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AUSTRALIAN POTATO INDUSTRY
EXTENSION PROJECT

# Plant Physiology driving Potato Genetic Potential

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# Plant Physiology driving Potato Genetic Potential

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## Potato Plant Growth

- Plant balance, yield influenced by environment and nutrition internal control relies on growth hormones
- Root system (the Brain- nutrients, water)
- Canopy (the Brawn – sugars energy)
  - Ethylene, ABA balance vegetative/storage (senescence)

## Potato Seed Dormancy

- Resting Phase = Dormancy
- Break in Dormancy = bud activity

# Plant Hormones – Modelling of the Potato Lifecycle

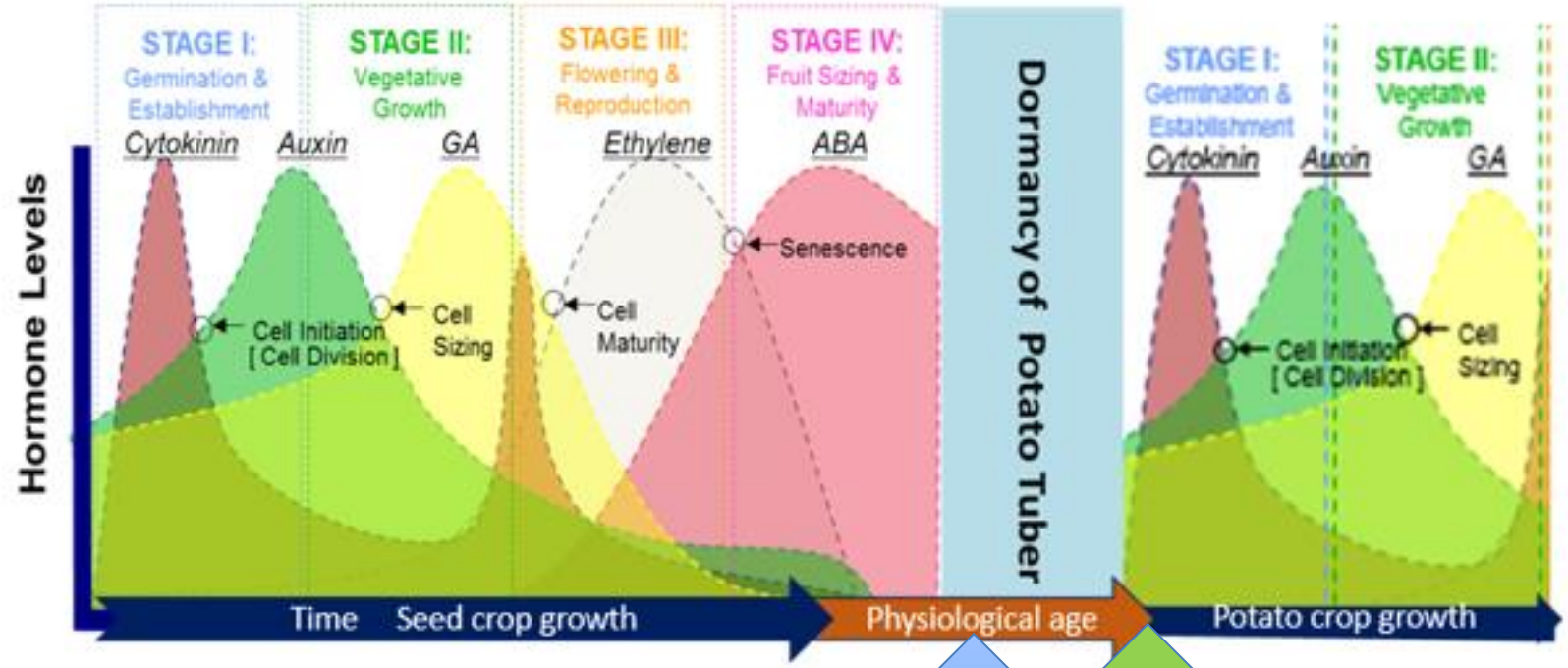


Figure 24 Diagrammatic Model of the function and relationsh grow lators in plants over the plant lifecycle (Cavallaro, 2010)

# Plant Hormones – Tuber development and growth

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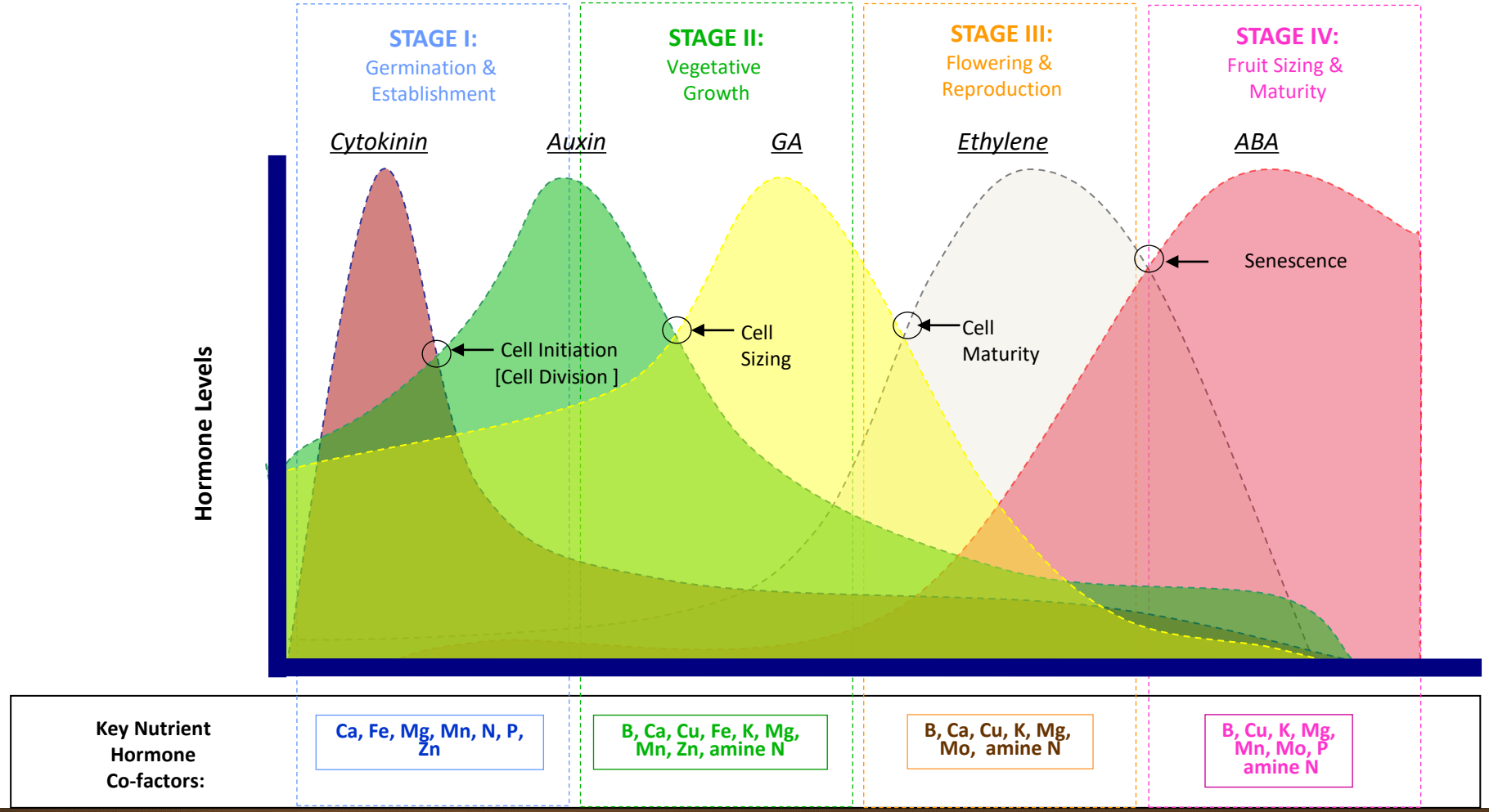




# Nutrients Affecting Hormonal Activity of Plants

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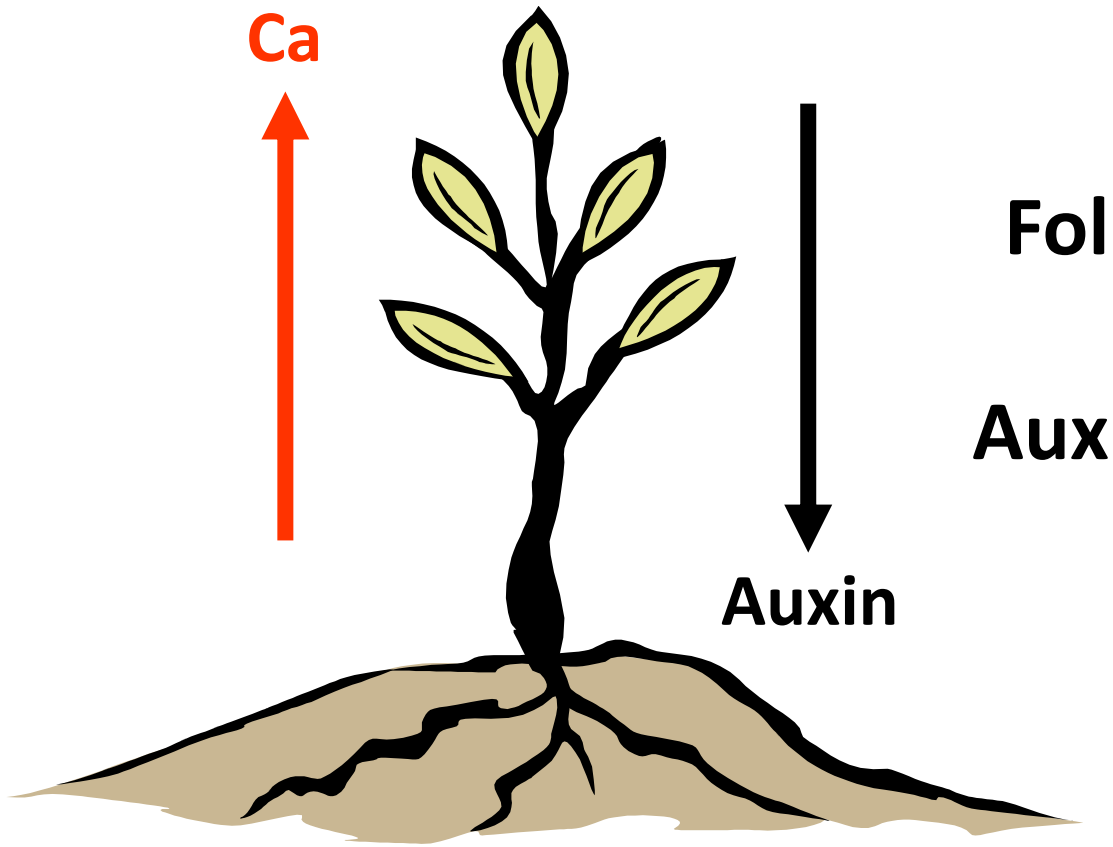
**Zn - Zinc is necessary to convert Trypthophan to IAA. The lack of IAA in new plant tissue (new leaves) inhibits cell division and causes new leaves to become yellow and small.**

Zinc deficiency will cause plants to have more problems with “sucking insects”. Yields can be greatly reduced.

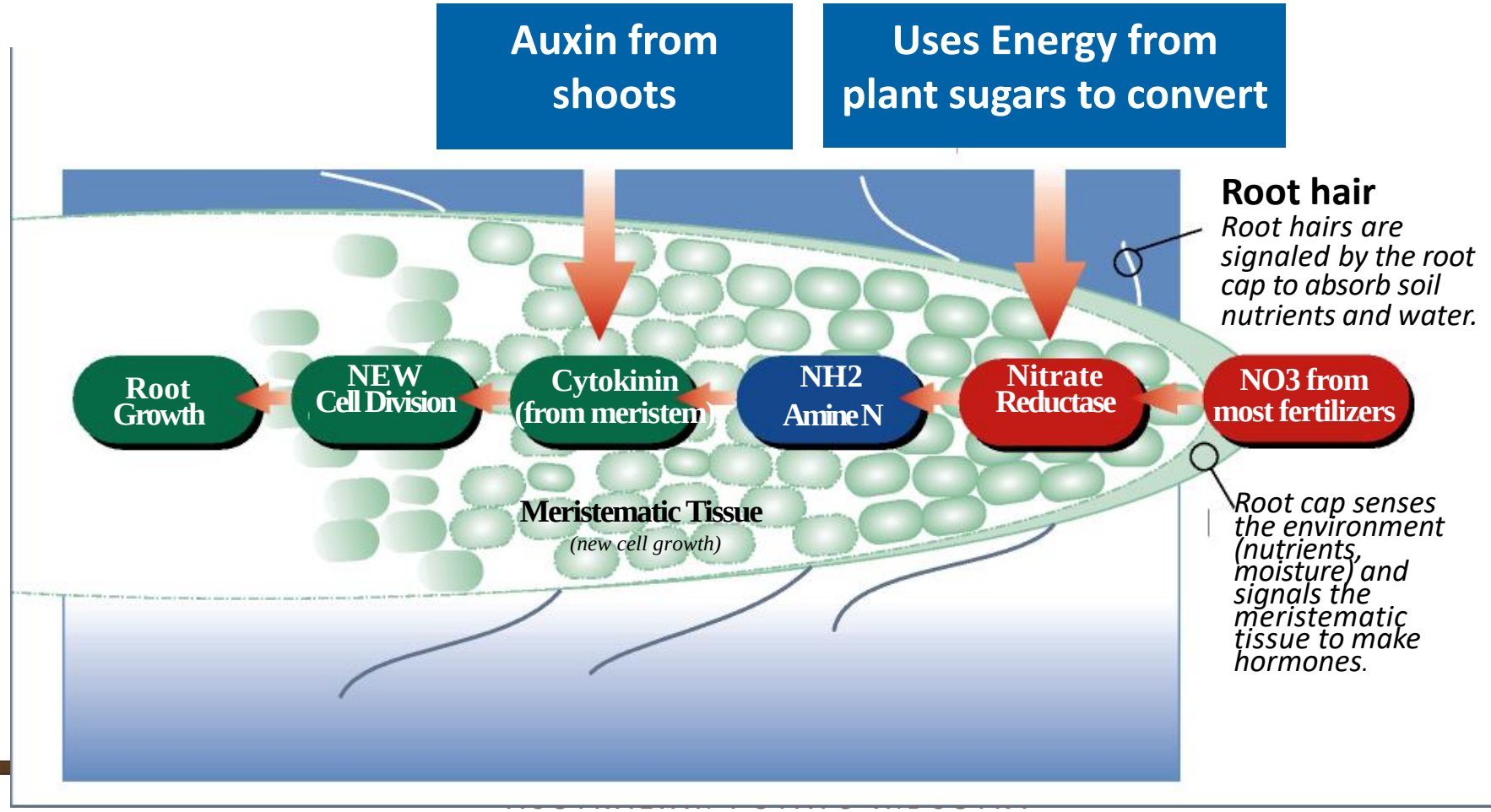
# Calcium and Root Growth




**Foliar-applied calcium does not make Auxin move downward.**

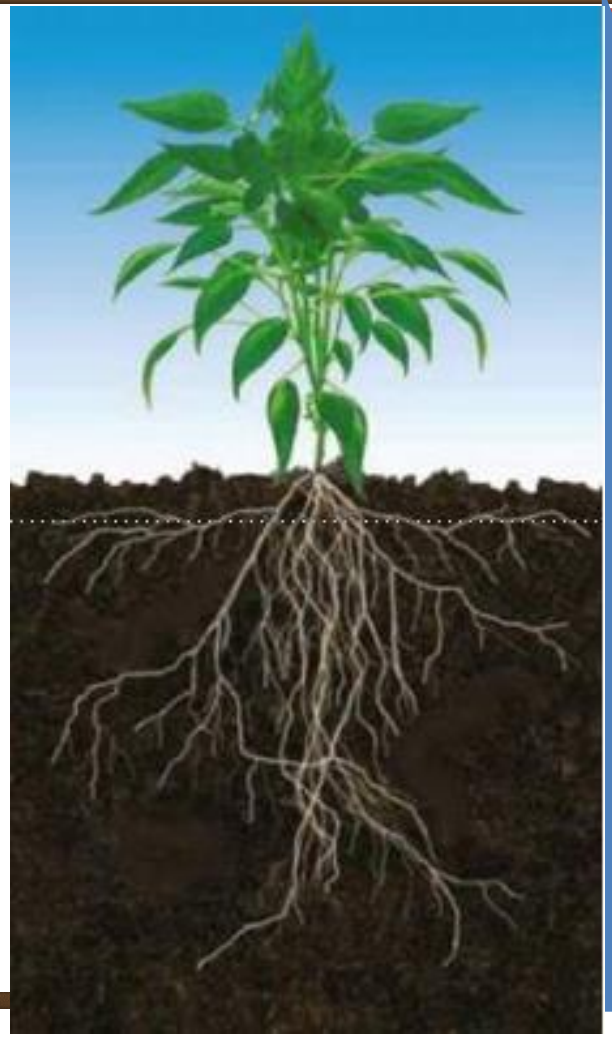
# Plant Hormones involved with Root Growth





# Hormone Balance

## The ratio of Cytokinin (from the roots) and Auxin (from the shoots)



Auxin

Cytokinin

} Vegetative Buds

} Branching

} Tubers

} Roots

# Canopy Recovery Driving Photosynthates to Tubers

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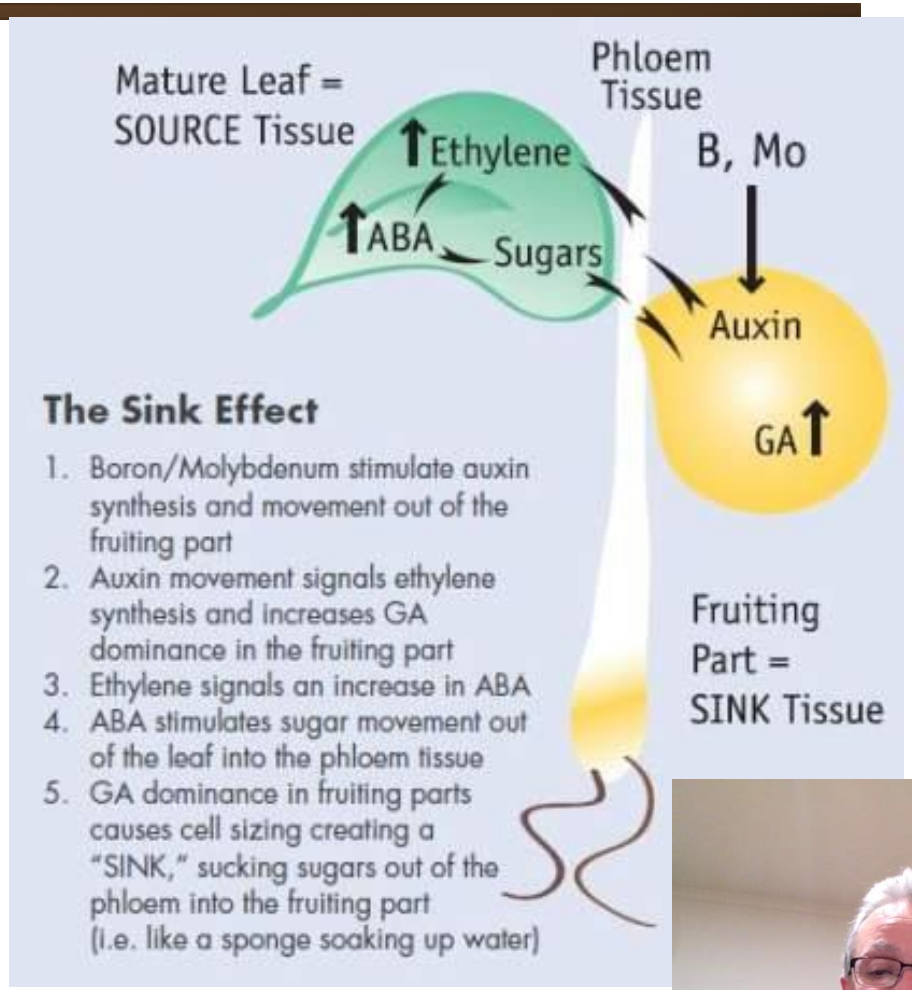
**Senescence pathway**

**Building tuber starch and sugars (weight)**

- Canopy maturity increase in Ethylene/ABA
- Tubers to size canopy burn down wastes canopy potential
- Control foliage ethylene levels buy closing stomata – triggers translocation




# Canopy Recovery  Delivering Yield and Solids

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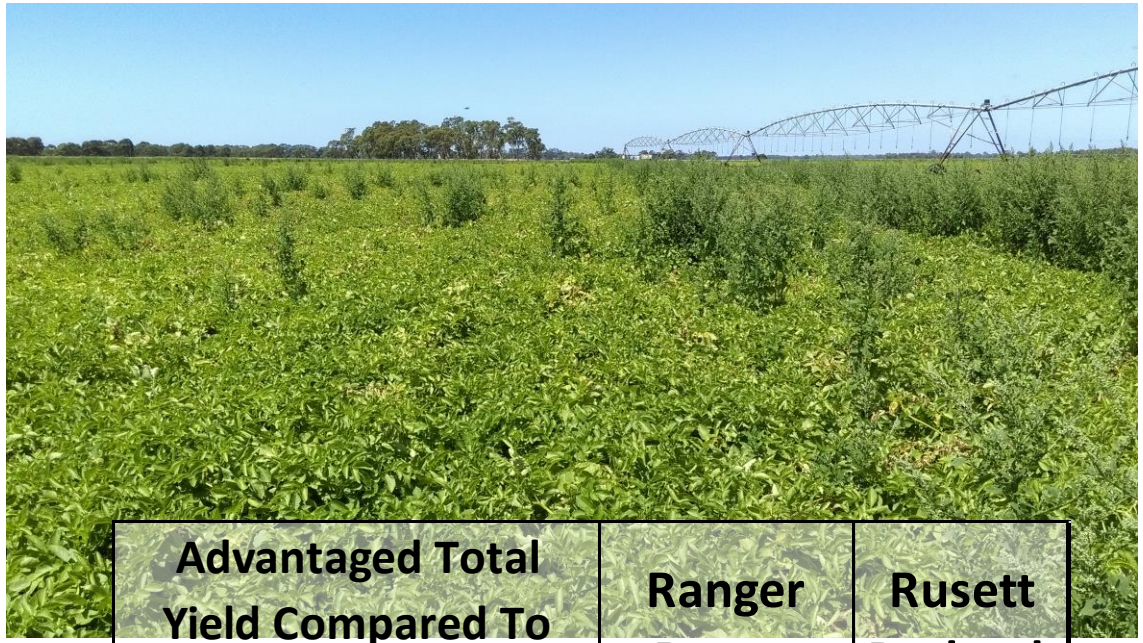
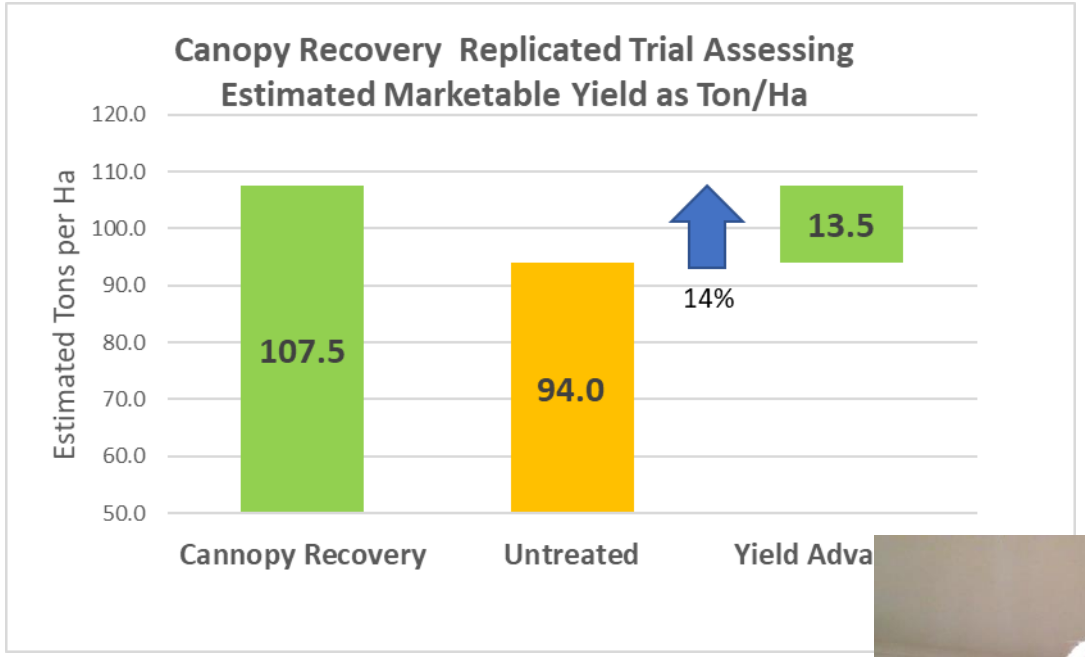
## Processing Crop canopy



| Advantaged Total Yield Compared To Grower Standard | Ranger Rusett | Rusett Burbank |
|---|---|---|
| Canopy Recovery | 19% | 15% |

## Fresh Market Trial Mallee




# Seed Sizing and Maturation

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- **Ethylene** (ETH): Controls hormone balance & movement

- **Abscisic Acid** (ABA): Controls water use, promotes ripening and cell maturity. Also causes seed & bud dormancy…"puts seed / bud to sleep".

# Plant Hormones – Potato seed dormancy and emergence

## Modelling of the Potato Lifecycle

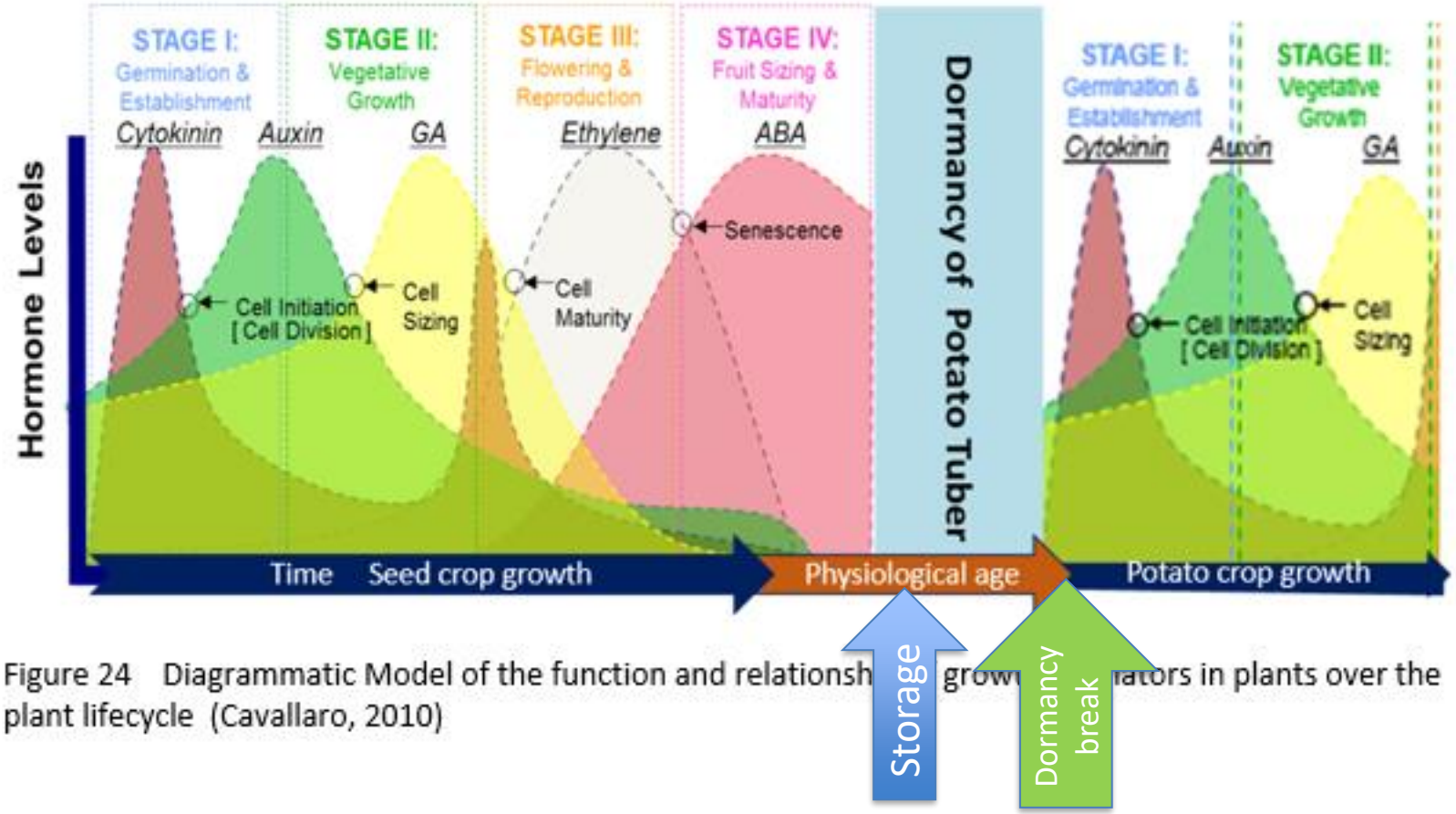


Figure 24 Diagrammatic Model of the function and relationsh grow lators in plants over the plant lifecycle (Cavallaro, 2010)

# Potato Seed Dormancy

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- Dormancy is induced by abscisic acid (ABA) and enters the tuber from the vine during tuber growth
- Even under optimal conditions seed dormancy is not broken until the amount of ABA is reduced and breakdown over time.
- The build up of cytokinin and gibberellins reduces the effect of ABA
- Carbohydrates stored in the tuber need to be broken down to sugars to feed the emerging sprouts – rate of respiration
- Temperature, stress, tuber damage

# Plant Hormones – Potato seed dormancy and emergence

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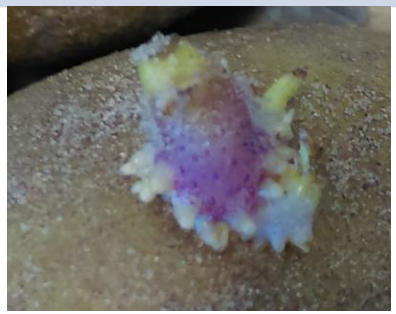
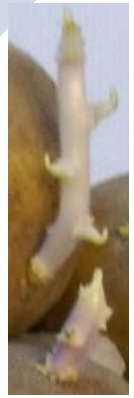
## Essential plant growth pathway

Cytokinin
cell division

Auxins
cell
differentiation



Gibberellic Acid
Cell elongation



# Stages of physiological age of seed potato

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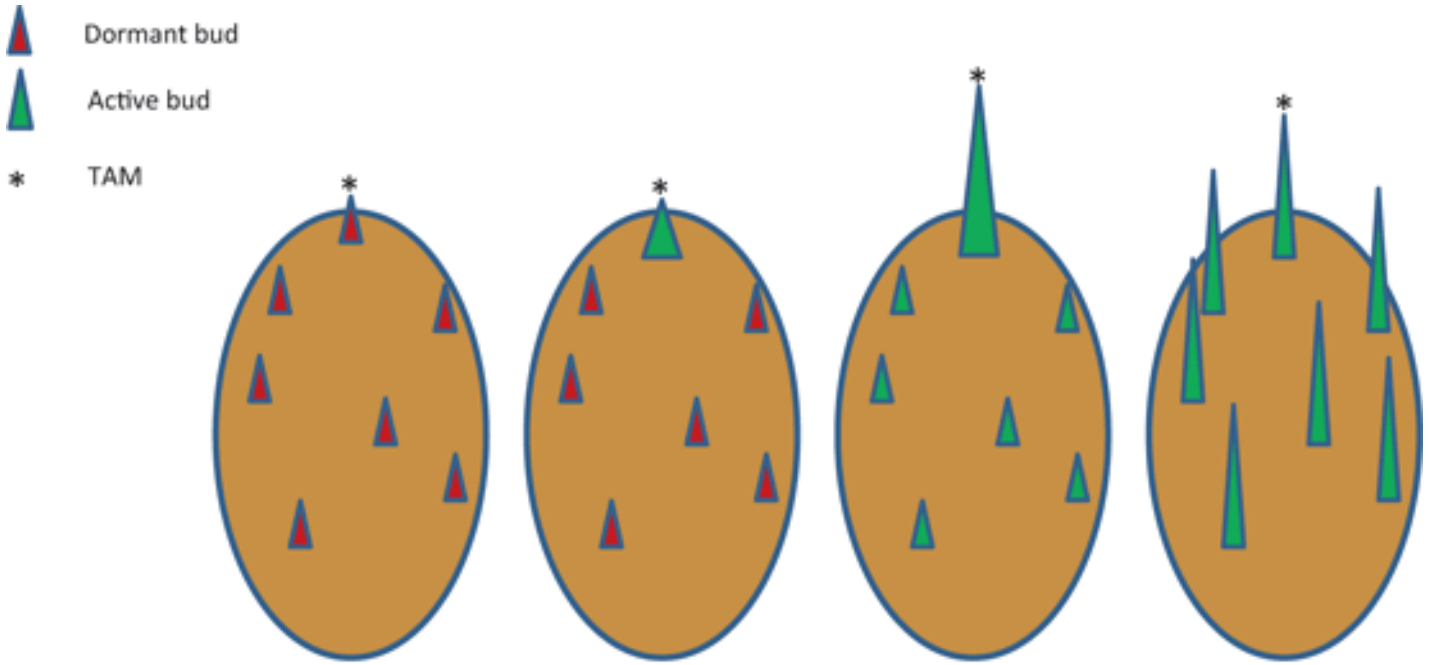
*(Images from Potato Facts: Selecting, Cutting and handling potato seed by S.B, Johnson Bulletin #2412)*

| | | |
|---|---|---|
| | Dormant | • Potatoes do not sprout at all<br>• Dormancy period varies depending on cultivar<br>• Chemical and non chemical means of breaking dormancy |
|  | Young | • Young seed is characterised by apical dominance<br>• Minimal sprouts<br>• Sprouts come of apical end of tuber<br>• Fewer stems per tuber<br>• Fewer tubers but large in size |
|  | Middle aged | • Multiple sprouts<br>• Loss of apical dominance<br>• Multiple stems (eg 3-6) per plant<br>• High number of tubers per plant, but reduced size.<br>• Middle aged seed that has been de-sprouted should be considered old seed |
|  | Old | • Excessive branching of sprouts<br>• Sprouts weak and do not produce vigorous plant<br>• proliferation tubers that plants lack vigour to bulk tubers |



# Stages of physiological age of seed potato




| | | | | |
|---|---|---|---|---|
| Tuber apical meristem (TAM): | dormant | active | AD | loss of AD |
| Lateral buds: | dormant | dormant | suppressed by TAM | active |

Source: Advances in Plant Dormancy
bridging Dormancy Releas
Dominance in Potato Tube

# Summary

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- Role of Plant Hormones.
  - Cytokinin, Auxin and GA
  - Ethylene and Abscisic Acid
- Role of key nutrients
  - Zinc, calcium, boron and molybdenum
- Seed Dormancy
  - ABA and Auxin
  - Cytokinin and GA
  - Environmental factors

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# Thank you