Chap 5. Differentiation and Development

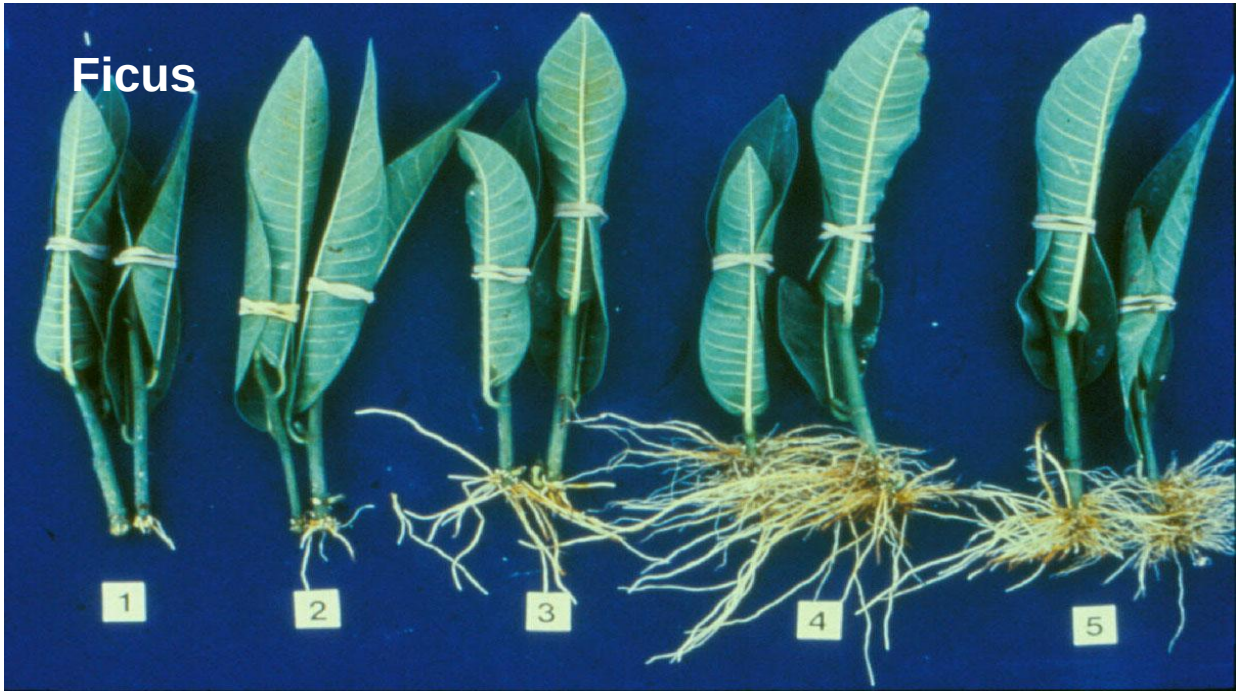
1. General Information
2. Plant Growth Hormones
3. Vegetative Physiology
4. Reproductive Physiology

1. Process of Differentiation

Differential growth in cell and tissues:

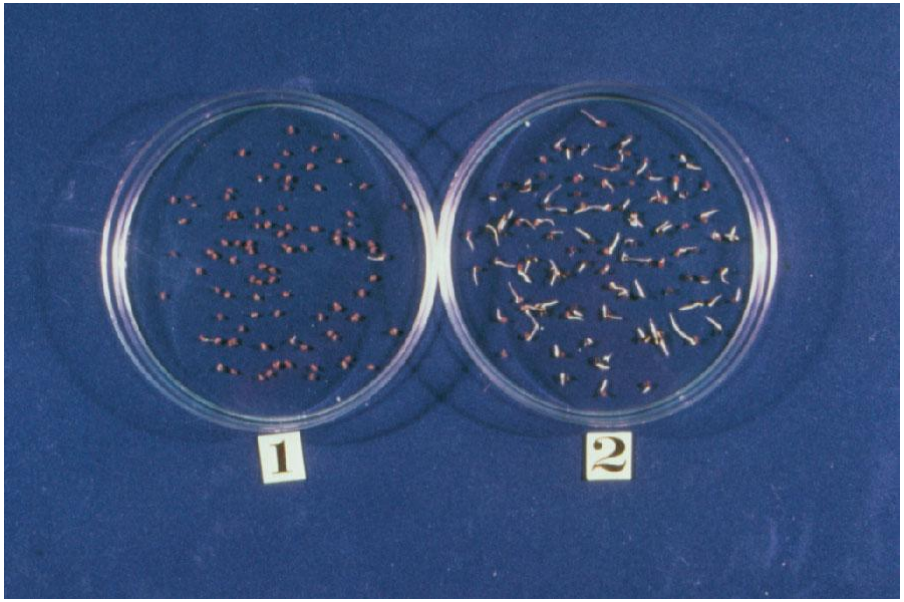
- **Orderly and systematic in mitotic cell division**
- **Genetically controlled development**
  - **by gene activation and deactivation**
  - **Also influenced by external environment**
- **Tissue and organ differentiation controlled by plant growth hormones that are produced indifferent parts of plants**

Influence of IBA Treatment on Root Formation



Cuttings treated with IBA: 1-control, 2-50% ethanol, 3-1000 ppm IBA, 4-2000 ppm IBA, 5-4000 ppm IBA

Enhancement of Seed Germination by GA Treatment



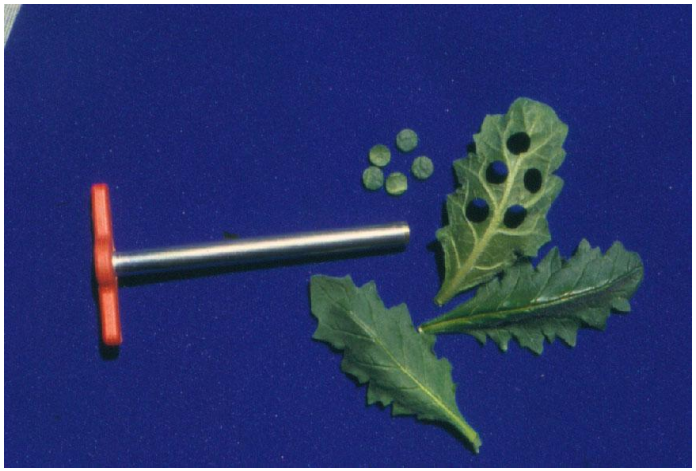
Seeds of Desert Beard Tongue (*Penstemon parryi*) is difficult to germinate due to seed dormancy (see 1 above). Treatment of seed with 200 ppm GA_3 for 24 hours leads to 95% germination (see 2 above).

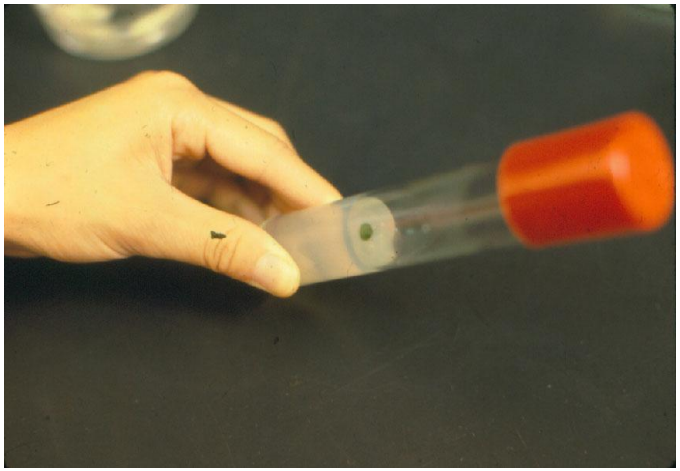
Seed treatment with GA_3 often ends up with elongated seedlings: control (left), GA_3 treated (right)

Use of Plant Hormones in Tissue Culture

Cytokinin- Stimulates shoot differentiation

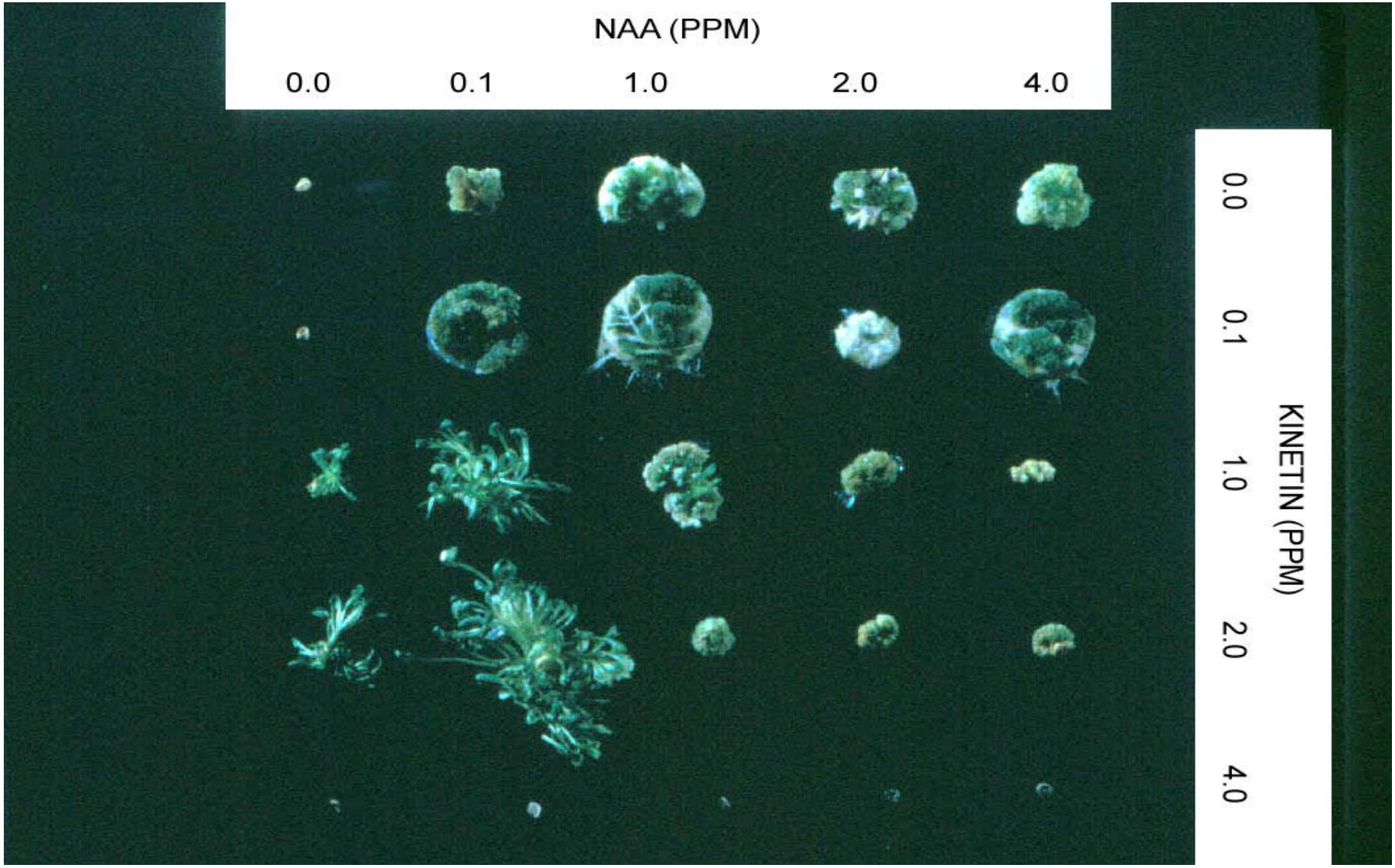
Auxin- Stimulates callus and root formation

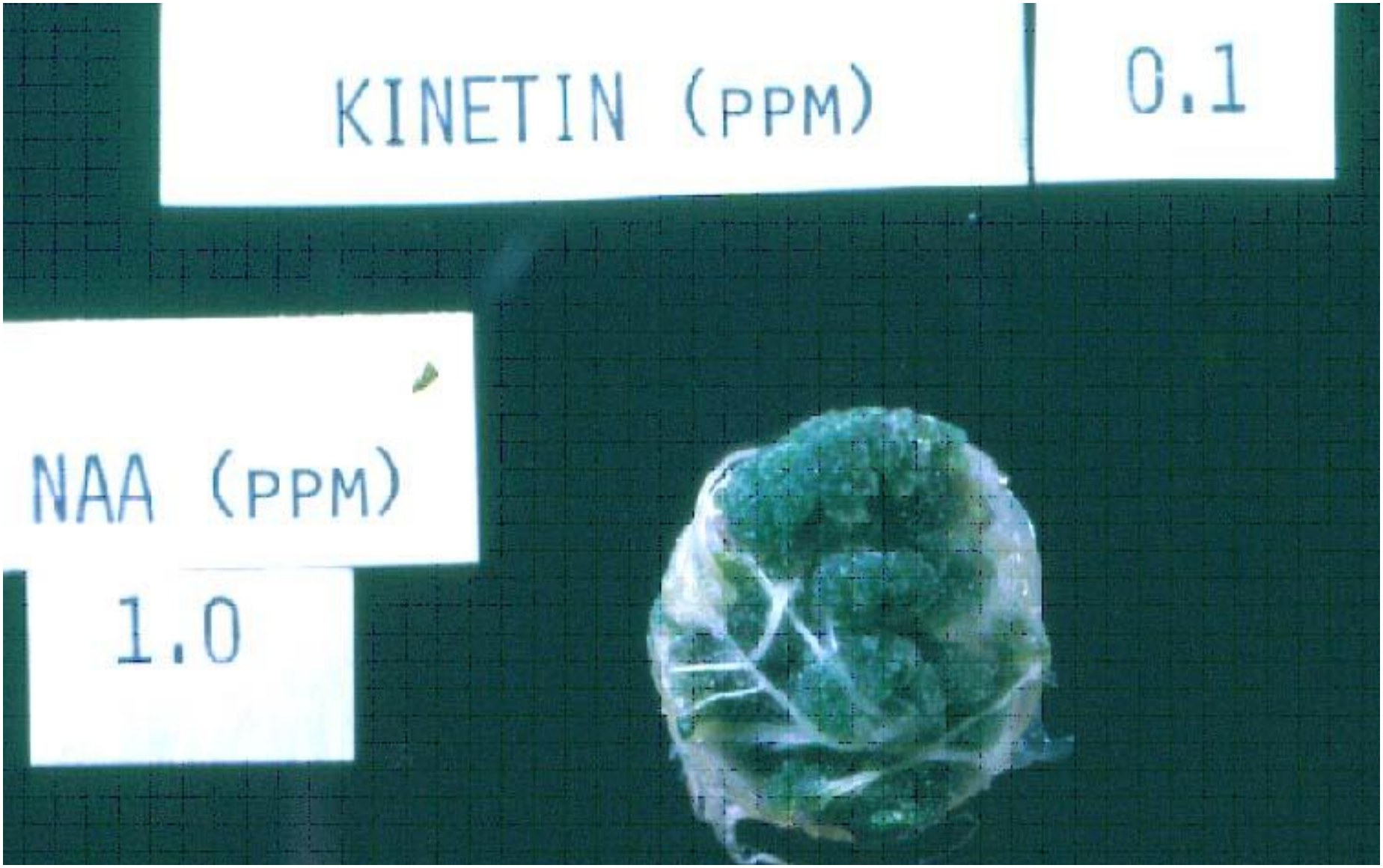




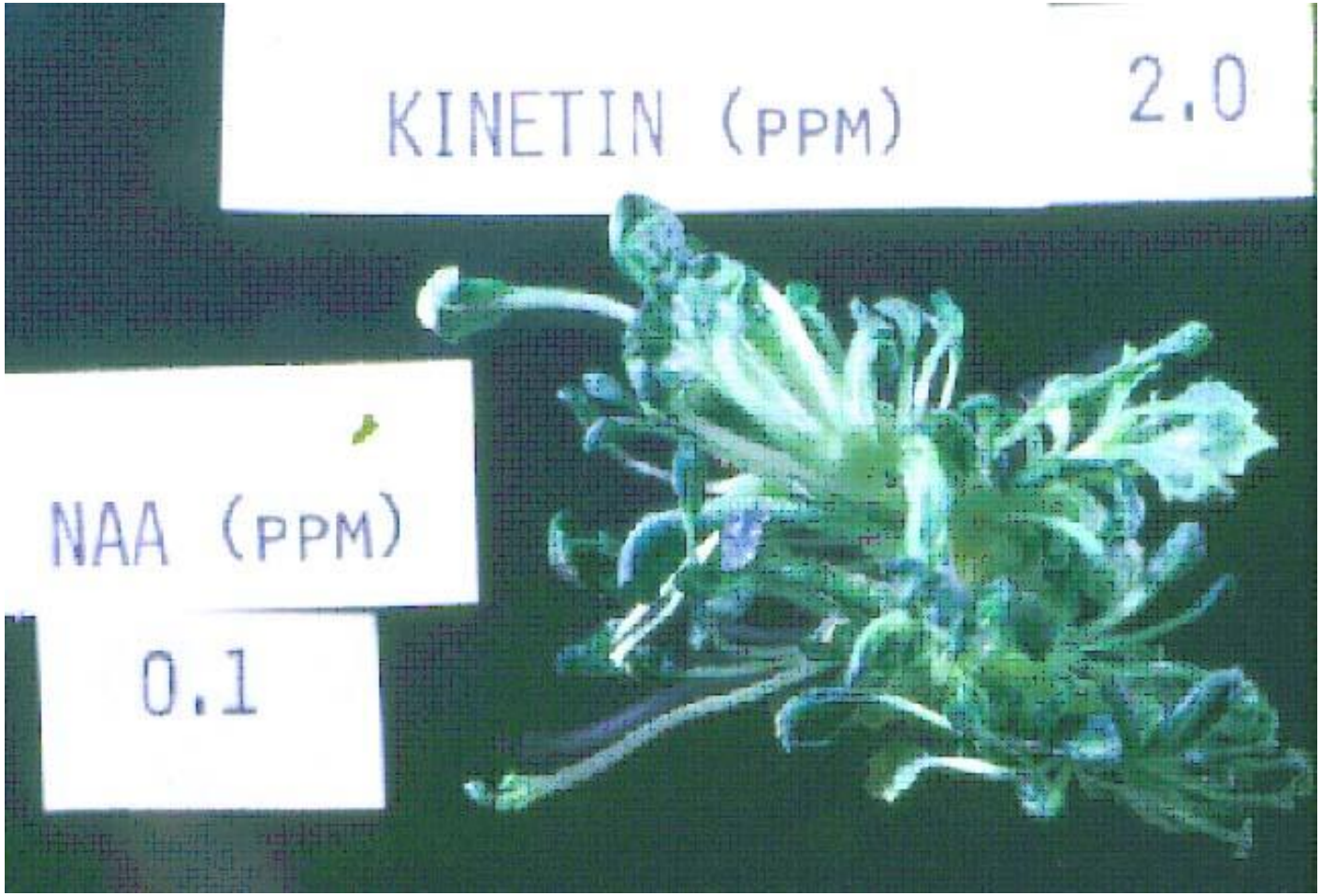
Leaf disc culture of *Salpiglossis*

Influence of cytokinin and auxin on differentiation of callus tissues in *Salpiglossis*



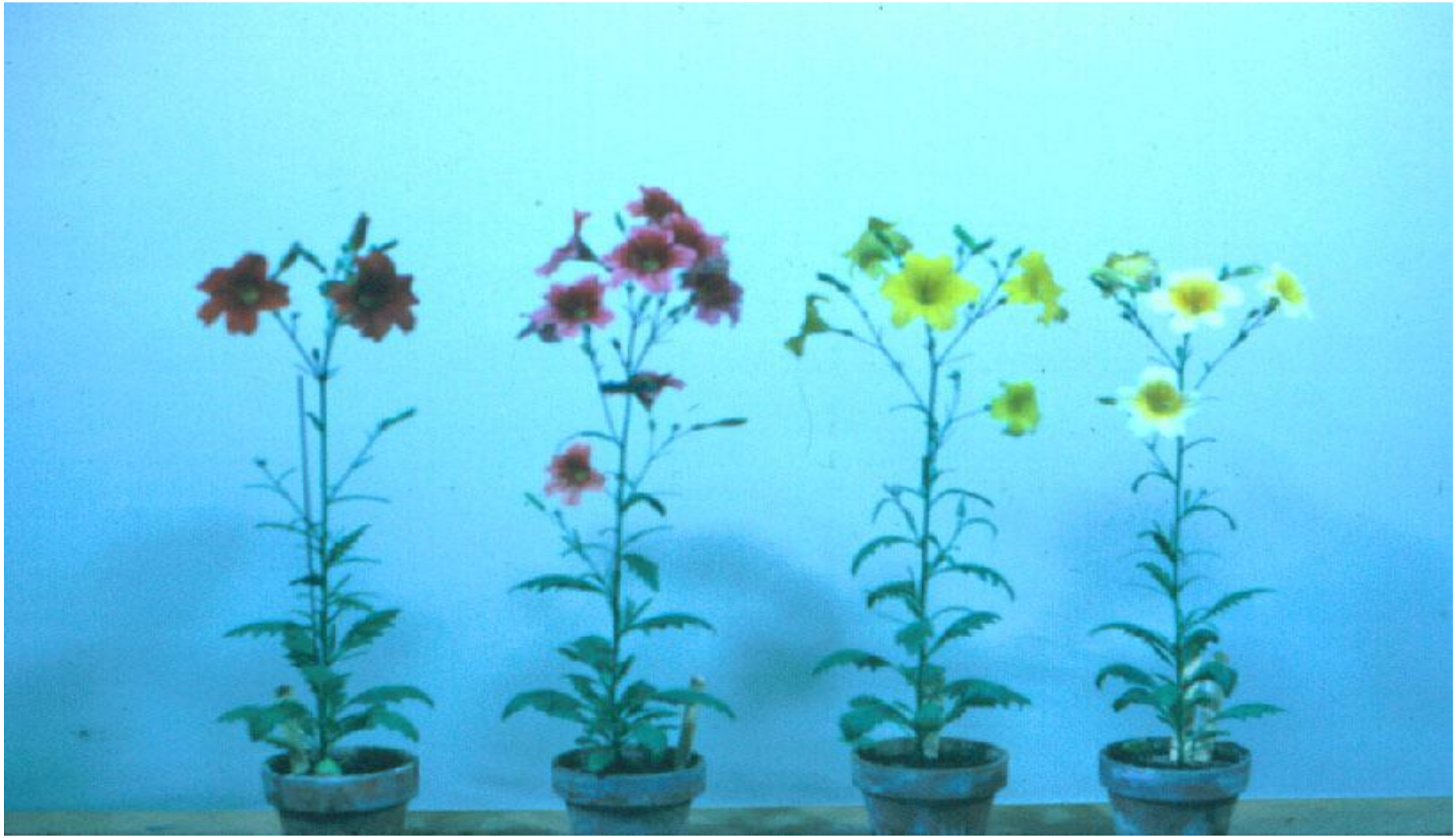


Callus proliferation and root production occur under a combination of low cytokinin and high auxin concentrations in the medium



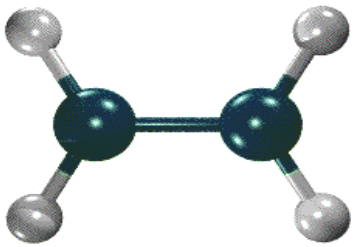
Shoot differentiation occurs under a combination of high cytokinin and low auxin levels in the medium

Shoots differentiated from callus are divided and rooted for use in clonal propagation



Flowering *Salpiglossis* plants which have been cloned from leaf disc cultures

Chemistry and Mode of Action
Ethvlene Gas



Carbon

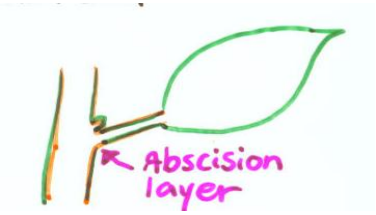
Hydrogen

- **Chemical Form: C_2H_4**
- **Plant Hormone**
  - fruit ripening
  - senescence
- **No color or odor**
- **Natural, gaseous**
- **Not toxic to human**

Agricultural Uses of Ethylene as a Plant Hormone

- Leaf abscission
- Hastens fruit ripening
- Flower induction
- Conversion of flower sex expression
- Germination enhancement
- Shorter plants
- Increase rubber content in plantation

Defoliation in Cotton and Potato



- Chemicals: Abscissic Acid (natural)
  Ethephon (ethylene)
- Defoliants: Ceron, Ethrel, etc.
- Used in cotton and potato field before harvesting

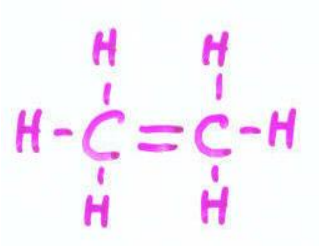
Cotton field ready to be harvested (lest-control, right-ethephon treated)

Responses of cut snapdragon flowers exposed to ethylene source for one night: A-flower stem placed in a plastic bag (control), B-flower stem placed in a plastic bag containing two apples.

Most cut flower stems are dipped in preservative solution containing silver thiosulfate (STS), inhibitor of ethylene gas effect.

Induction of Flowering

- Use ethephon, an ethylene releasing chemical
- Flower induction in pineapple and bromeliads



Ethephon is applied to young plants of pineapple and bromeliads to induce flowering

Ripening of Fruits

- Chemical: Ethephon (ethylene)
- Ripening of green banana, tomatoes, persimmons

Use of ethylene gas in fruit ripening and degreening

1. **Ethylene promotes fruit maturation and ripening**
   - **a. Crops: tomatoes, banana, pineapple, dates, persimmons, pears, apples, honeydew melons, mango, avocados, papaya, jujubes**
   - **b. Doses: Internal tissue concentration of 0.1-1.0 ppm**

     Ambient level of about 10 ppm is often used for ripening
2. **Chlorophyll elimination (Degreening)**
   - **a. Crops: citrus crops, including orange, grapefruit**
   - **b. Does: 1-20 ppm ethylene**

Some commercially available ethylene gas applicators

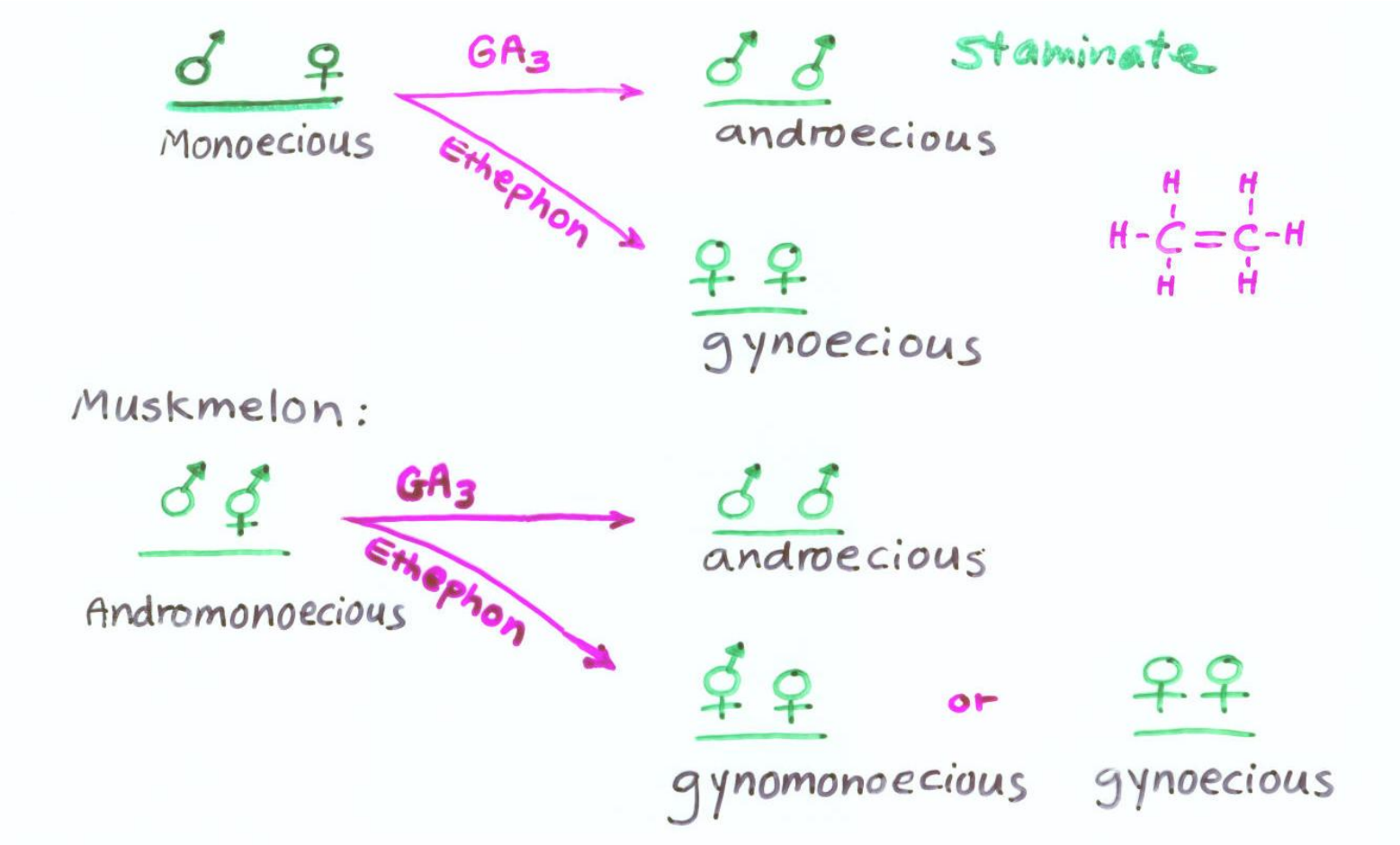
Fruit Ripening in Gas Chambers, SuperValu, Fargo

Ethylene gas used in ripening bananas (*SuperValue*): A-instructions on ripening procedures, B-source of ethylene (ethanol), C-warning signe, D-ethylene gas generator (Easy-Ripe) in use.

Ripening of green banana using ethylene gas, Super Value store in Fargo

Conversion of Flower Sex Expression in Cucurbits

- Gibberellins (GA_3) promote maleness
- Ethylene promotes femaleness



Conversion of Flower Sex in Muskmelon

A-First flower flowers induced by ethylene are female flowers; B-a close-up of pistillate flower induced by ethylene; C-vines showing pistillate and hermaphroditic flowers only on a treated plant. D-pistillate, perfect and male flowers formed on ethylene treated plants.

Ethephon application converts male flowers to female flowers in muskmelon

An example of flower sex expression in a muskmelon plant after treatment with ethephon

Muskmelon Fruits Developed from Ethylene-Induced Flowers

Top row-control (not treated), Bottom row-elongated fruits developed from ethylene induced female flowers

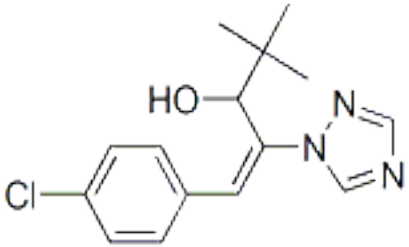
Some Chemical Growth Retardants

Short-lasting

Phosphon (B-9)
Chlormequat (CCC)
Ancymidol (A-Rest)

Long-lasting

Bonzi - Paclobrutrazol
Sumagic - Uniconazole

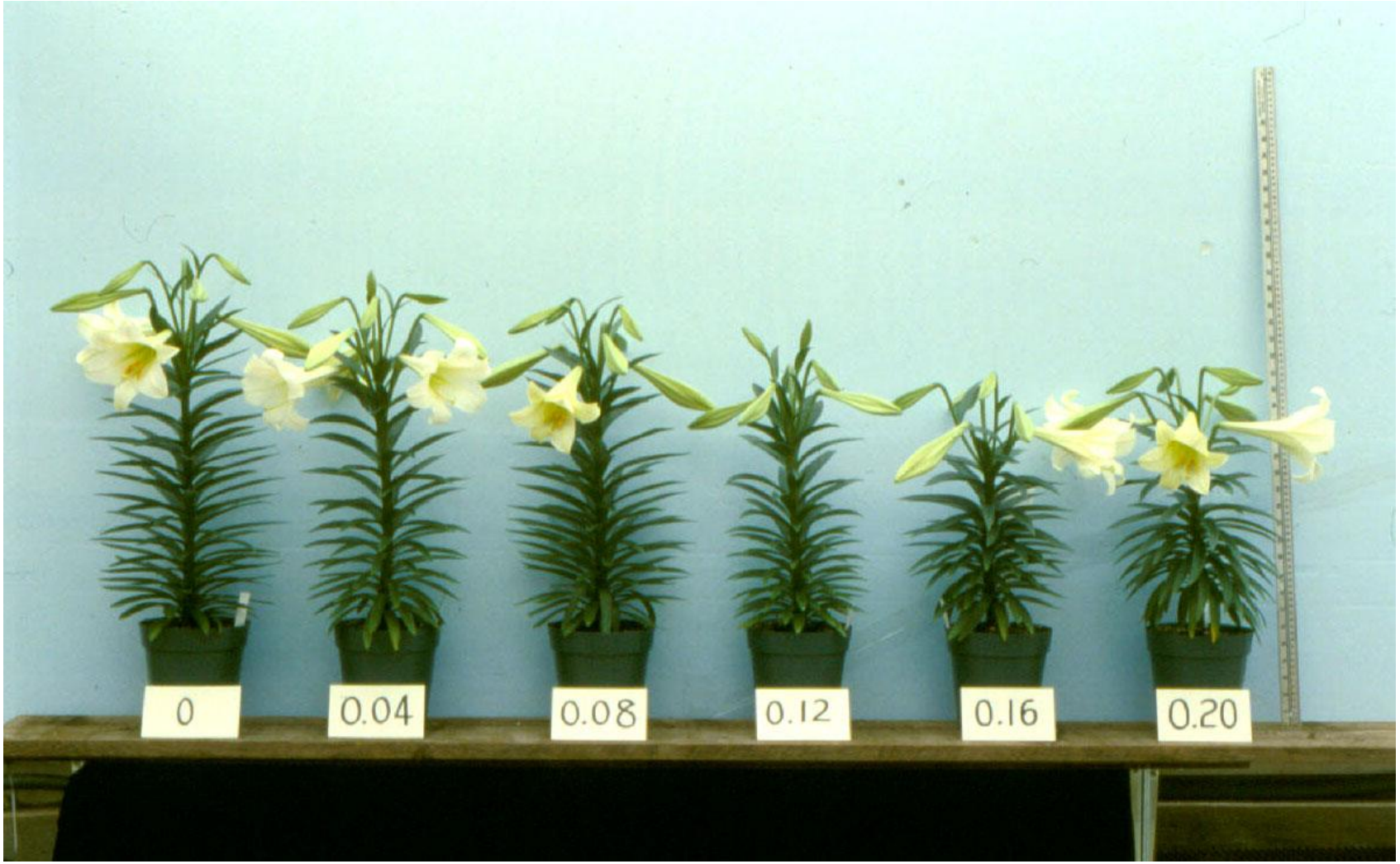


Uniconazole

Greenhouse Production of Easter Lily

Easter lily plants grown in this Colorado greenhouse were too tall to fit into boxes for mass marketing and had to be thrown away

Easter Lily Height Control by Uniconozole (Sumagic)

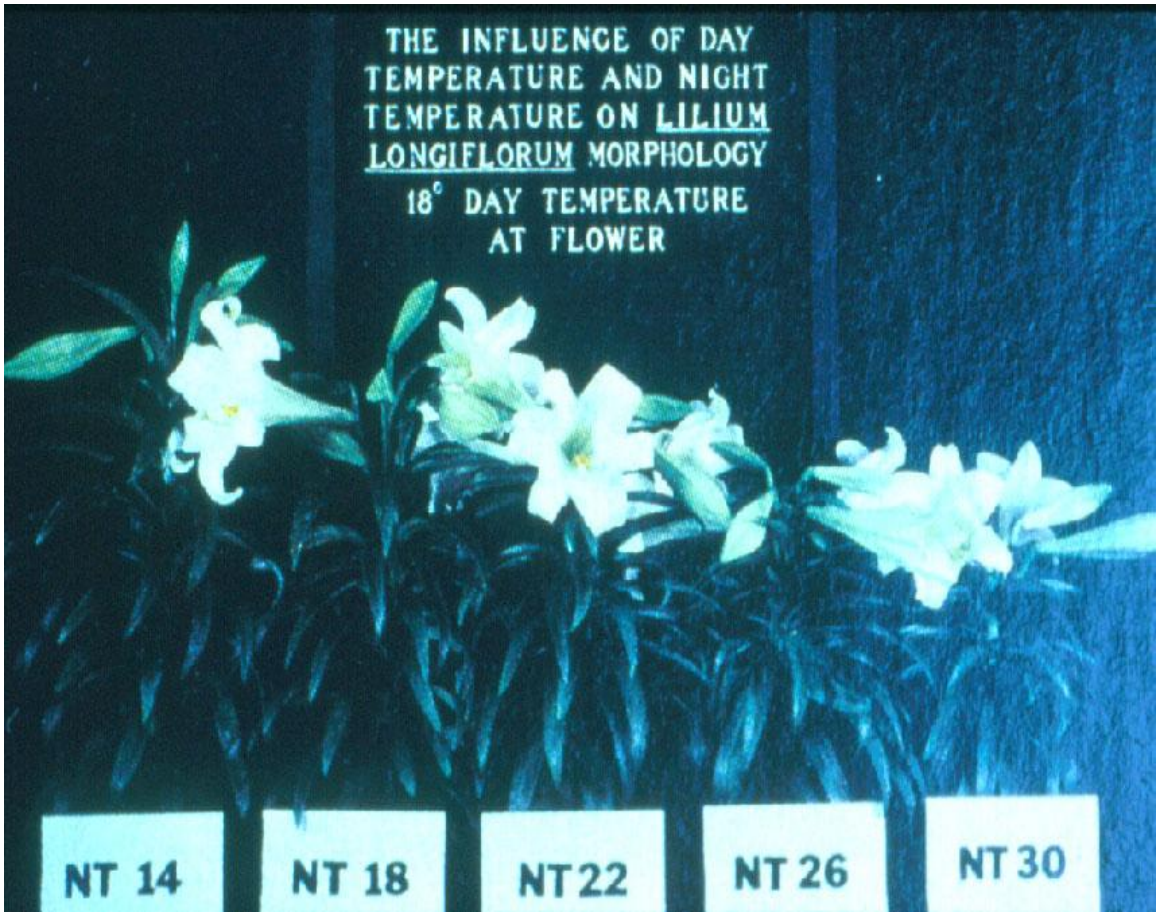


Easter lily pots receiving increasing amounts of Uniconazole (from L to R: 0, 0.04. 0.08, 0.12, 0.16, 0.20 mg)

Influence of DIF

Difference between Day and Night Temperatures

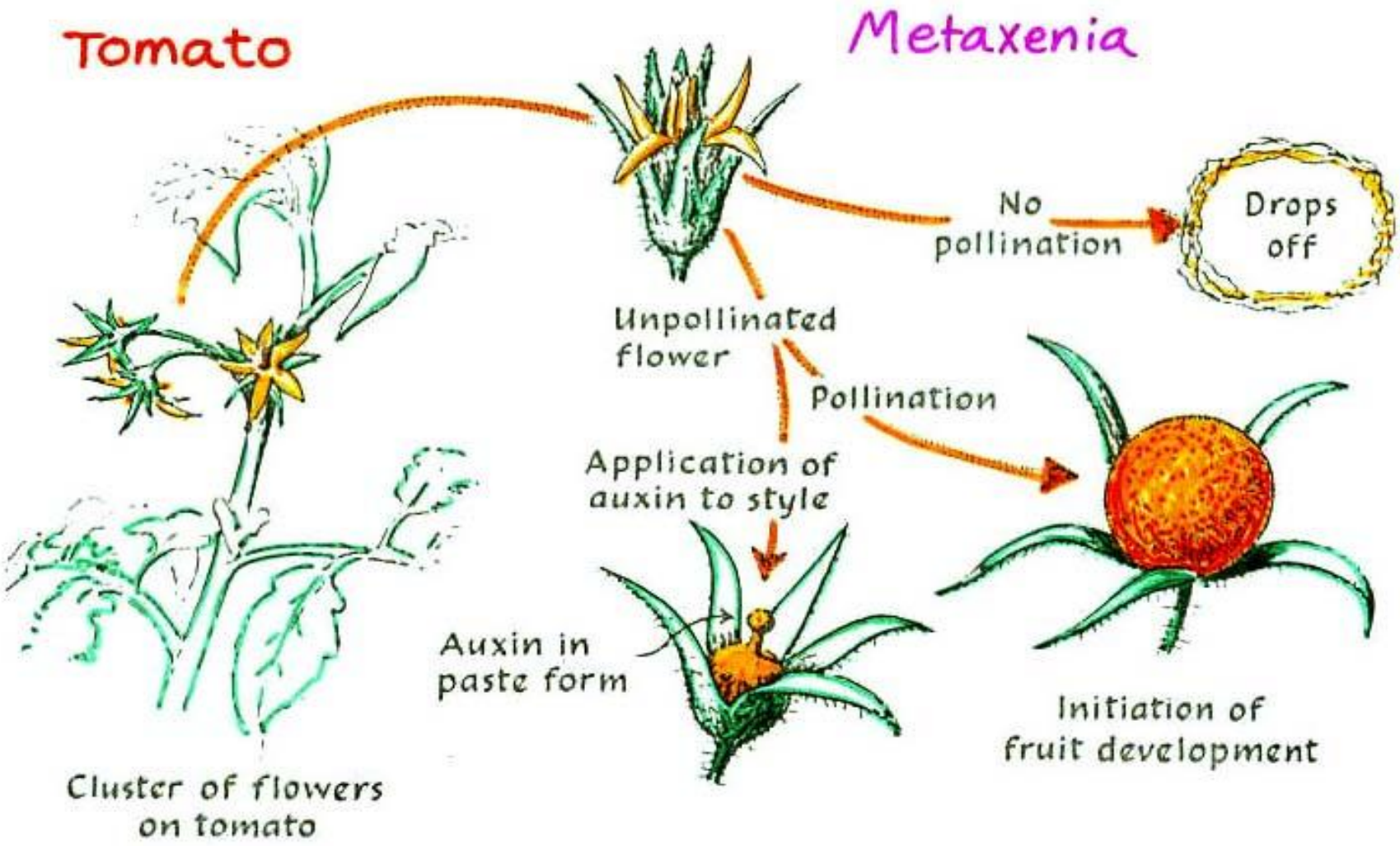
Positive DIF – Plants become tall
Negative DIF – Plants become short



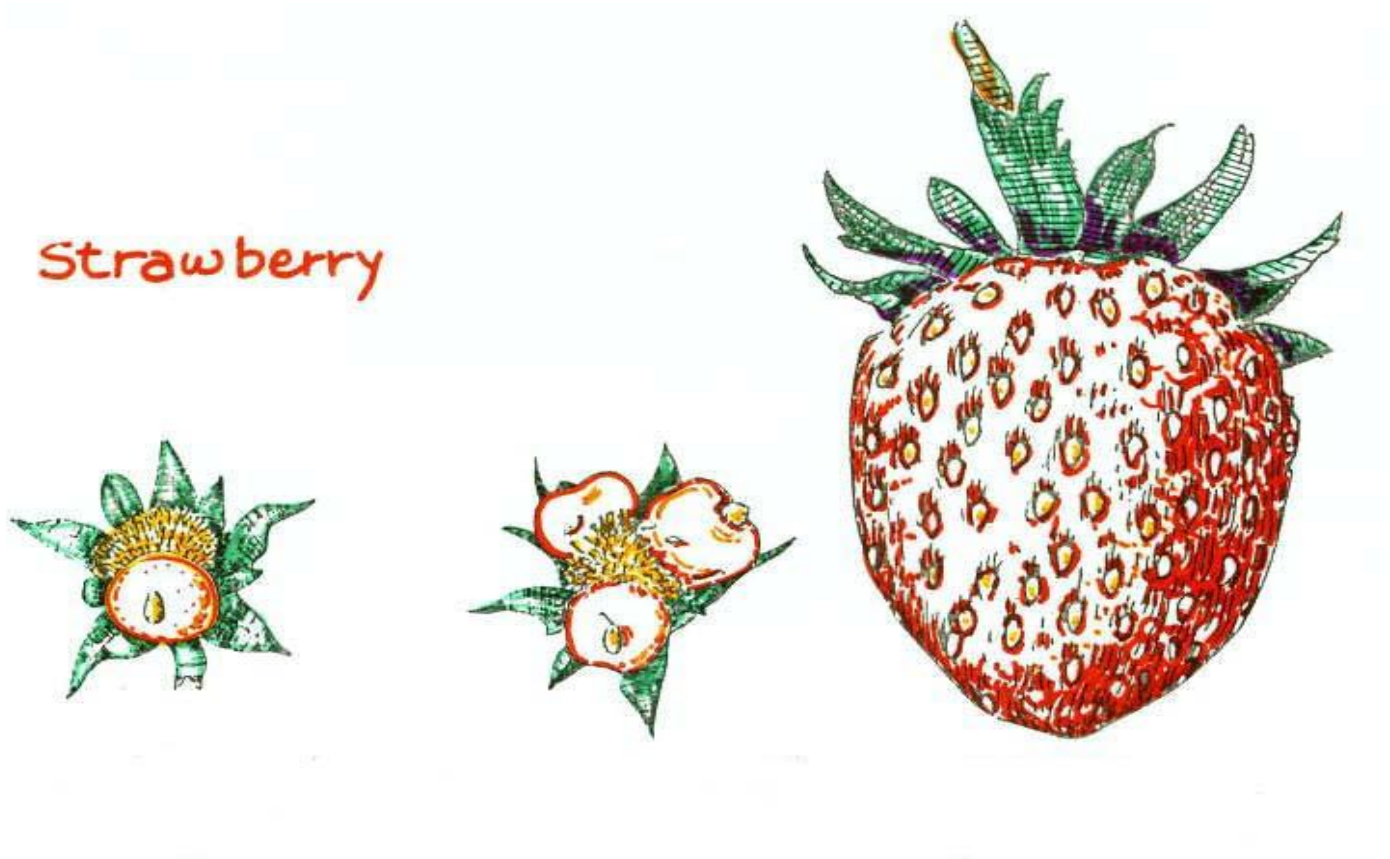
Plant height control on *Liatris* (gay feather) by growth retardant application (left-treated, right-control)

Metaxenia

Influence of Pollination on Fruit Set



Influence of pollination on aggregate fruit development in strawberry



Growth of receptacle into fruit was influenced by number of individual flowers pollinated and fertilized (left to right: one, two, numerous achenes developing after pollination