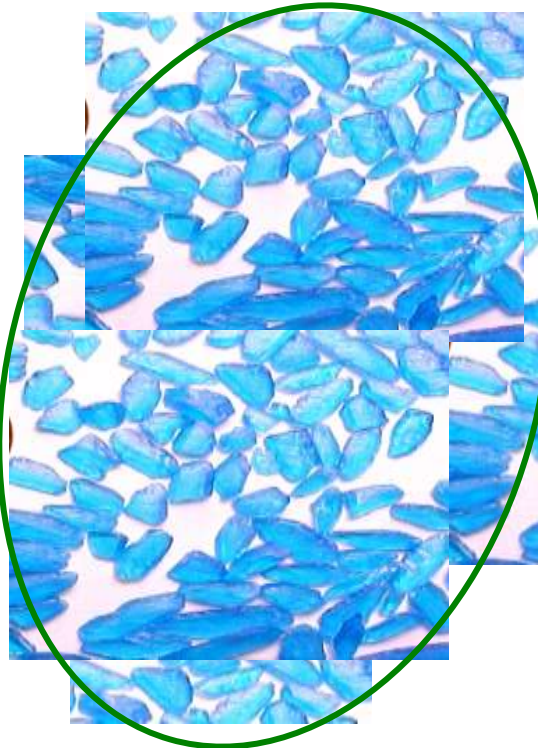
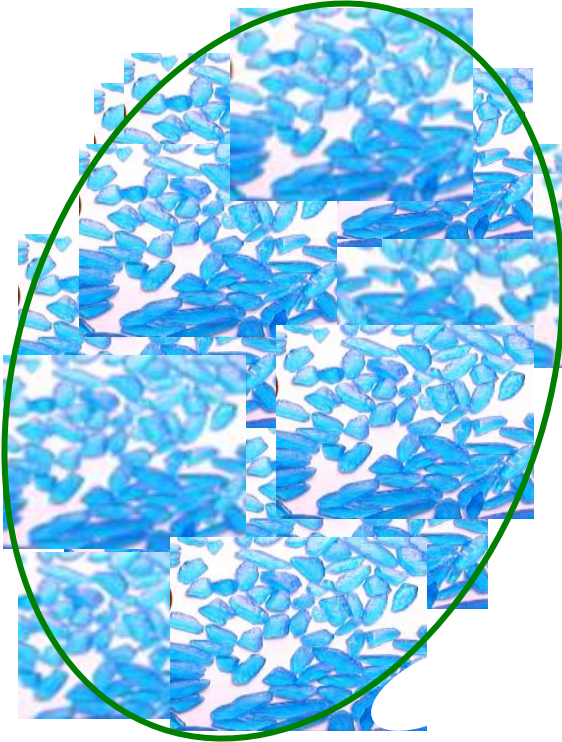
Copper sulphate particle



Particle size

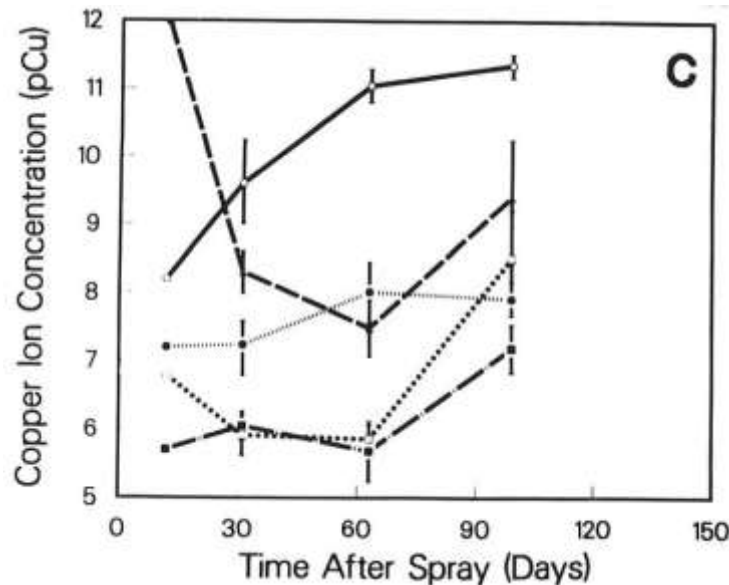
Smaller particles

- * larger surface area
- * more Cu ions released
- * better coverage
- * multi-layers



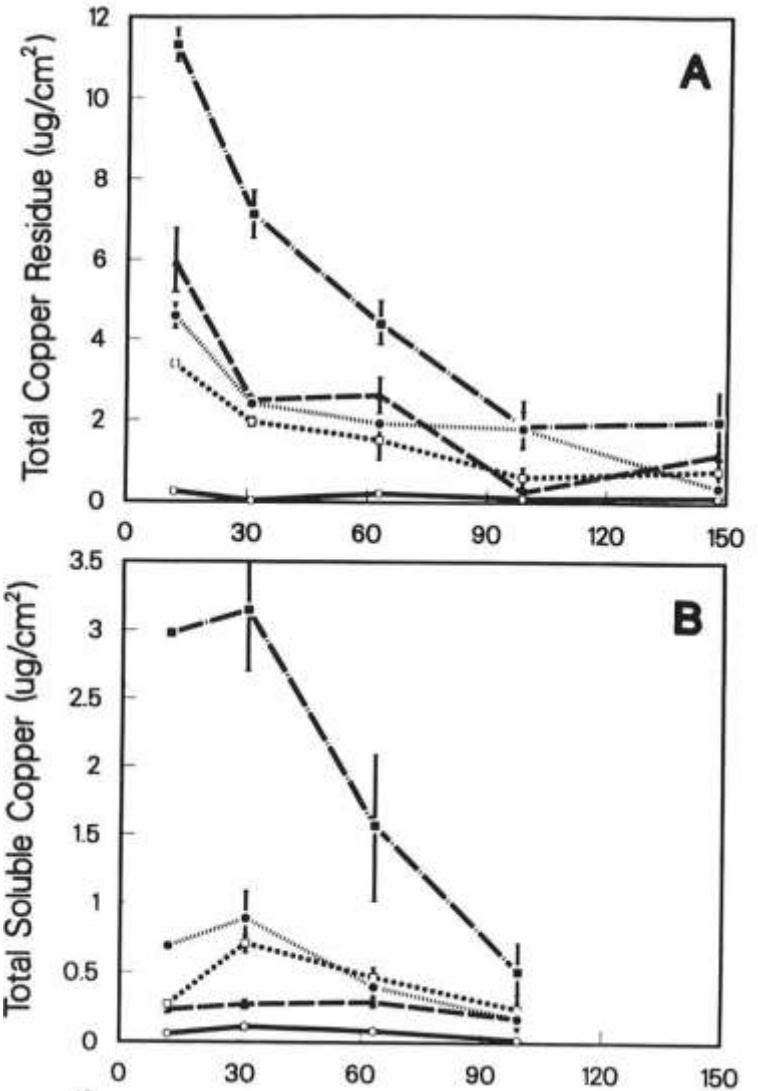
Copper residual activity

- * (A) Half life 45 days
- * (B) Dissolved Cu is 1/4 total Cu
- * (C) Free Cu ions (ug/ml – ppb)
0.1% of dissolved
- * increased after application



Source: Menkissoglu & Lindow 1991

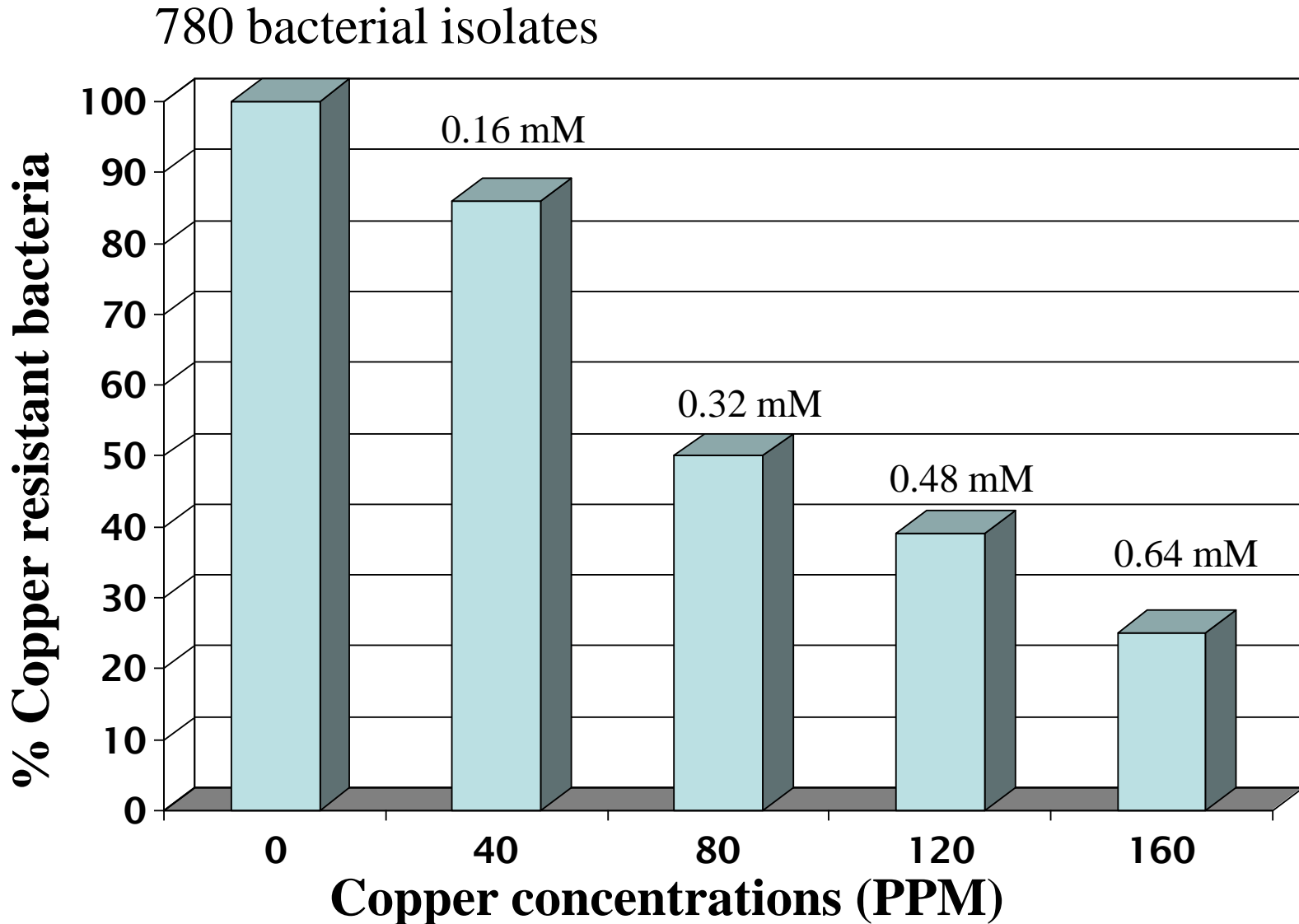
Cu(OH)₂ at 1.2 & 3.6 g/L



Development of Cu resistance

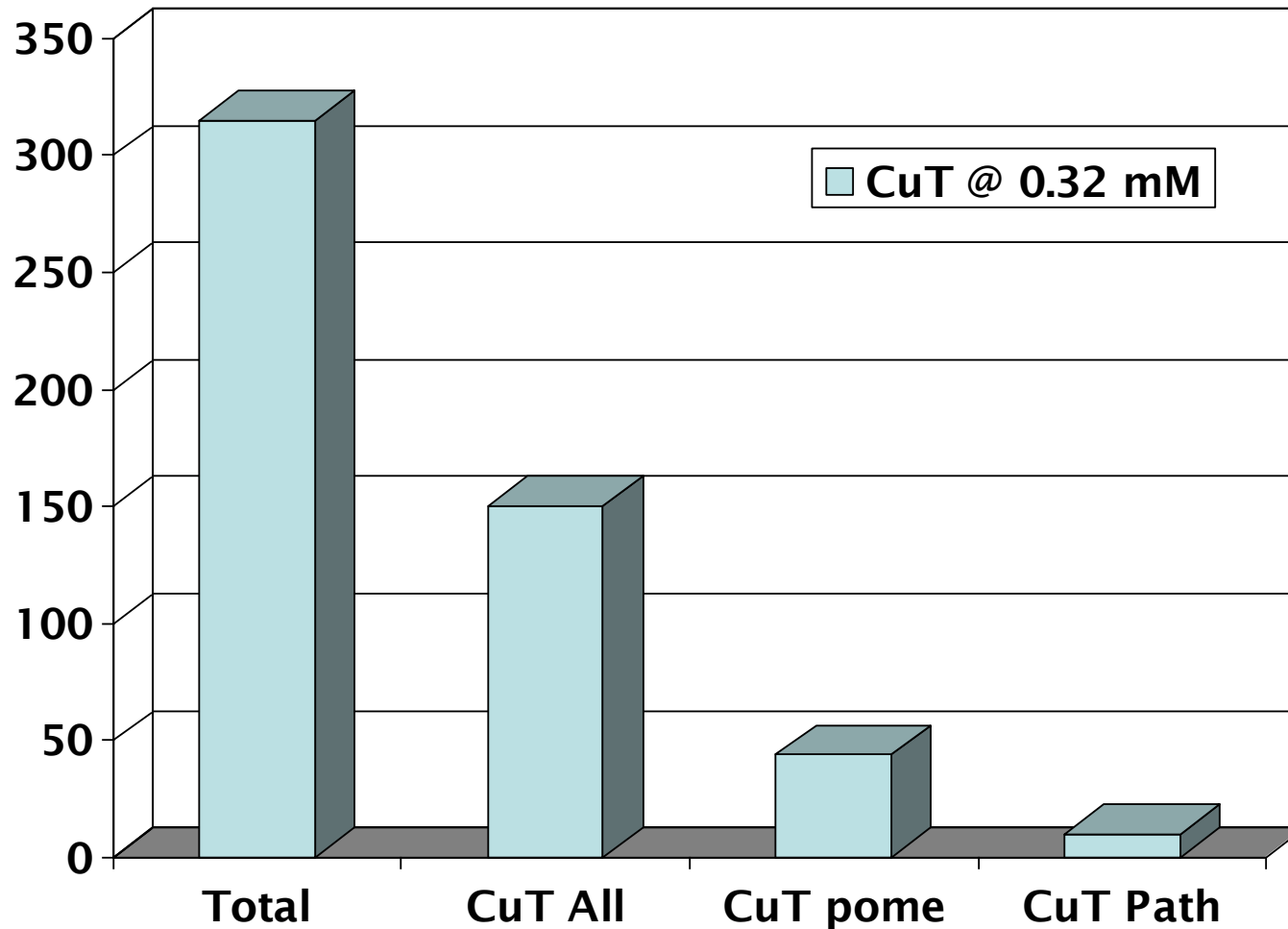
- * Long history of copper use
- * A large reservoir of resistant bacteria in the soils
- * Hyper-accumulates Cu in bacterial cells
- * or 'Excretes' Cu from bacterial cells
- * Resistant bacteria tolerate 80x more Cu ions
- * Cu and antibiotic resistance genes closely associated
- * Mobile genetic elements
- * Links to antibiotic resistance in plant bacteria, USA, Denmark

Percentage of copper resistant bacteria



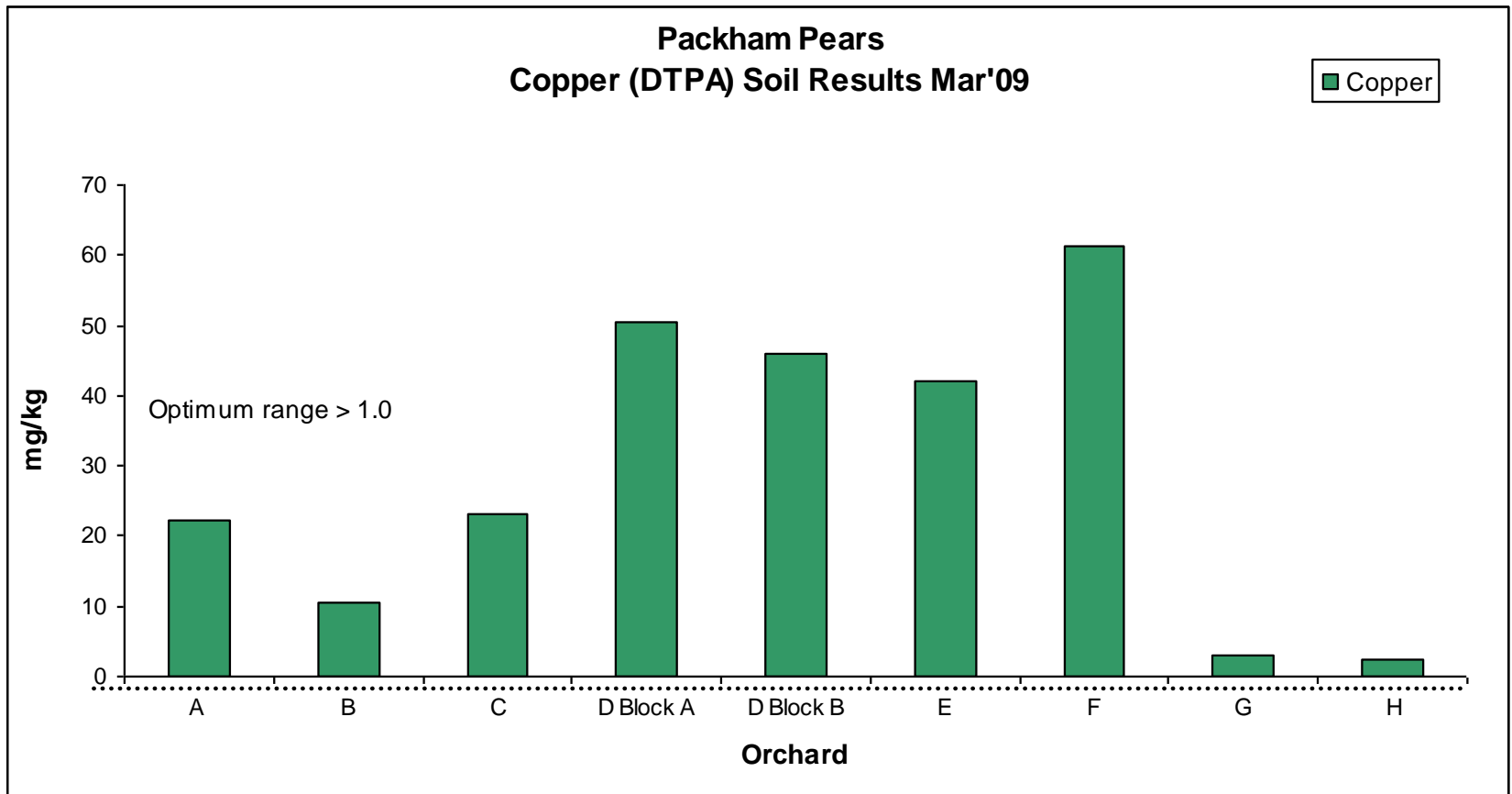
Copper resistance in Australia

Number of bacterial isolates tested and resistant to Cu



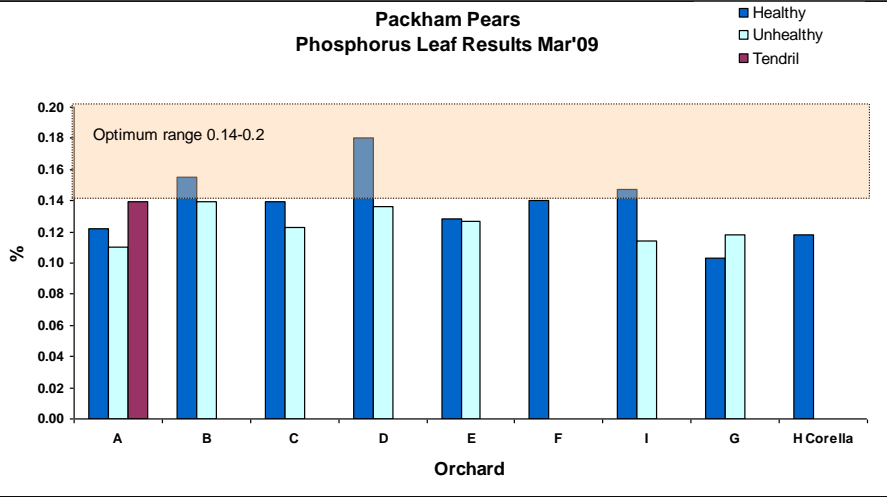
Copper resistance

- * Widespread – all fruit growing regions
- * Also, excess levels of copper in orchard soils

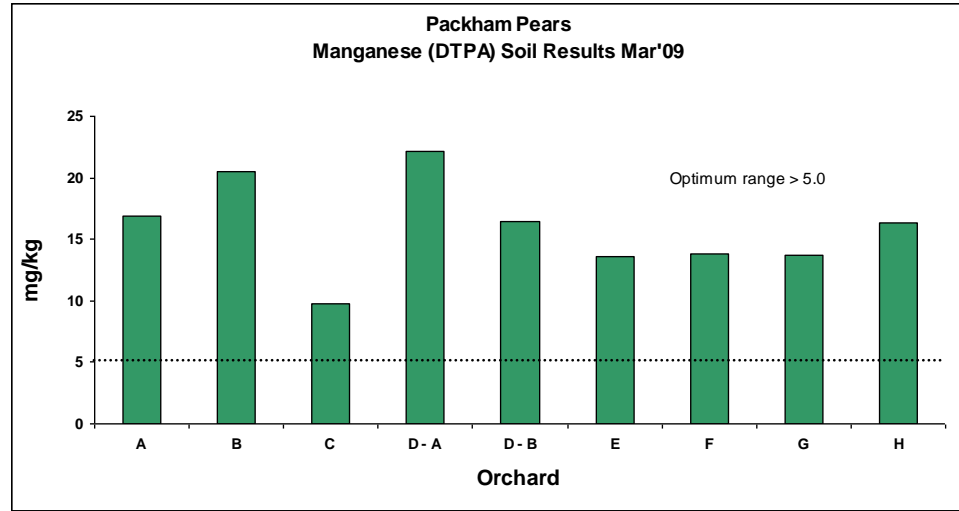


Leaf & Soil Nutrients

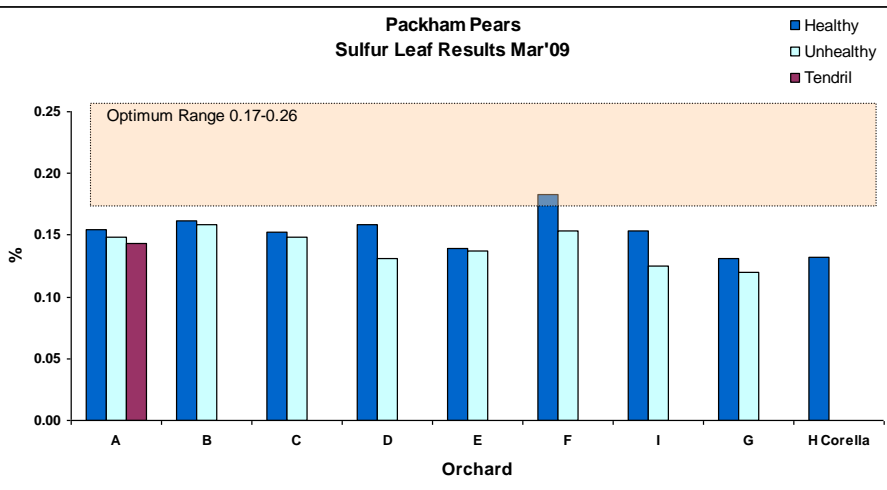
Packham Pears
Phosphorus Leaf Results Mar'09



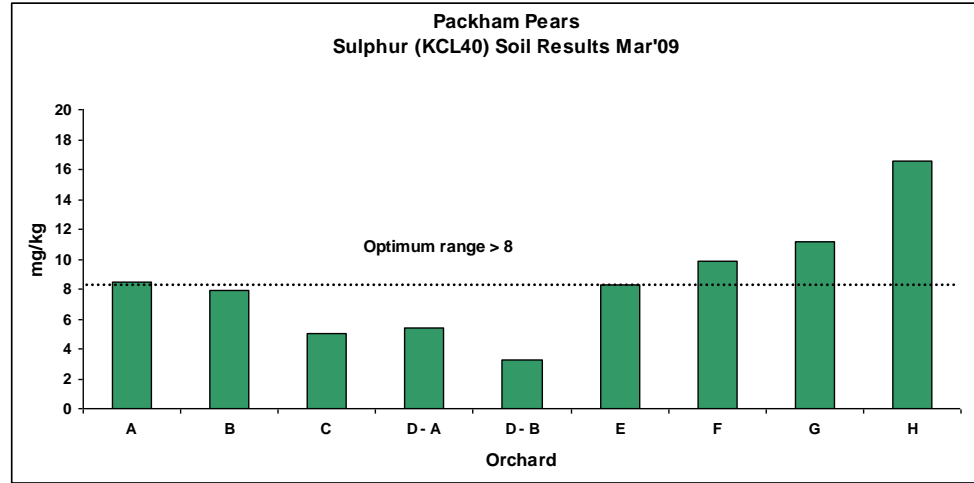
Packham Pears
Manganese (DTPA) Soil Results Mar'09



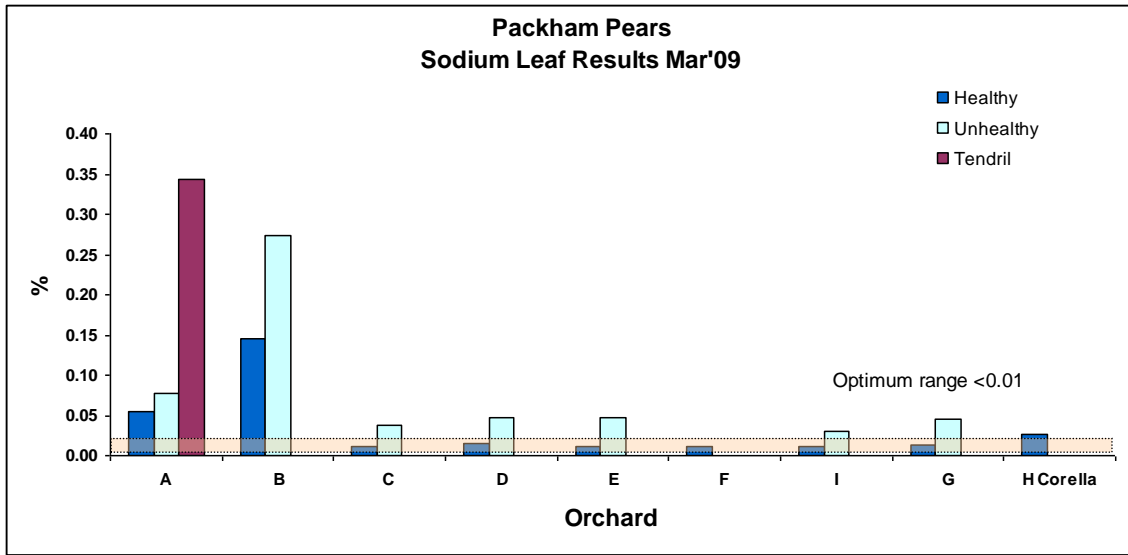
Packham Pears
Sulfur Leaf Results Mar'09



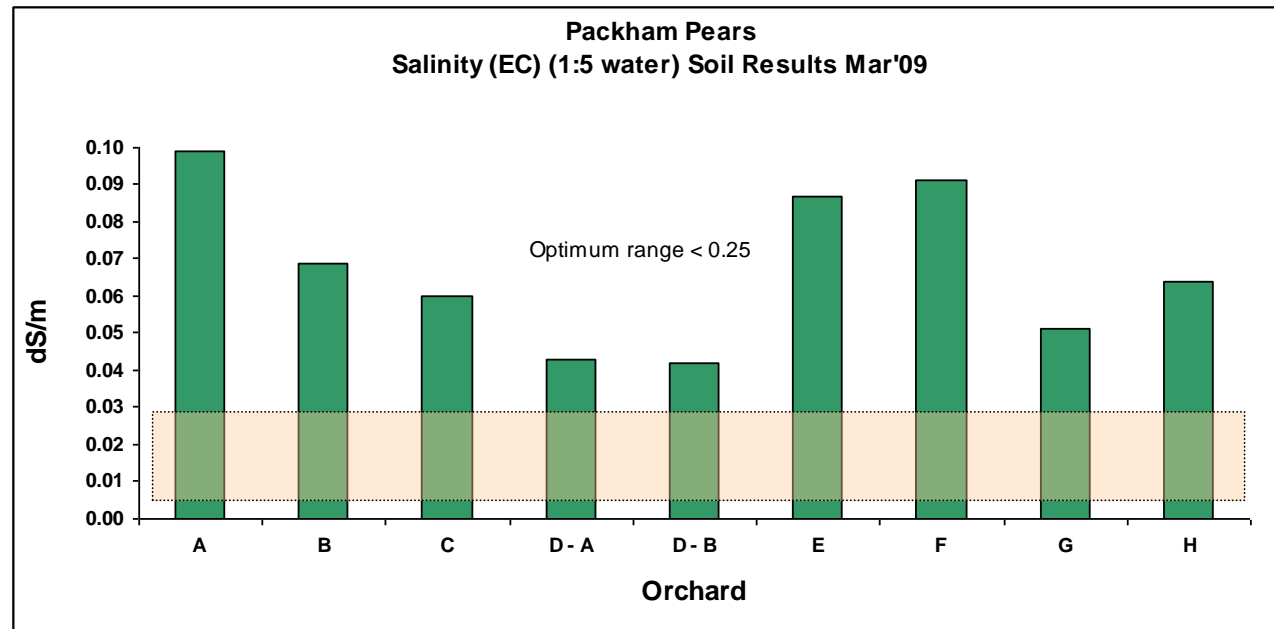
Packham Pears
Sulphur (KCL40) Soil Results Mar'09



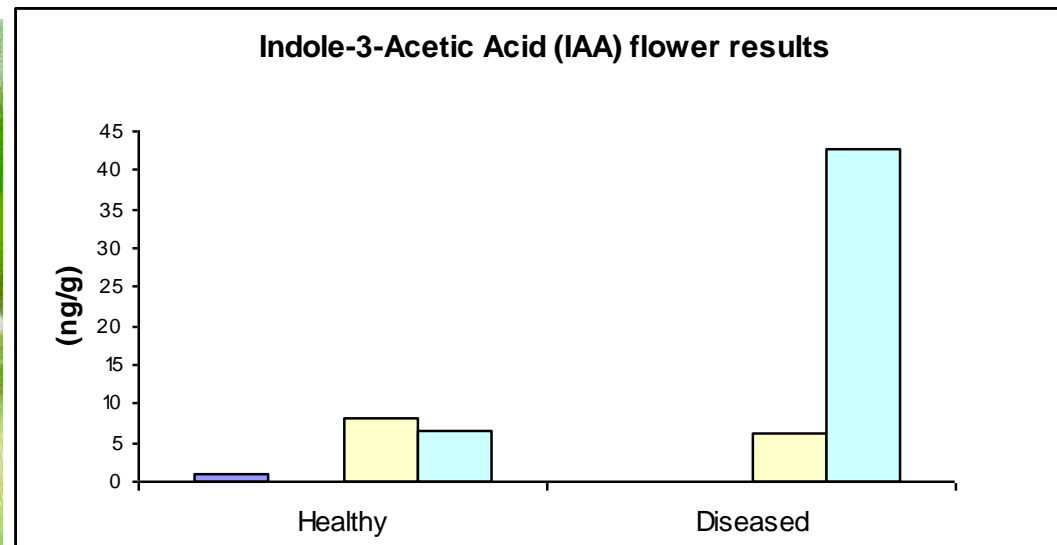
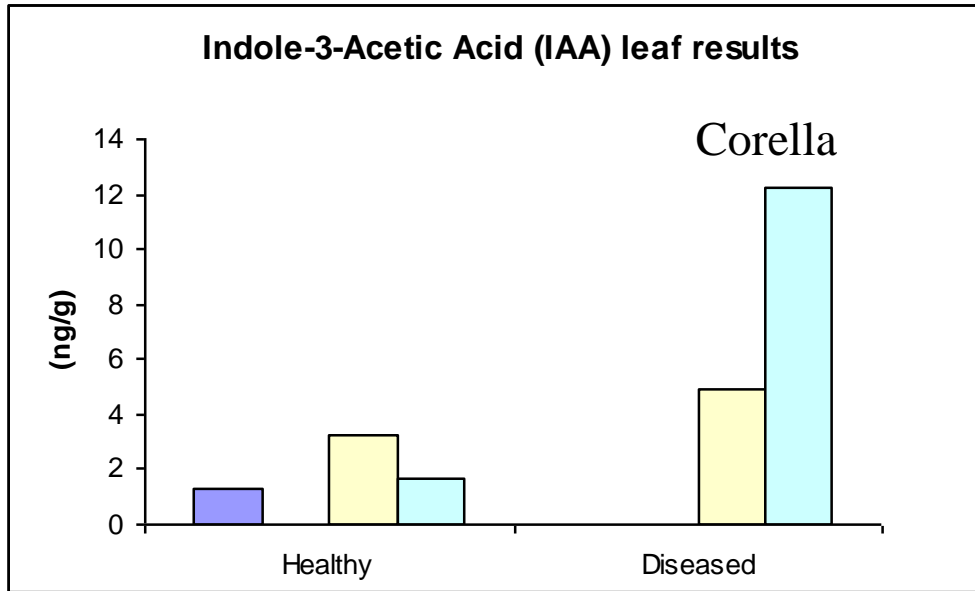
Leaf and Soil Nutrients



Salinity risks



Effect of growth regulator



Diagnosis of plant health issues



Deficiency
Toxicity
Herbicide
Growth hormone

Bacteria
Fungal
Phytoplasma
Virus
Insects

Environmental
Mechanical

Holistic approach

Complex tree health considerations

- * Need holistic attention to tree growth, nutrition, water, balanced soil and leaf nutrients, targeted pesticide applications, training & pruning.
- * Utilise smart technology, computer models, weather monitoring tools, pest prediction tools to guide pest outbreaks and spray applications.
- * Reduce pesticide build-up & drift.
- * Monitoring, analysis, record keeping.
- * Diagnosis of tree health issues.
- * Access knowledge (web, industry, R&D organisations, consultants, service & product specialists).
- **Good quality fruit and profitable business**

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