Winter Yellows -
A closer look at this physiological disorder and other issues

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Outline

Winter Yellows:
- Typical symptoms
- What we know
- Previous instances

Reasons why?
- Weather patterns
- Carbohydrates
  - leaves
  - roots

- Summary
  - Other issues
Typical symptoms

- **Yellowing of leaves**
  - Leaves stay yellow throughout winter

- **Autumn**

- **Usually latest flush affected**

- **Younger trees (2-5yrs)**
  - Little/no crop
Other symptoms include….

Sometimes:
- whole tree affected
- leaf fall
- out-of-season flowering

- Spring recovery
Previous work

After 1952-1954 outbreaks...

Affected leaves:

- low in calcium
  (1-2%, 3.5-4.5% in healthy leaves)
- high in starch

- Roots - starch depleted → death smallest roots 1st

- Applying N aggravated symptoms
Previous recorded occurrences - MIA

Plant disease surveys 1952-1986

- 1953 – widespread (+ coast & lower Murray)
- 1955 – young trees
- 1956 & 1963 – scattered trees, mild symptoms
- 1973 – severe (+ Narromine)
- 1977 - young blocks
- 2005 – widespread
- 2008 - widespread
1952 weather

Griffith Weather Data 1952

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1953 weather - WY

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Max | Min | Rainfall
2007 weather

Griffith Weather Data 2007

Date

Temperature (°C)

Rainfall (mm)

Temp Max

Temp Min

Rainfall
Griffith Weather Data 2008

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Legend:
- Max
- Min
- Rainfall
Climatic triggers?

- Good summer rainfall
- Sudden cold snaps in early-mid autumn
Carbohydrates (CHO)

• Solar energy stored as chemical energy in form of CHO & other compounds

• Leaves manufacture CHO

• Accumulated: leaves (1st), branches, trunks, roots (last)

• Tree CHO levels variable: seasonal demands of competing developing vegetative & reproductive sinks

• Starch main CHO
CHO - sinks & storage

• Actively growing organs – strong/priority SINKS

• Storage: roots (highest) > leaves/branches
  > trunk (lowest)

• Allocation to storage – lower priority than needs of actively organs
CHO – sinks & storage

- Reserves affect flowering, fruit set and yield following year.

**Large crop loads** (e.g. “on” year):
- depletes CHO → severe tree collapses/dies e.g. Murcott
- reduces summer/autumn flush

**CHO accumulation**:
- most rapid between 5 – 15°C
- affects photosynthesis/CHO transport
Leaves

- Long lived: 2+yrs if N adequate
- Photosynthesis rates relatively low
- Photosynthesis optimum 25-30°C, → reduced - at high temps >35 °C & low temps
- Up to 45% dry matter – mostly cell walls complex CHO
Leaves & CHO

- Age affects CHO storage & export
- No CHO export until FULLY expanded (1-2mths)
- Significant importer prior to export
- New flush – strong sink
Leaves & CHO

- Older/shaded leaves export greater portion of CHO & more rapidly
- Shaded leaves—significant contributor to autumn & winter CHO reserves
- Starch not readily mobilised for export
- No sinks → chloroplasts packed with starch → cell membrane damage
Movement of carbohydrates

Fruit source CHO principally from leaves of same growth cycle
(Source: Goldschmidt & Koch, adapted from Powell & Krezdorn 1977)
Root growth

3 factors:
- shoot growth*
- soil temperature
- soil water

• Growth alternates with shoot growth
  - greatest when shoots not growing

* Major factor controlling intensity of root growth
Root growth

Valencia on Rough lemon

Valencia on Carrizo citrange

Root growth – temperature & water

**Soil temperature:**
- most intense at > 27°C
- limited < 22°C
- none below 14°C

**Soil water:**
- Little growth ≤ -50 kPa (-0.05 MPa)
Roots & CHO reserves

- Highest CHO reserves usually in root

- Starch accumulation in roots mostly autumn & winter - dependent fruit/vegetative flush demands

- Build up greatest in absence of veg/fruit sinks (e.g. off year)
  → C depletion high under a heavy crop load
Summary - why leaves turn yellow

- Latest leaf flush – able to produce CHO
  - but can’t export (leaves too young)
  + also a sink for CHO
- If no/little fruit – no sink competition for CHO → flush
- CHO movement to roots restricted
- Sudden low temperatures
  → photosynthesis slows
  + CHO accumulates

So .....
Summary - why leaves turn yellow

• Youngest leaf flush → loaded with starch
  → normally re-greens following spring
  Severe - permanent damage to leaf structure

• Roots starved of CHO → die
Reducing impact of winter yellows on young trees

- Avoid promoting vigorous autumn flush
- Leave some fruit on
Other reasons for leaf yellowing
Don’t plant root-bound trees
Check young tree roots before planting
Other reasons for leaf yellowing...
Choose soil type carefully
Manage irrigation to avoid over watering
Other contributors to tree collapse
collar rot

Remove/check tree guards
References

- Fraser, L.R. and Barkley, P. Virus and related diseases of citrus in New South Wales. Dept. of Agriculture, NSW.