PLANT GROWTH REGULATORS

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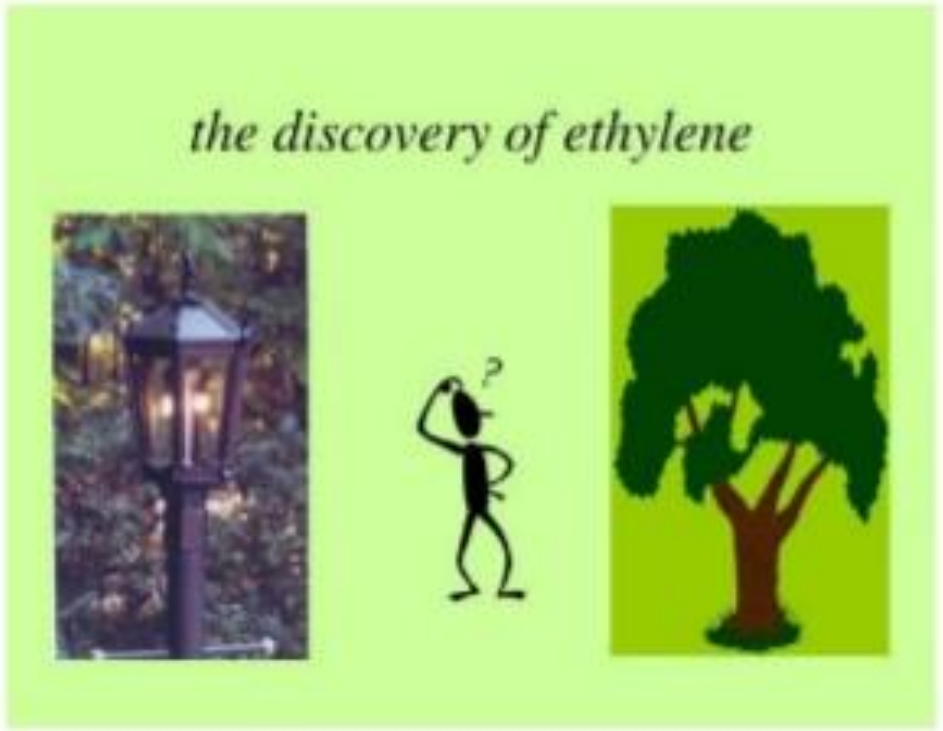
Ethylene Discovery

- During the nineteenth century , when **coal gas** was used for street illumination it was observed that the trees in the vicinity of streetlamps **defoliated** more extensively than other trees

Then they discovered that ethylene was the

active component for coal gas



The Discovery of Ethylene

- The oldest identified growth regulator
- Was used by the ancient Egyptians to cause fig ripening
- The Chinese burned incense in closed rooms to cause pear ripening
- Discovered in 1901 by Dimitry Neljubow
- In 1910 H. H. Cousins showed that plants can produce their own ethylene
- Discovery of Ethylene's role in abscission was in 1917 by S Doubt
- In 1934 ethylene was shown as a natural plant product

Discovery of ethylene

- In the 1800s, it was recognized that street lights that burned gas, could cause neighboring plants to develop short, thick stems and cause the leaves to fall off. In 1901, Dimitry Neljubow identified that a byproduct of gas combustion was ethylene gas and that this gas could affect plant growth.
- In R. Gane showed that this same gas was naturally produced by plants and that it caused faster ripening of many fruits.
- Synthesis of ethylene is inhibited by carbon dioxide and requires oxygen.

INTRODUCTION

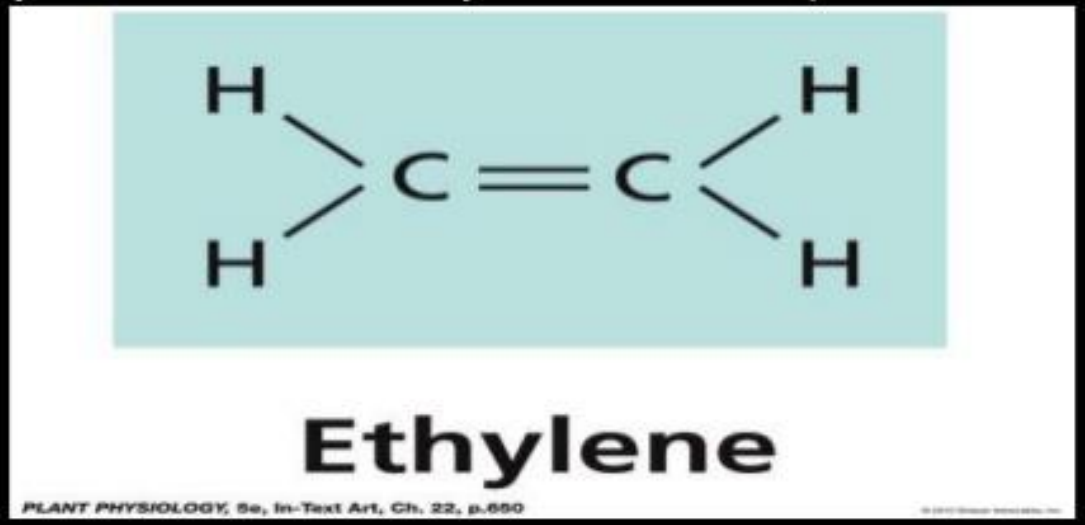
- Ethylene is the simplest unsaturated hydrocarbon compound and is a major product of the petroleum industry.
- In japan, about eight million tons of ethylene were produced in 1990 alone.
- It is of interest that this gas acts as plant hormone. Today ethylene is the plant hormone, which is best understood with regard of Biosynthesis, regulation of Biosynthesis.
- It look several years to establish before it became evident that ethylene was a natural plant hormone in early 1920

Ethylene

- Ethylene is the only gaseous plant hormone (C_2H_4)
- It is produced naturally by higher plants and is able to diffuse readily, via intercellular spaces, throughout the entire plant body
- Ethylene is involved primarily in plant responses to environmental stresses such as flooding and drought, and in response to infection, wounding and mechanical pressure
- It also influences a wide range of developmental processes, including shoot elongation, flowering, seed germination, fruit ripening and leaf abscission and senescence

STRUCTURE AND BIOSYNTHESIS

- Ethylene is the simplest olefin (mol. Wt. 28) .



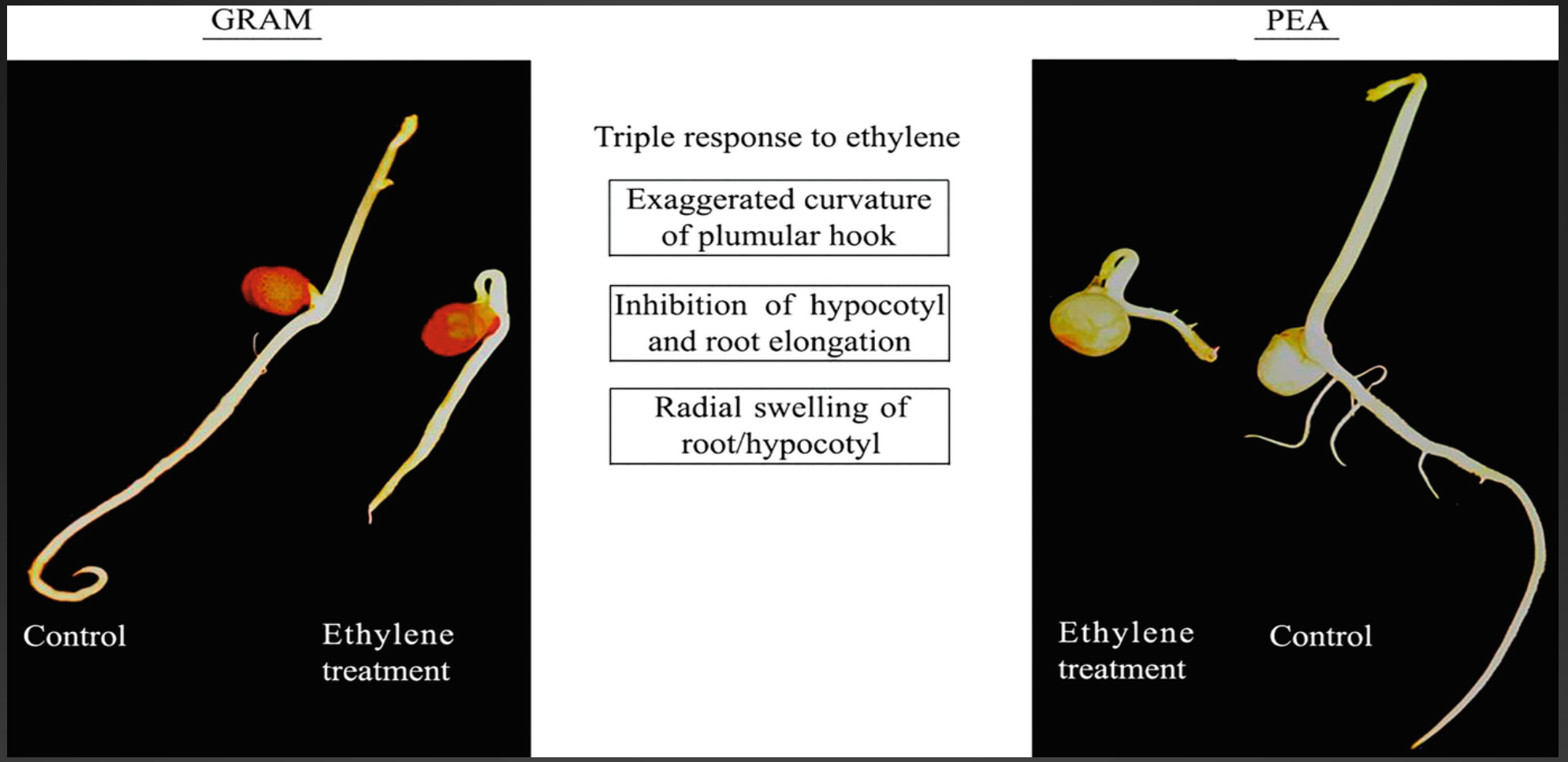
- It is lighter than water under physiological conditions and readily undergoes oxidation.

Plant Hormones - Ethylene

- Found in
  - Tissues of ripening fruit
  - Nodes of stems
  - Aging leaves and flowers
- Major functions
  - Changes of ovary to become fruit
    - Degradation of cell walls; softening
    - Dropping from plant
  - Leaf abscission
    - Loss of leaves to prevent water loss
    - Tissue at base of petiole dies
  - Senescence (aging)
    - Autumn leaves; withering flowers

Bioassay of ethylene : It is done on the principle of triple response which includes three characteristic effects of ehtylene on etiolated seedlings of pea-viz. Swelling of nodes. Inhibition of elongation of internodes of stem. Induction of horizontal growth of stem against gravity.

BIOASSAY OF ETHYLENE



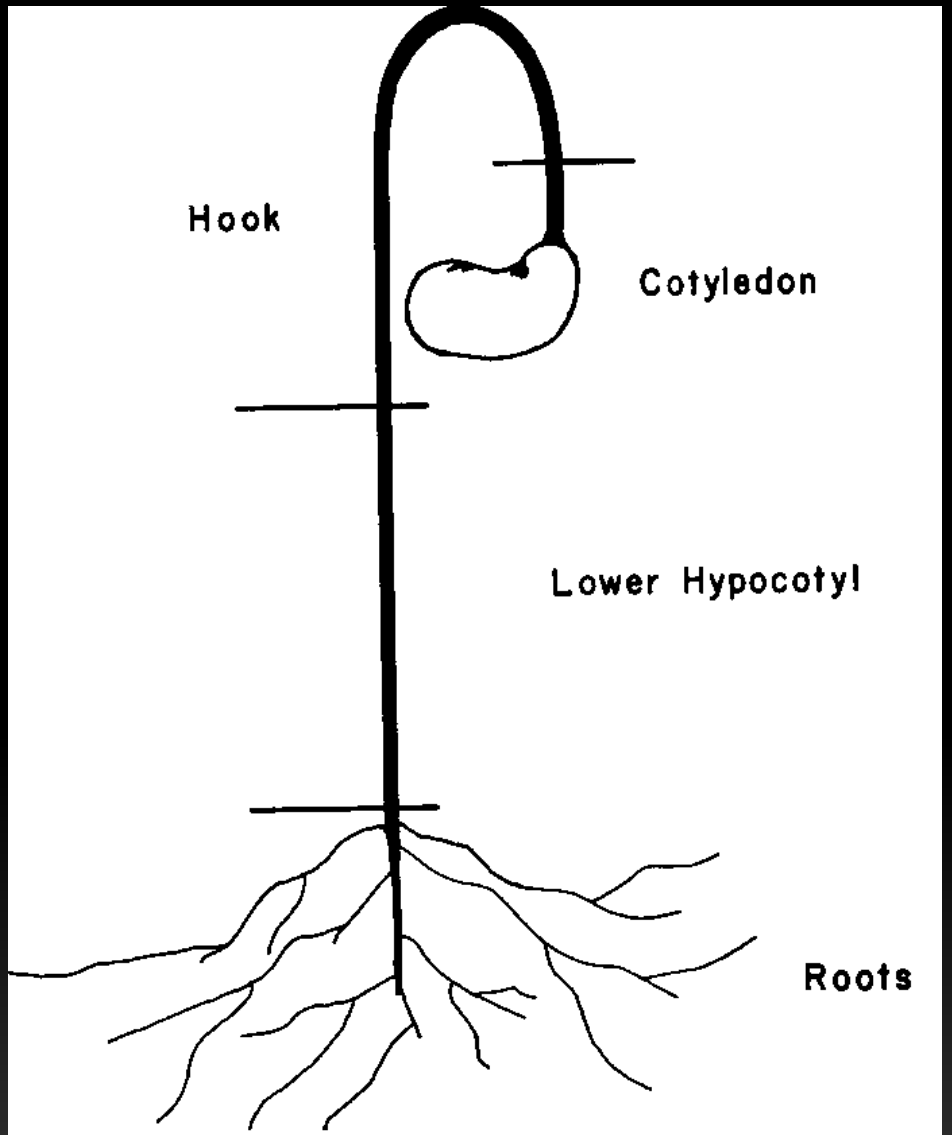
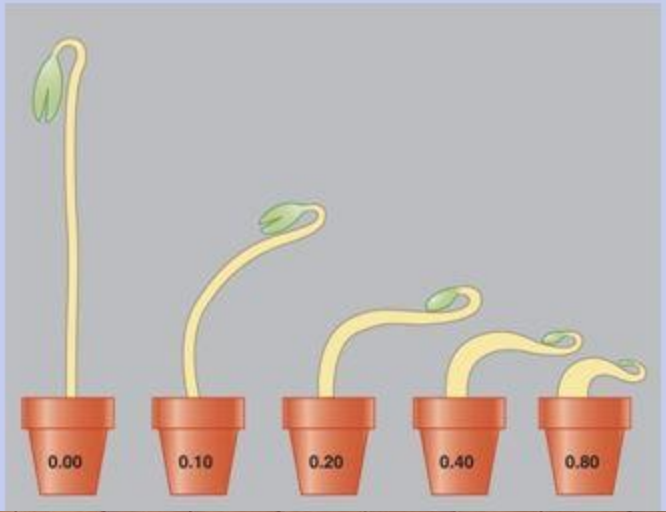


FIG. 3. A diagram of an etiolated bean plant. The seedling was cut

Ethylene

- **Ethylene** is a hormone gas released by plant cells
- **Multiple effects**
  - response to mechanical stress
    - triple response
      - slow stem elongation
      - thickening of stem
      - curvature to stem growth
  - leaf drop (like in Fall)
    - apoptosis
  - fruit ripening



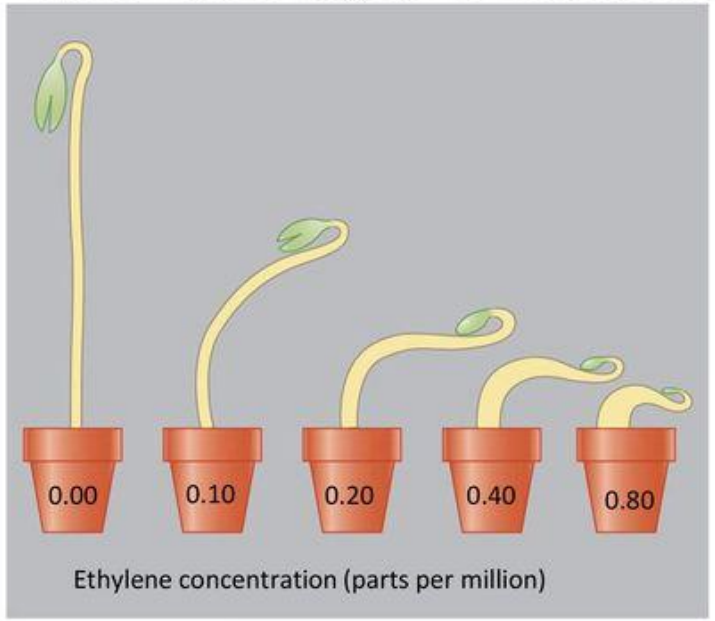
The Triple Response to Mechanical Stress

- Ethylene induces the triple response
  - Which allows a growing shoot to avoid obstacles

1. Slowing of stem elongation
2. Thickening of the stem
3. Curvature causing stem to grow horizontally.

EXPERIMENT Germinating pea seedlings were placed in the dark and exposed to varying ethylene concentrations. Their growth was compared with a control seedling not treated with ethylene.

RESULTS All the treated seedlings exhibited the triple response. Response was greater with increased concentration.



CONCLUSION Ethylene induces the triple response in pea seedlings, with increased ethylene concentration causing increased response.

Figure 39.13

PHYSIOLOGICAL EFFECTS OF ETHYLENE

- Fruit ripening.
- Plumular hook formation.
- Triple response.
- Formation of adventitious roots and root hairs.
- Leaf epinasty.
- Senescence.
- Abscission of leaves.

Ethylene stimulates:

- Synthesis of ethylene in ripening climacteric fruit
- Ripening of climacteric fruit and some non-climacteric fruit.
- Anthocyanin synthesis in ripening fruit.
- Chlorophyll destruction and yellowing (eg., degreening of citrus).
- Seed germination.
- Adventitious root formation.
- Respiration
- Flower initiation eg., pineapple.
- Abscission and senescence.

Fruit ripening and anthocyanin synthesis in rambutan

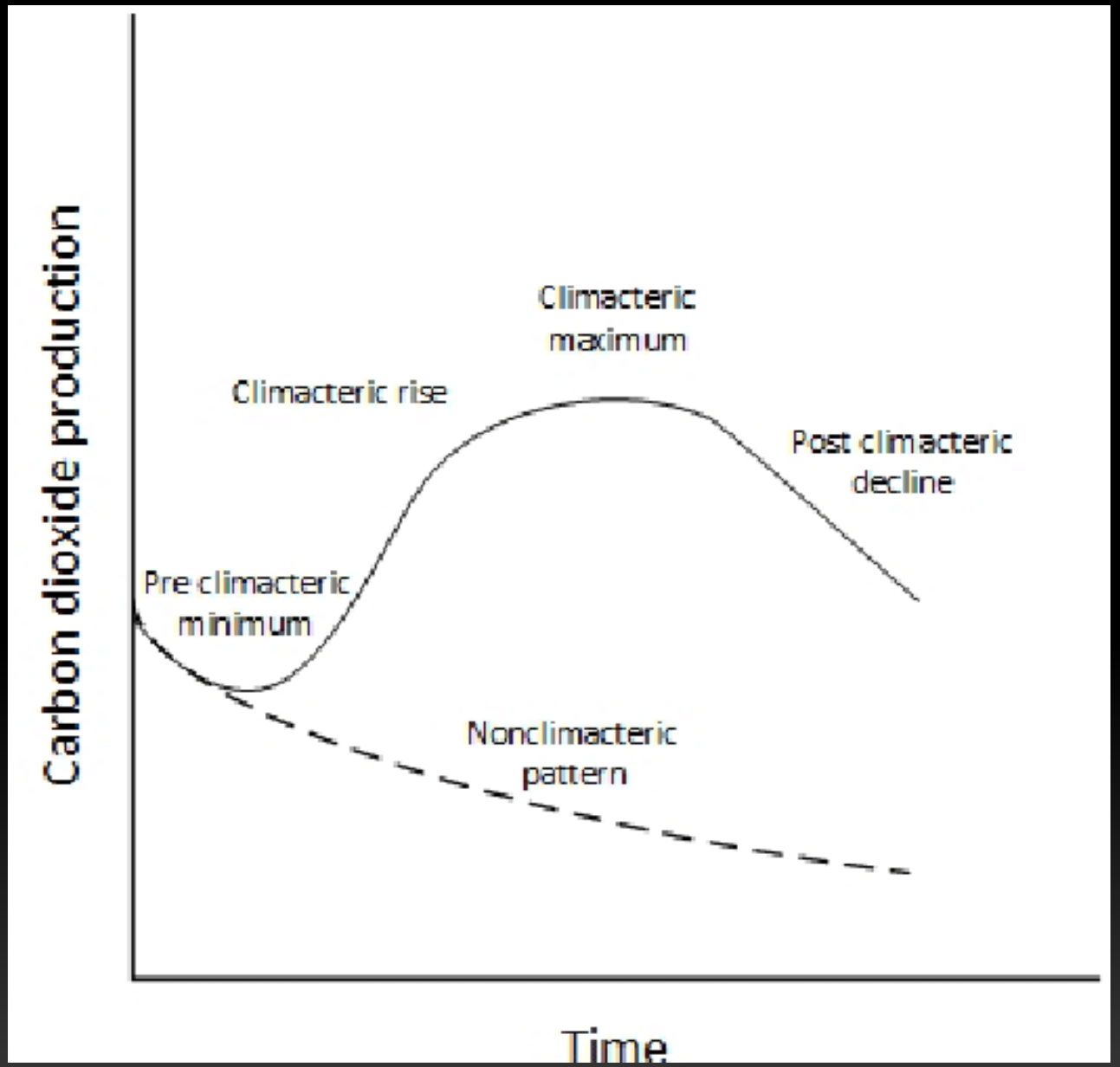
Two types of fruit

- Climacteric fruit
  - Needs ethylene for ripening

Tomato, Apple, Banana, Mango, Peach, Pears, Avocado, Melon

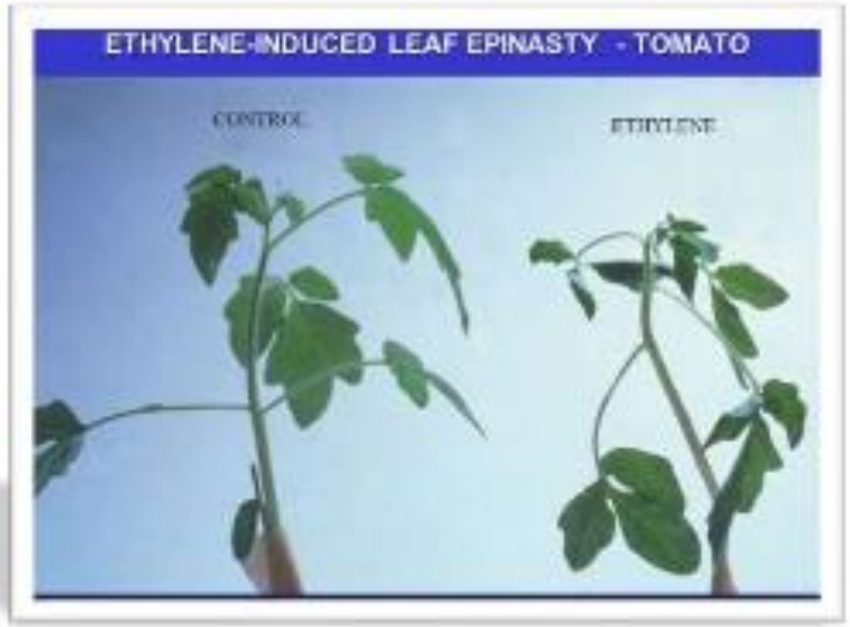
- Non-climacteric fruit
  - does not need ethylene

Citrus, Grape, Watermelon, Strawberries


Carbon dioxide production
Climacteric maximum
Climacteric rise
Post climacteric decline
Pre climacteric minimum
Nonclimacteric pattern
Time

✓Leaf Epinasty:

When upper side (adaxial side) of the petiole of the leaf grows faster than the lower side (abaxial side), the leaf curves downward. This is called as epinasty.



What is senescence?

- Senescence is defined as the period when synthetic (anabolic) biochemical process gives way to degradative (catabolic) process.
- Phenomenon of ageing.
- Process towards the termination of life i.e. Death.
- Deteriorative process that naturally terminate the functional life of plant or plant organ
- **Development and maturation** of fruit are completed only when attached to the plant, but **ripening and senescence** may proceed on/off the plant.

- **Significance of Senescence**
- The process has many advantages in the cellular mechanism.
- (i) Because of this, new, functionally efficient organs or organisms are created and the old, functionally inefficient are discarded.
- (ii) It ensures recovery and reutilization of mineral elements and organic nutrients from older senescing organs to the newly formed growing organs.

Abscission

- abscission the separation of leaves, flowers, and fruits from plants after the formation of an abscission zone at the base of their petioles, peduncles, and pedicels.
- Abscission, a physiologically determined program of cell separation,provides a mechanism whereby every discrete, multicellular plant organ, such as leaves, flowers, or fruits, becomes detached from the plant body in a controlled manner

Abscission

- Leaf and Fruit **<u>falling off the plant</u>**
- **Auxin** and **Ethylene**
- Ethylene **ripens the fruit**
- **<u>NO ABSCISSION</u>** –
  - ***Leaf IAA > Stem IAA***
  - ***Fruit IAA > Stem IAA***
- **<u>ABSCISSION</u>** –
  - ***Leaf IAA < Stem IAA***
  - ***Fruit IAA < Stem IAA***

Induction of abscission

- There are a variety of enviromental factors accelarate abscission
- Mineral defeciency,draught .low light as being responsible for the shedding of flowers and fruit .
- Pollination accelarated petal abscission and failure of embryonic development seemed associated with the shedding of young fruit .
- Both enviromental and natural factors influencer the rate of natural abscission .