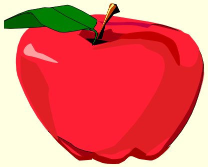
T.A.S.C.



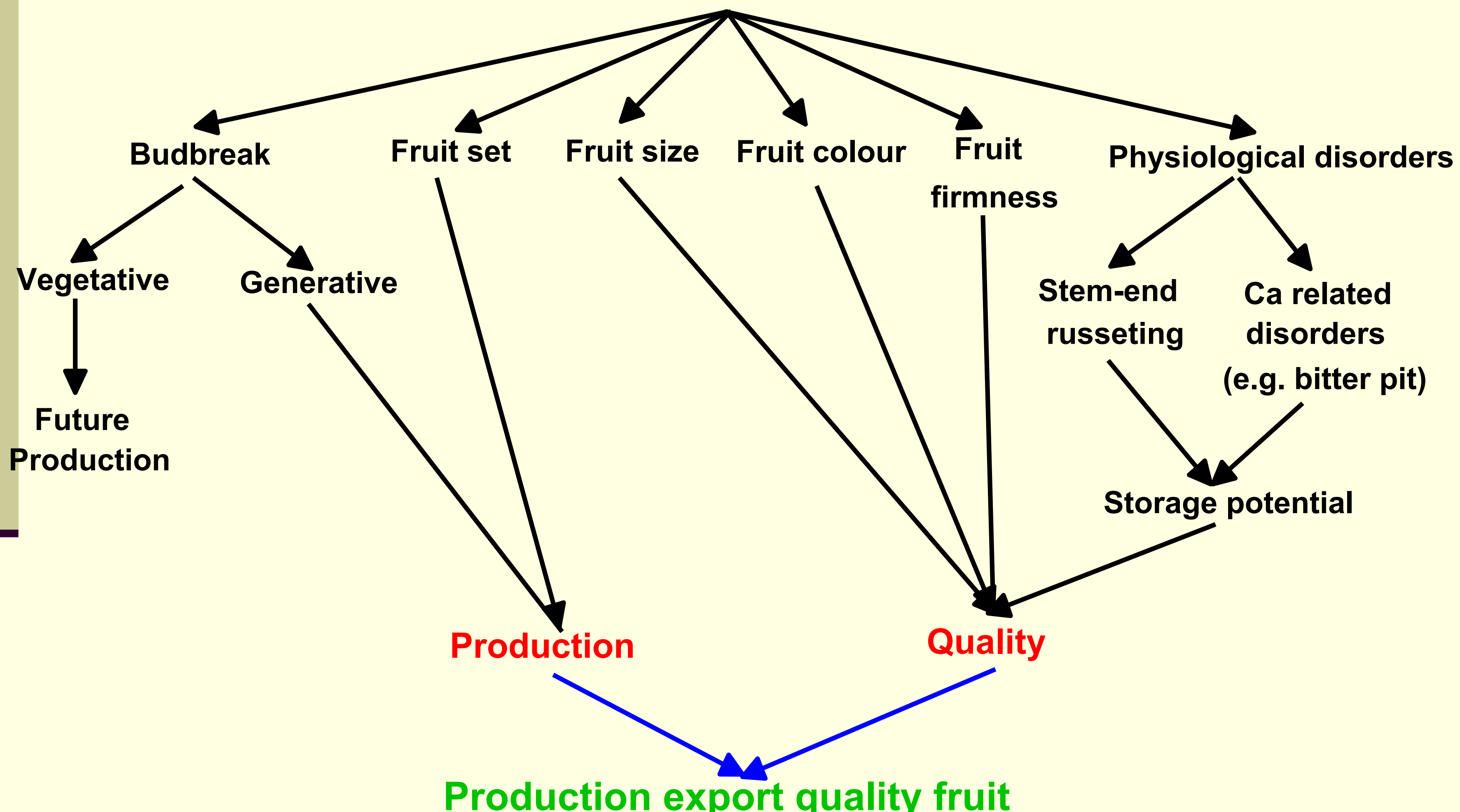
Research 20/05/2004

The effect of dormancy and rest-breaking on production and fruit quality

Dormancy

- Dormancy concept - different types of dormancy
- Chilling requirements - factors affecting chilling requirements, monitoring systems, starting - , final date
- Methods to determine chilling requirements for new variety
- Timing rest-breaking sprays

Effect of rest breaking on



Definition Dormancy

- Physiological condition of deciduous fruit trees during which no noticeable growth takes place:
  - **No cell division takes place in terminal or lateral buds.**
  - **Rest cannot be broken even when temperatures and soil moisture favor growth.**
  - **No bud break with gibberellic acid or rest breaking sprays (DNOC, Dormex, etc.) and pruning.**
  - **Dormancy or rest can only be broken by exposure to winter chilling**

Dormancy three stages :

- paradormancy (summer dormancy or correlative inhibition)
- endodormancy (winter dormancy or rest)
- ecodormancy (imposed dormancy or quiescence)

- Paradormancy regulated by conditions within plant but outside bud, e.g. apical dominance
- Endodormancy controlled by conditions within bud, e.g., failure of buds to grow in autumn
- Ecodormancy controlled by conditions outside plant, failure of buds to grow in late winter

End of rest

- 50 % of the buds capable to grow within a given period time
- when held at an appropriate temperature with their bases in water

Factors affecting dormancy

- Dormancy induction , maintenance and release → continuum
- Dormancy affected by :
  - site of the bud,
  - photo-period,
  - environmental induction
    - Low temperature in colder regions
    - Low temperatures + short days in warmer areas
- phytohormones,
- effective chilling temperatures,
- bud differences,
- environment and/or cultural practices,
- dormancy breaking chemicals,
- stress management.

Factors affecting dormancy

- 1885 H. Muller-Thurgau shortened shoot growth period

↓

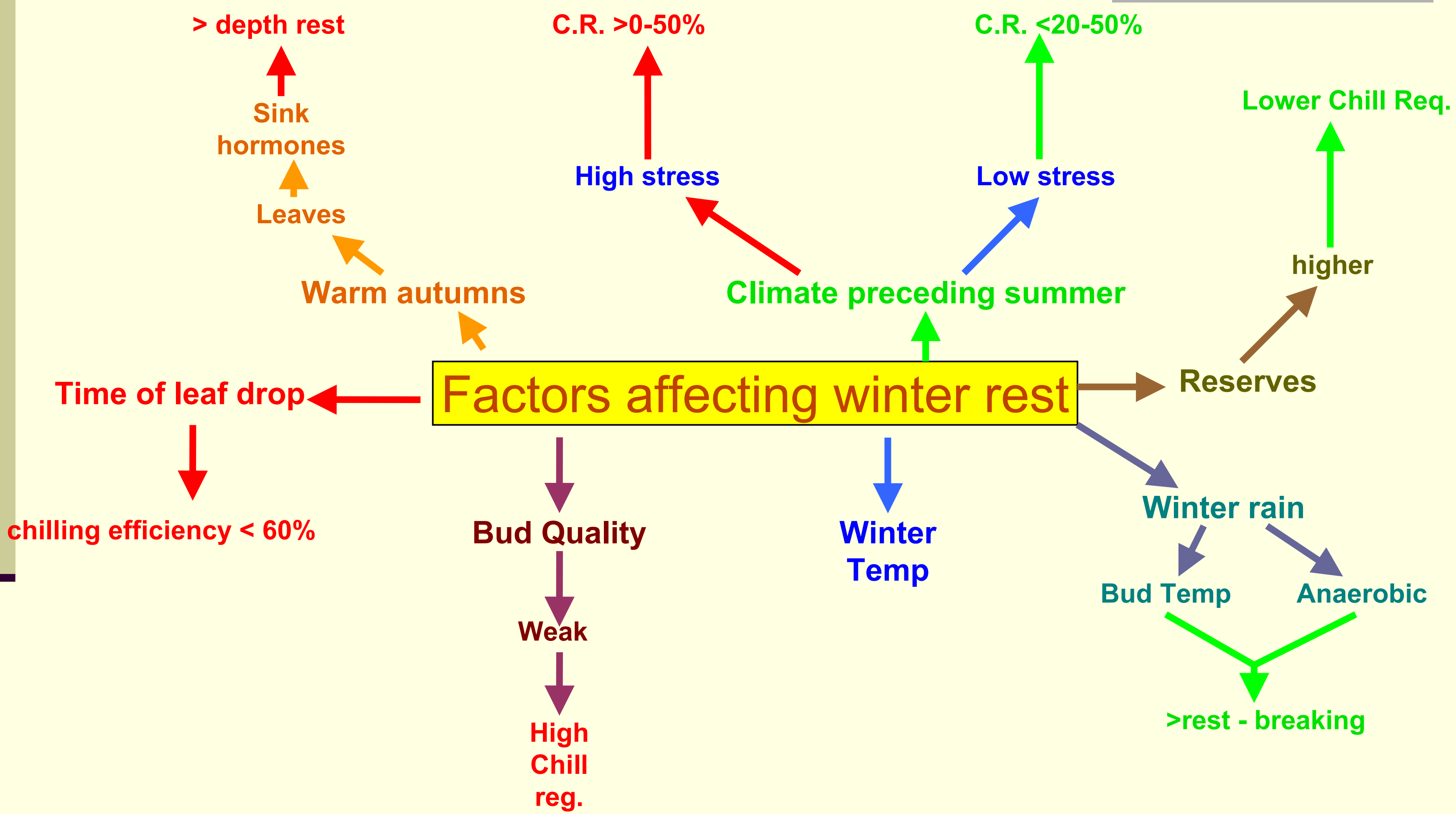
- early inception of bud dormancy and shortens its duration
- 1934 Chandler and Tufts extended growth period of shoots

↓

- delays bud break the following spring if there is insufficient chilling

Vegetative maturity critical point in dormancy cycle

Vegetative maturity critical point in dormancy cycle



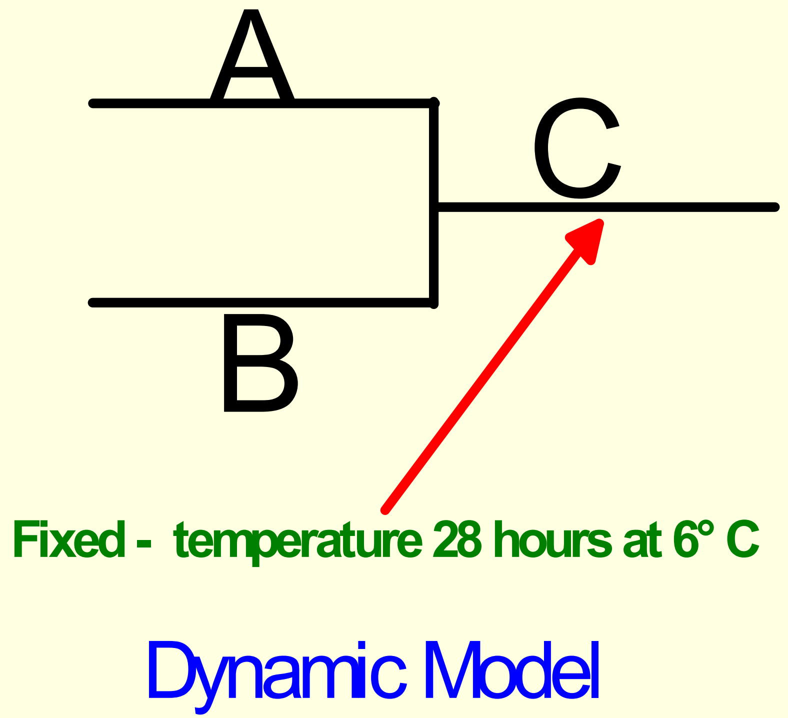
Chill-unit accumulation

- **Temperatures > or < 0° C to 7° C are not believed to contribute toward chill-unit accumulation**
- **Temperatures below 0° C are considered to have no effect in breaking dormancy**

- Models
- **“Richardson” or "Utah “**
- **Temperatures between 0° and 16° C promote the breaking of rest.**
- **Maximum promotion at 7° C (1h at 7° C = 1 chill unit - CU).**

“Dynamic model”

- Temperatures between 0 and 13° have positive effects
- Above 18° C negative
- 13° to 16° C enhance response, cycled with lower temperatures
- Dynamic model differs from Utah Model in that chilling units , once accumulated, cannot be negated by high temperature.

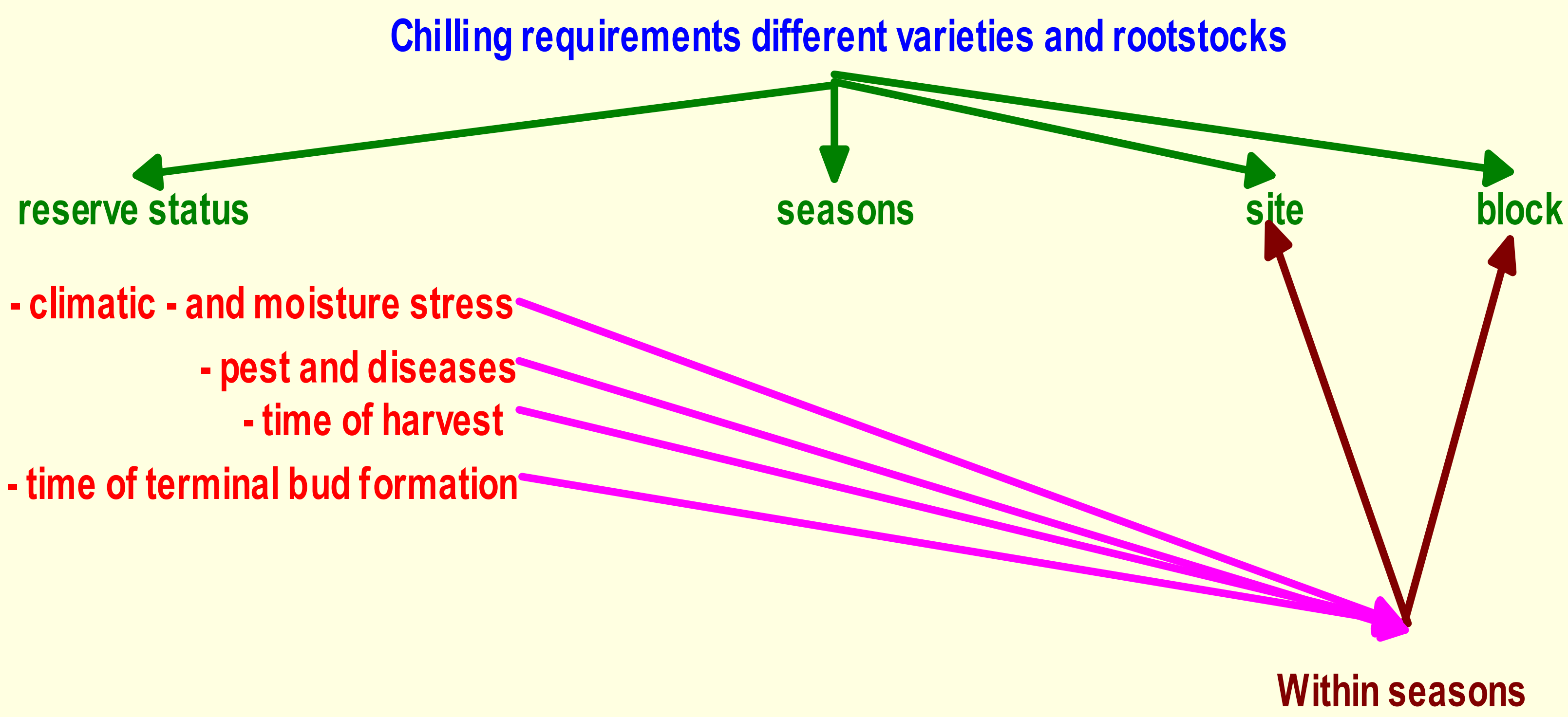


South African model
(ICE - Infruitec Chill Units)

- **Mixture Richardson/Dynamic**
- **high temperatures no effect on chill unit accumulation.**

Degree C	Units
< 1.4	0
1.5 - 2.4	0.5
2.5 - 9.1	1
9.2 - 12.4	0.5
> 12.5	0

Chilling requirements



Completion of rest

buds break when exposed to 20° C in a laboratory

1 August

Varieties

Chilling requirements	Varieties
Category I (extreme high)	Rome Beauty, **Macoun (family of Honeycrisp),** Northern Spy
Category II	McIntosh
Category III	Winesap
Category IV	**Red Delicious types, Golden Delicious types, Cox Orange. Gala types, Fuji types** (Own research)
Category V	Yellow Newtown
Category VI	Early McIntosh, Winter Banana, White Winter Pearmain, **Granny Smith**
Category VII	**Pink Lady®**

Rootstocks

Chilling requirements	Rootstocks
Very low	Indonesian rootstocks
Low	M26, M27, B9
High	MM104, MM106, Northern Spy
850 ICE/T.A.S.C. units	M9

Start of rest-breaking

Tree reached physiological maturity

||

maximum depth rest leaf-drop in autumn.

||

buds deepest rest

↓

50 % leaf drop

||

gibberellic acid treatments

Effect lack of chilling (or delayed foliation - DF)

Lack of **effective** chilling has an influence not only on tree development but fruit quality as well:

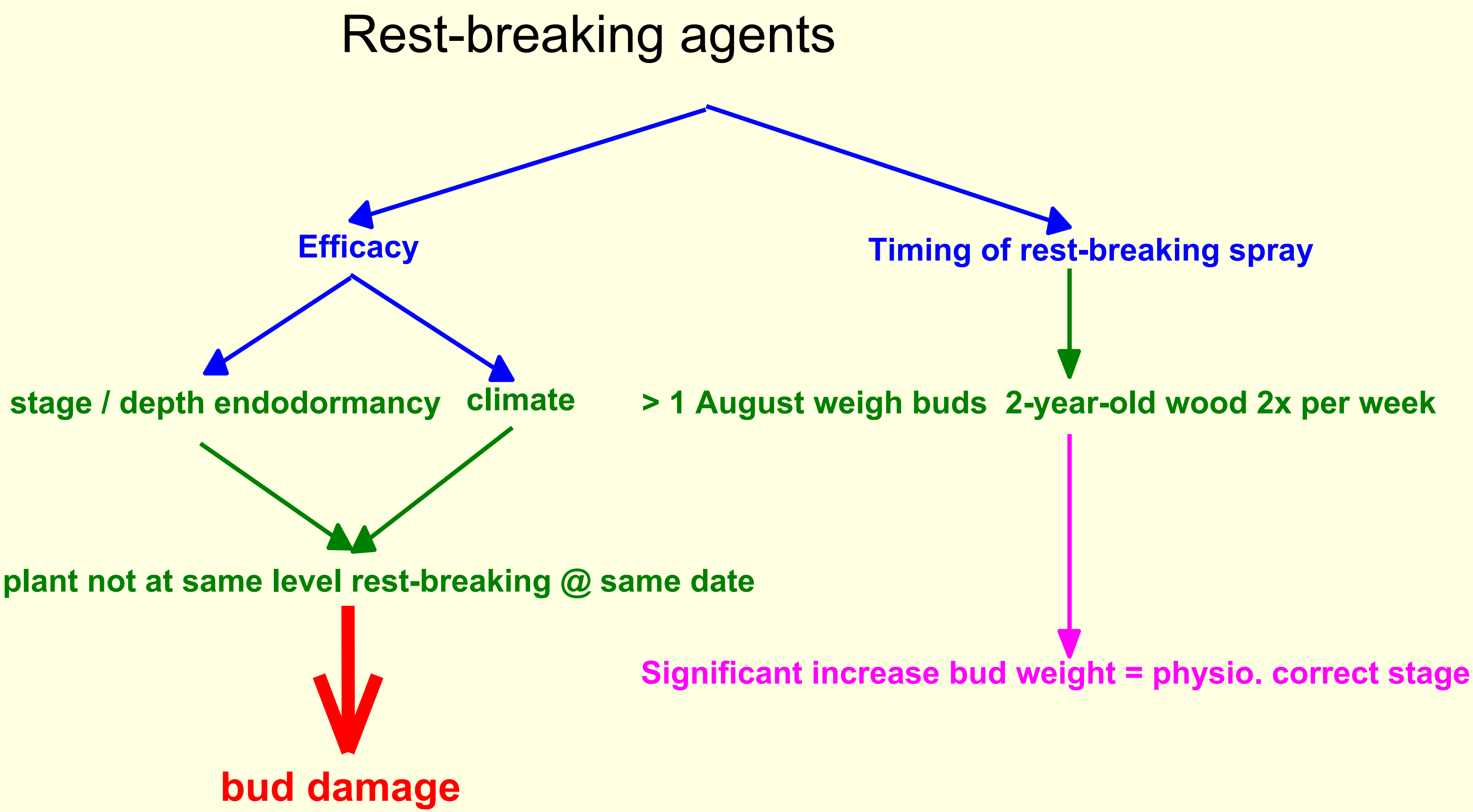
- **Effect on the tree**
  - **Poor and late start of laterals,**
  - **Relative advantage to terminals,**
  - **Correlative inhibition of laterals ("bare wood"),**
  - **Vigorous and long terminal growth,**
  - **Need for excessive pruning,**
  - **Few spurs,**
  - **Delay in fruit bearing,**
  - **Low yield,**
  - **Unchecked vegetative growth,**
  - **High chilling requirement in vigorously growing branches,**
  - **Delayed and protracted flowering season,**
  - **Flower buds open prior to leaf buds,**
  - **Excessive drain on reserves,**
  - **Lack of leaf coverage during the season, leads to sunburn of wood,**

Effect lack of chilling (or delayed foliation - DF)

Lack of **effective** chilling has an influence not only on tree development but fruit quality as well:

- **Fruit**
  - **Poor fruit development,**
  - **Small fruit,**
  - **Irregular ripening**
  - **Size distribution affected,**
  - **Storage potential affected,**
  - **Possible increase small fruit and in fruit drop.**

Rest - break Agents



Rest - break Agents

ACTION

aside, cyanide, mineral oils, thiodiazuron → respiratory metabolism

thiourea and cyanamide treatments → reduced catalase activity

hydrogen cyanamide treatments → stress response to the shock treatment

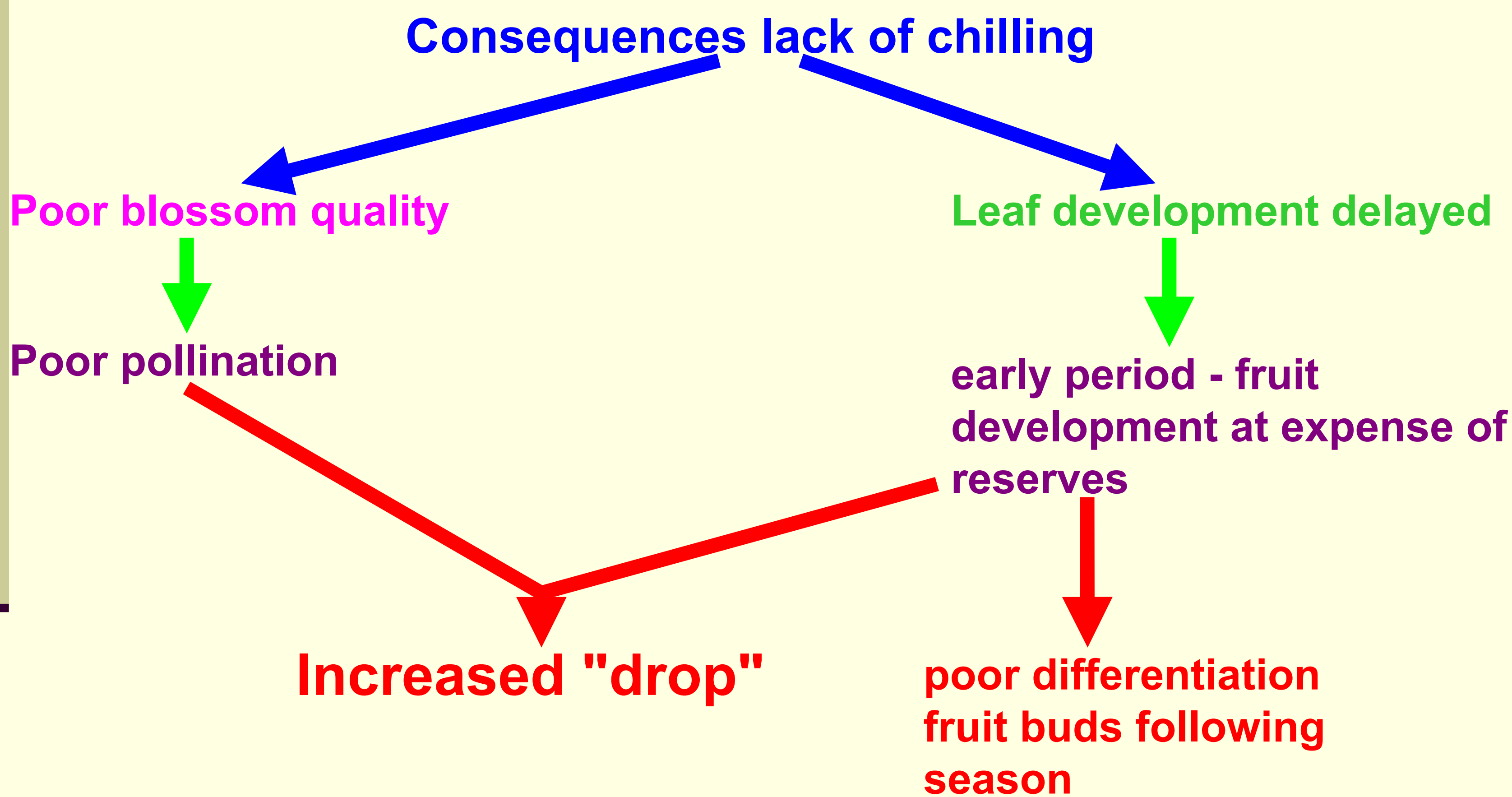
Effect lack of chilling on production and fruit set

- Extended blossom period
- < 30% fruit buds open
- female flower parts or seed-forming parts deformed
- male organs or pollen producing parts affected

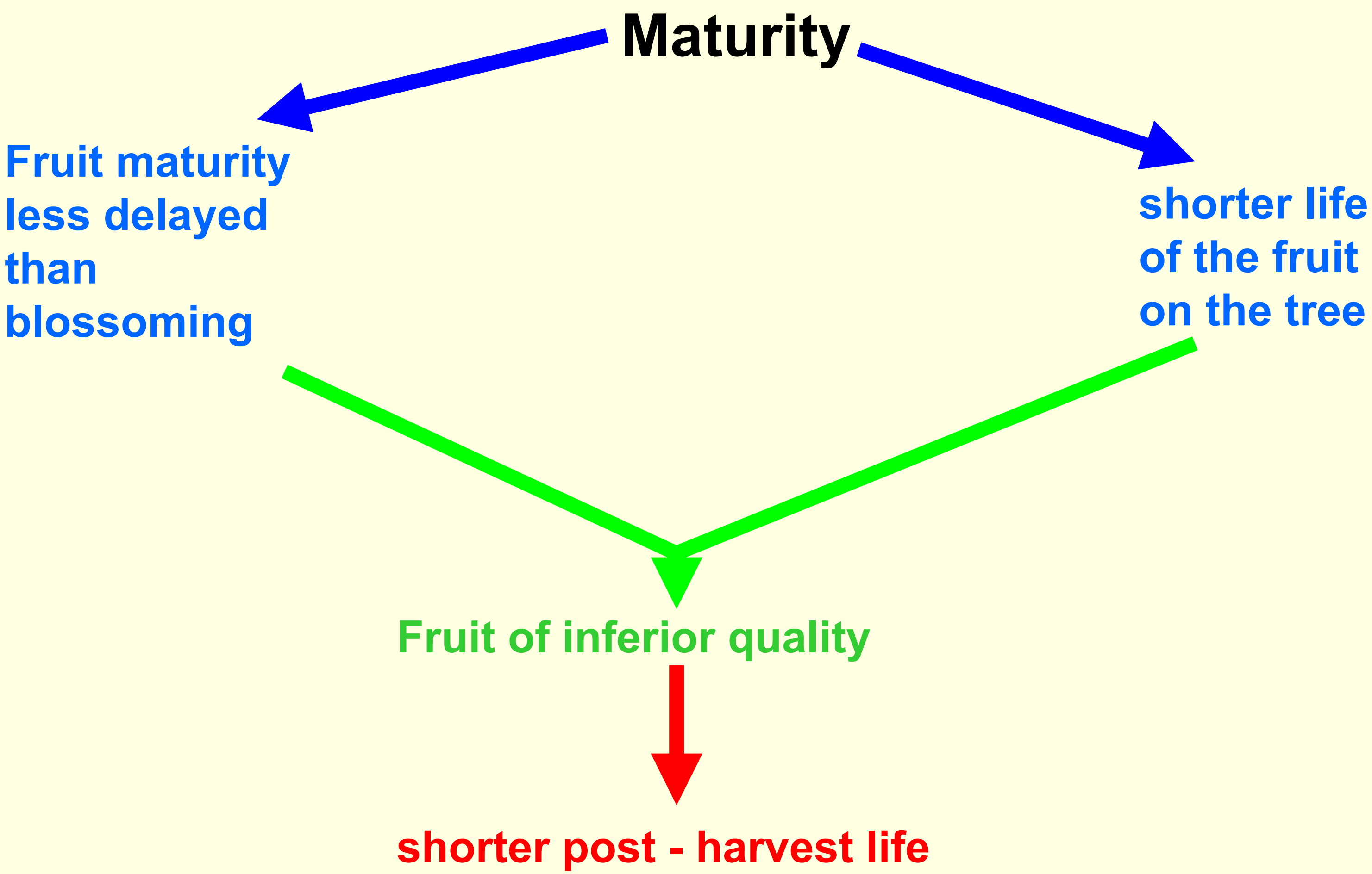
→ Fruit set affected

Leaf buds - greater chilling requirement → emergence > delayed than flower buds

Consequences lack of chilling

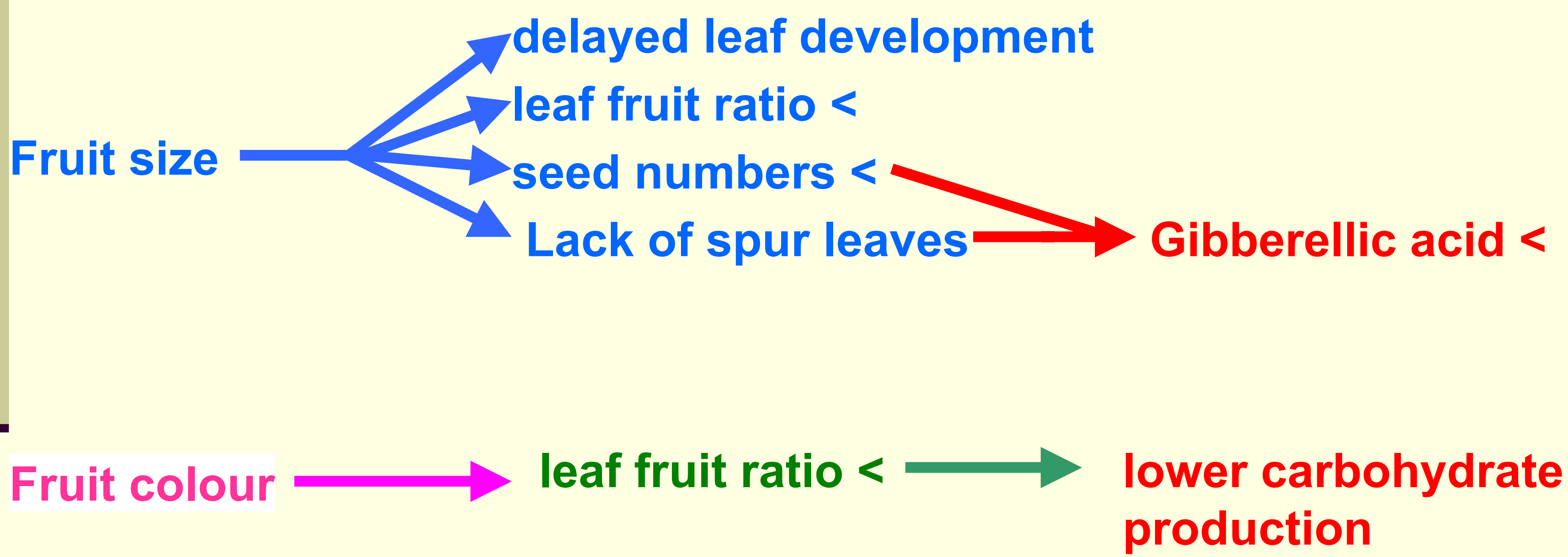


Maturity


Maturity
Fruit maturity less delayed than blossoming
shorter life of the fruit on the tree
Fruit of inferior quality
shorter post - harvest life

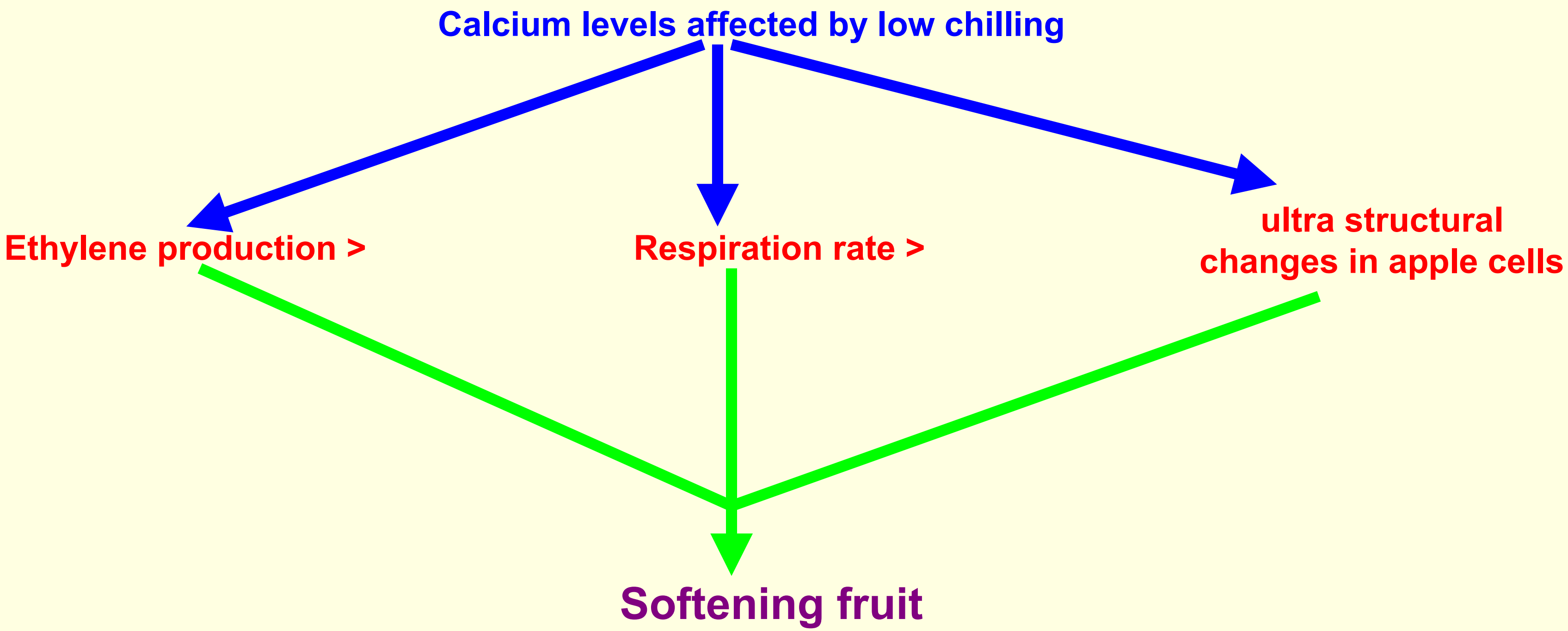
Effect of lack of chilling on fruit quality

Negative effect on

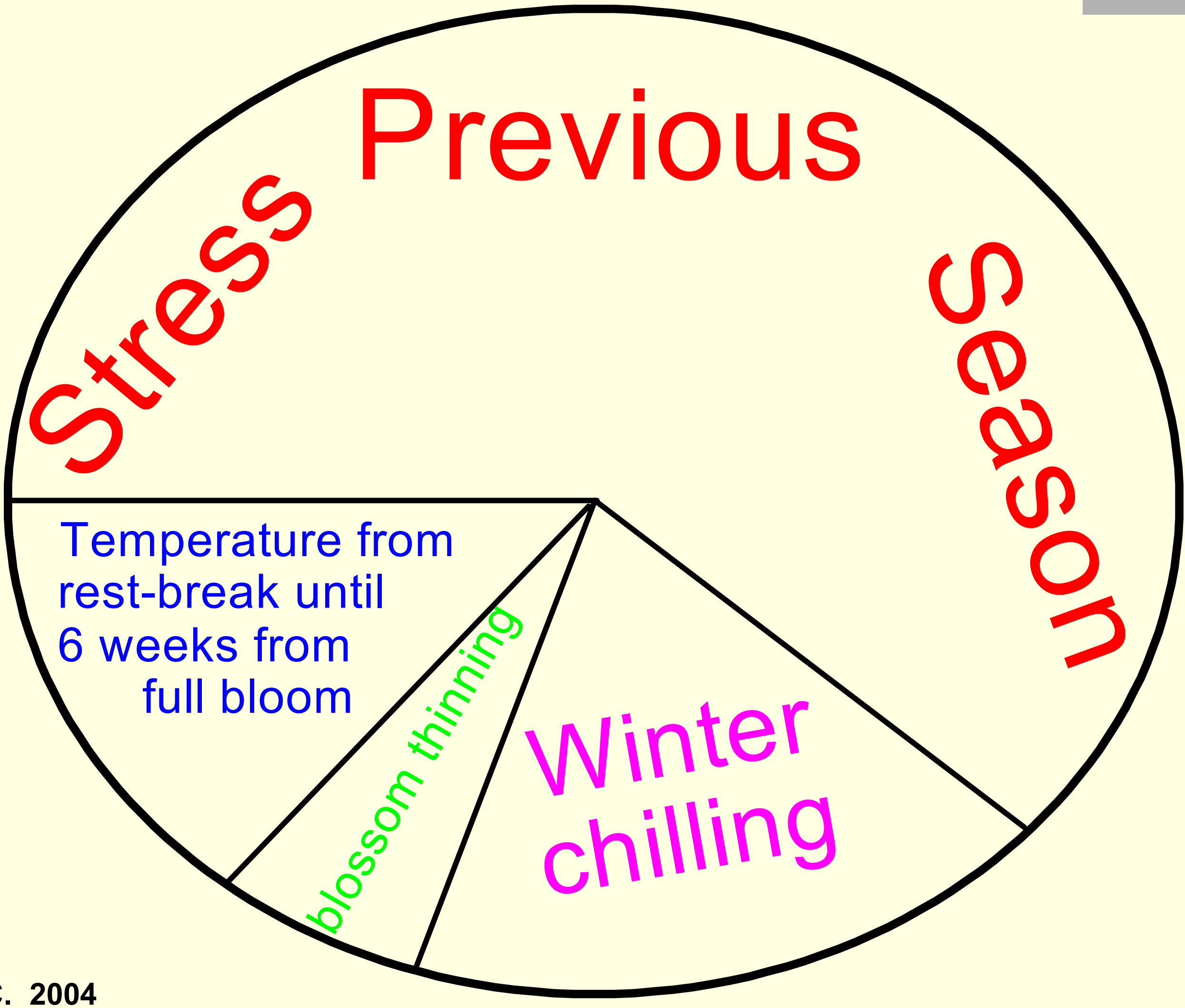


Firmness

Low chilling has a direct effect on cell density of the fruit (see next diagram)



Firmness



Previous
Stress
Season
Temperature from rest-break until 6 weeks from full bloom
blossom thinning
Winter chilling

Stem-end russeting

low chilling (<1000 CU) results in stem-end russeting

↑

low levels of gibberrelic acid available to the fruit

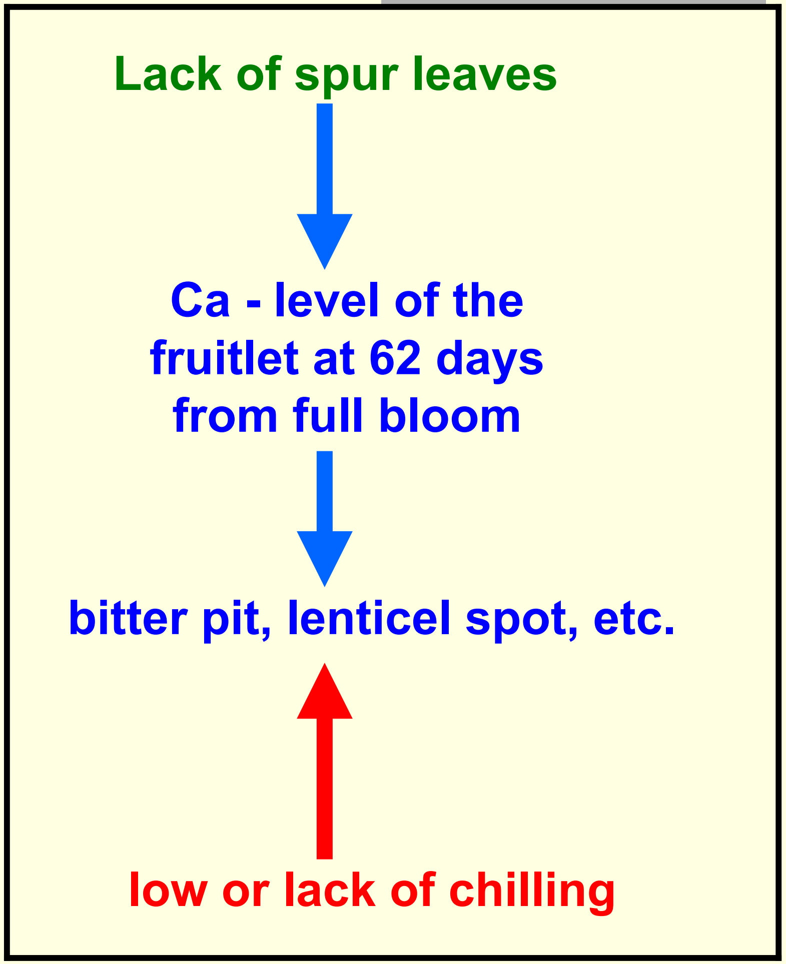
↑

spur leaves are lacking

Examples: Gala, Red Delicious, Elstar, Stem-end cracking Fuji?

Calcium related disorders

- Spur leaves responsible large part of the transport calcium
  - First from reserves
  - then from soil via roots



Optimumising flow of calcium towards the fruit

- **Fruit on dards with a large actively transpiring leaf area.**

  ← **effective rest-breaking**

- **well developed shoot emanating from the bourse capable of an optimum transpiration flow past the end of the dard.**

Effect on Fruit quality in practice

Effect chilling on fruit quality – Gala and Elstar

GALA

Increased Chilling

Brazil

South Africa

New Zealand

Chile

Washington State USA

Large fruit size

Less BP*

S-E Russeting**

Fraiburgo to Vacaria → Fruit Quality

*BP = Bitter Pit

**S-E Russting = Stem -end Russeting

Effect on Fruit quality in practice

Elstar

Variety Elstar, Holland more stem- end russeting during years when effective chilling is low