Postharvest Biology of Perishable Commodities

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Postharvest Technology for Perishable Commodities

Outline:

- Introduction
  - book, website, comparative, loss
- Biology
  - transpiration, respiration, ethylene

Resources

- usda handbook 66
- postharvest ucdavis

Comparative characteristic of crops

Agronomic crops	Horticultural crops
Water content 10-20 %	70-95 %
Respiration and transpiration low	High
Hard, durable	Soft, perishable
Small in size	Large
Stored for more than one year	2-3 days or longer
Loss from fungi and insect	Bacteria, fungi, insect, and senescence

POSTHARVEST BIOLOGY

1) TRANSPIRATION
2) RESPIRATION
3) ETHYLENE PRODUCTION
4) COMPOSITIONAL CHANGE

CARBOHYDRATE, PROTEIN, FAT, PIGMENT

PHENOL, VITAMIN, VOLATILE, MINERAL

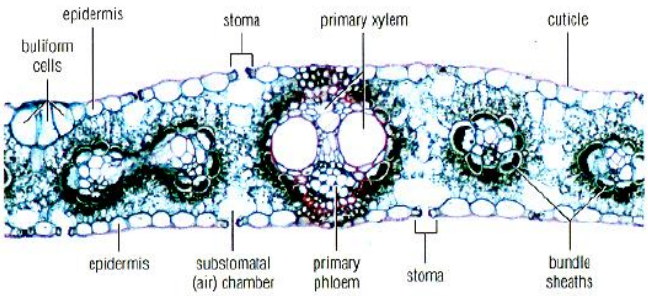
FACTORS INFLUENCING WATER LOSS

INTERNAL FACTORS

1. SURFACE TO VOLUME RATIO

2. Opening

Opening-stomata



Opening - Lenticel

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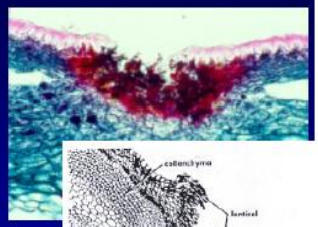
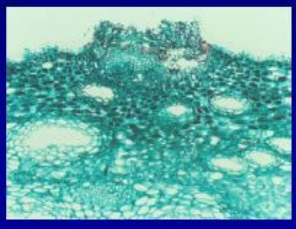
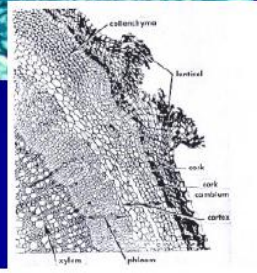
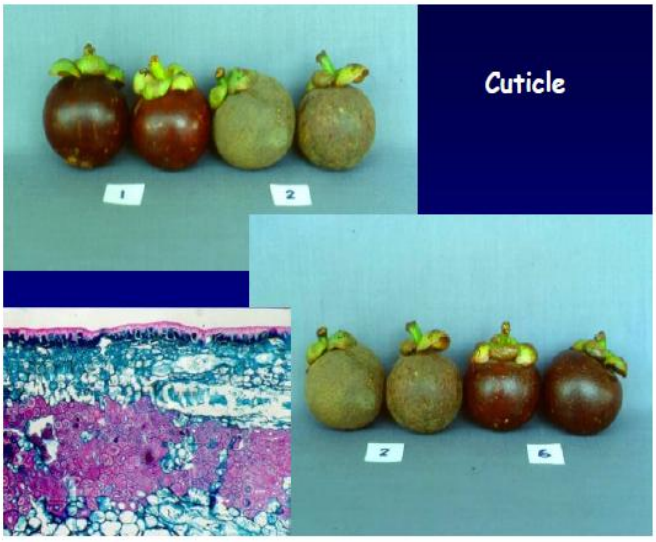






3.Surface cuticle

Cuticle

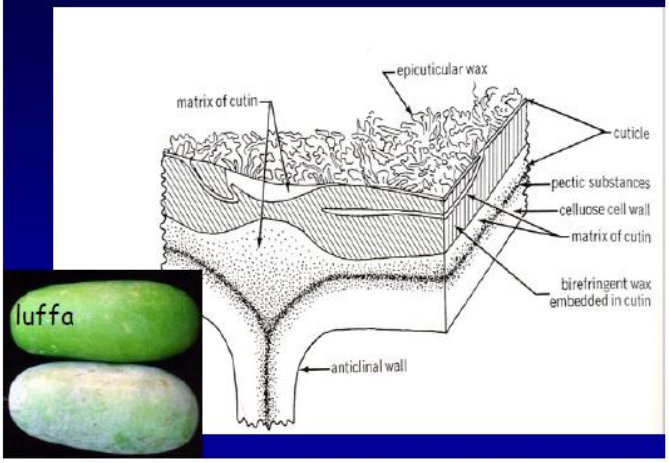


Weight loss of mangosteen after harvest

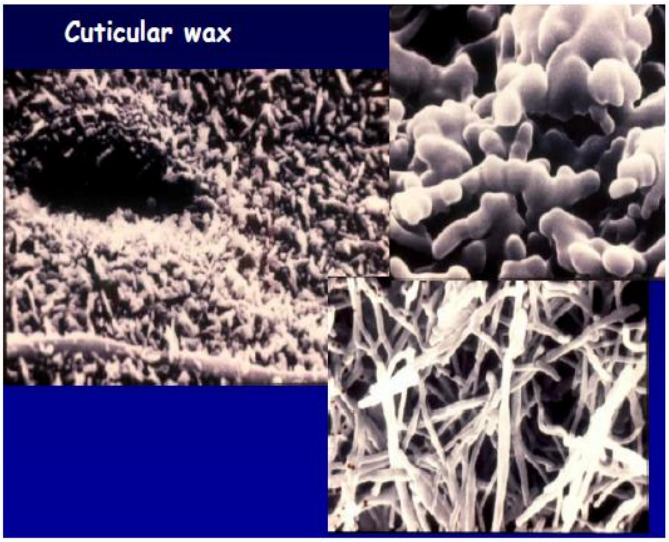
Sugar (soluble solids), titratable acidity and ascorbic acid in two type of mangosteen

Mangosteen skin	Soluble solids (Brix)	Acids (%)	Vit C (mg / 100 g)
Normal	18.8 ± 0.72	0.70 ± 0.04	1.02 ± 0.8
Damage	20.2 ± 0.87	0.78 ± 0.03	0.39 ± 0.14
T-test	*	**	ns

Cuticle component



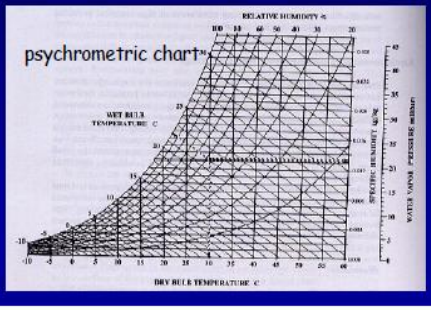
Cuticular wax



FACTORS INFLUENCING WATER LOSS

EXTERNAL FACTORS

1. HUMIDITY
2. TEMPERATURE

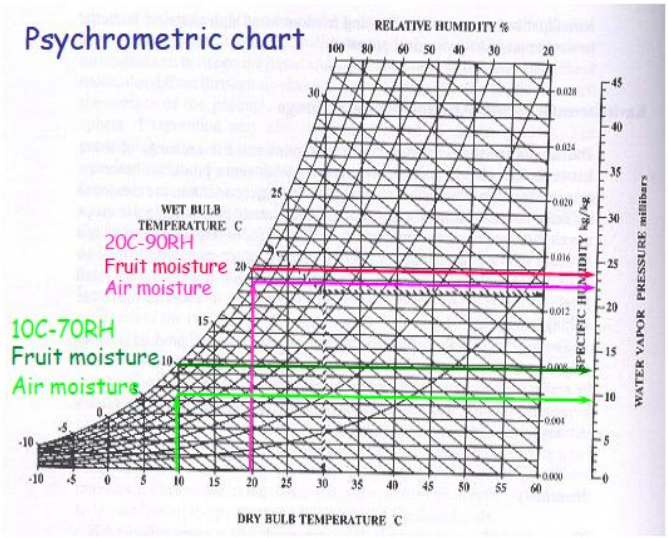


Compare 2 situations

20 °C 90%RH

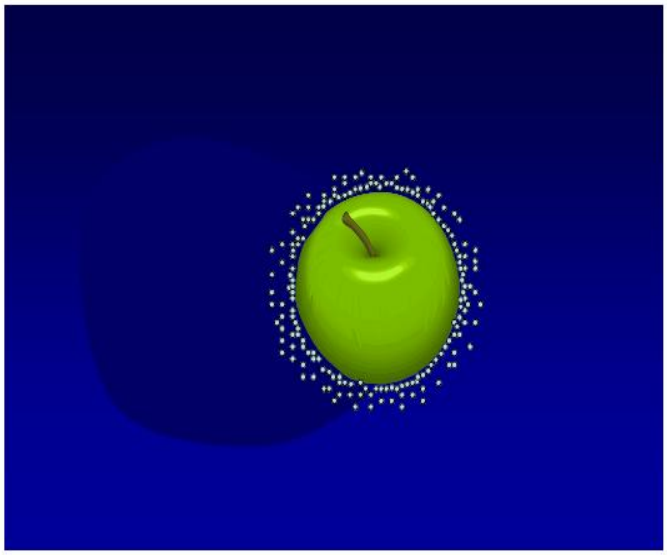
10 °C 70%RH

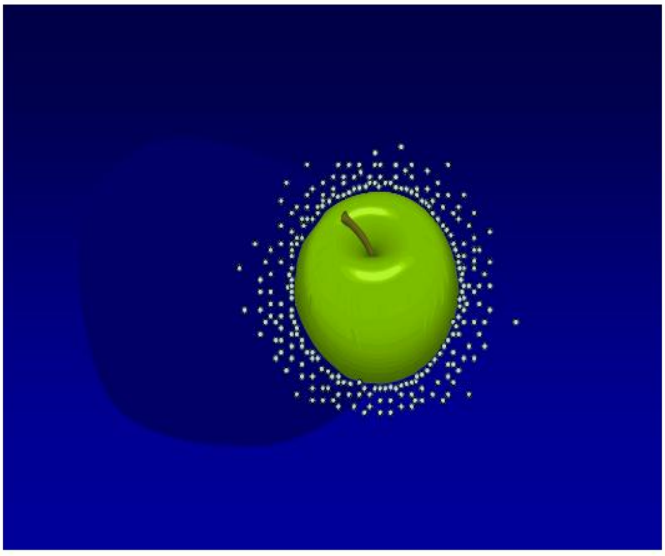
- Which one loss more water?

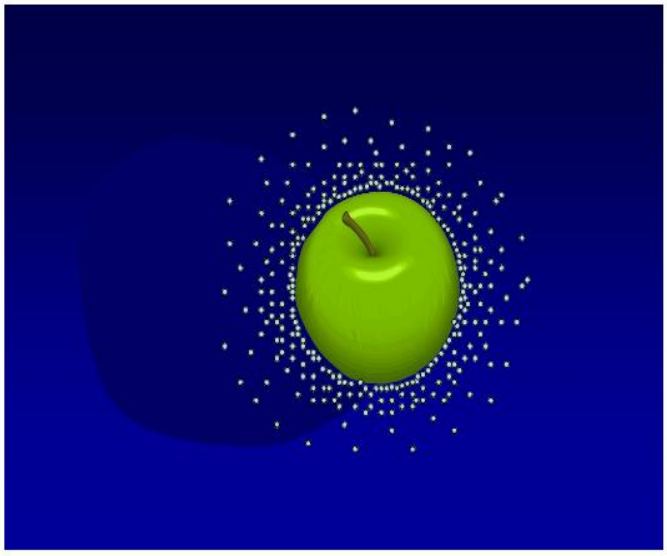


3. Air movement

DIFFUSION ZONE or BOUNDARY LAYER

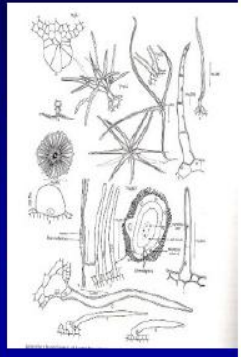






Other structure

hair and trichome



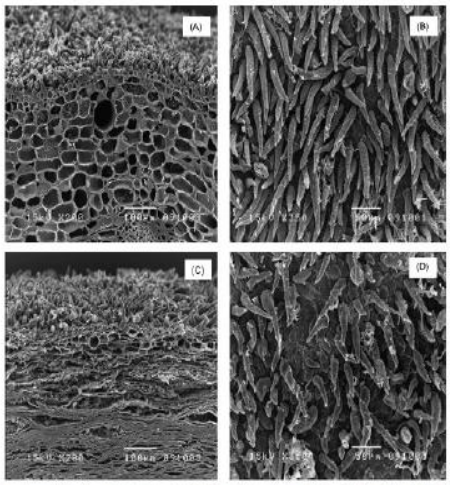


Fig. 4. Scanning electron micrographs of longkong peel just after harvesting (A and B) and after stored under ambient conditions for 4 d (C and D). (A) and (C) are cross-sections of longkong peel, while (B) and (D) are surface representations of longkong (Bar = 100 μm).

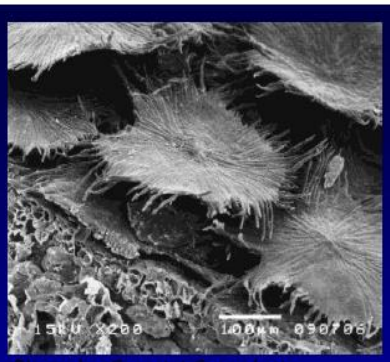


Photo by Somsiri Sangchote

a. Gas exchange (O_2, CO_2, C_2H_4)
b. Moisture loss

e. Susceptibility to mechanical damage
f. Resistance to temp. and physical stress

FACTORS INFLUENCING WATER LOSS

EXTERNAL FACTORS

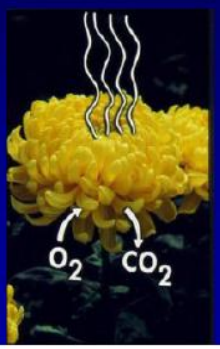
1. HUMIDITY
2. TEMPERATURE
3. AIR MOVEMENT
4. PRESSURE

PREVENTING WATER LOSS

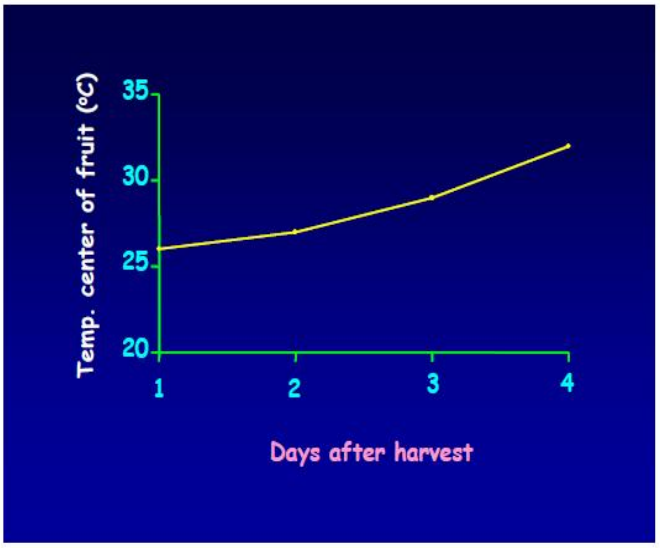
1. HUMIDITY	HIGHEST
2. TEMPERATURE	LOWEST
3. AIR MOVEMENT	LOWEST
4. PRESSURE	NORMAL

II. RESPIRATION

$C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O + ENERGY(683kcal)$

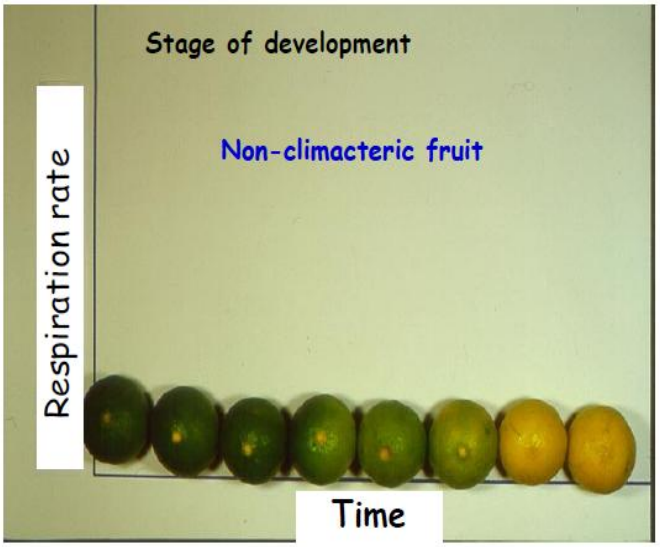


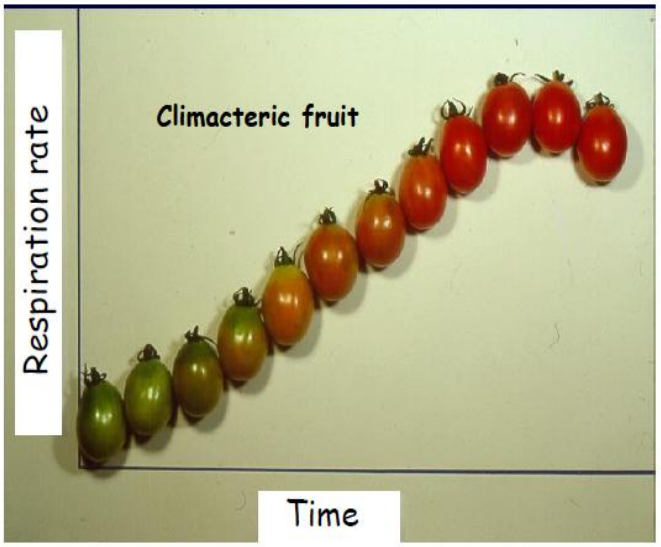
Durian respiration

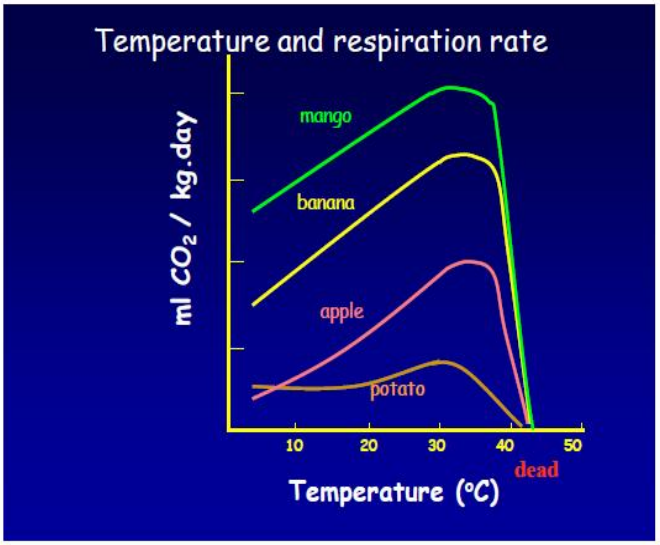


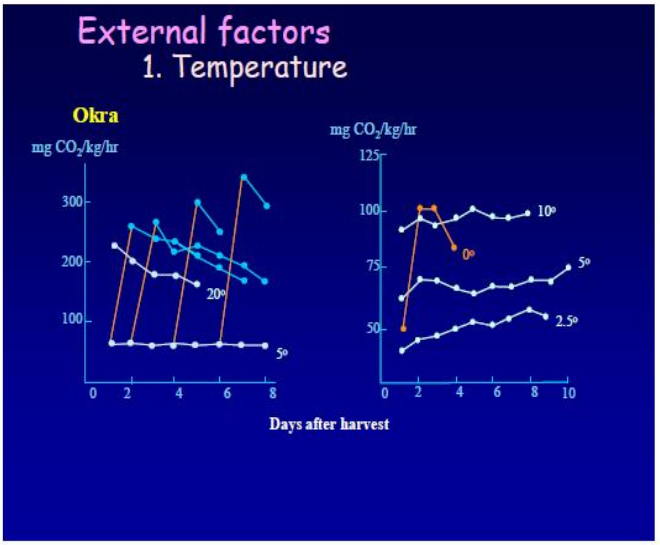
INTERNAL FACTORS: GENETIC

Resp. RATE	$mgCO_2/kg.hr$	COMMODITIES
VERY LOW	<5	SEEDS
LOW	5-10	ROOT CROPS
MEDIUM	10-40	FRUITS
HIGH	40-100	VEGETABLES
VERY HIGH	>100	TROPICAL FRUITS









Relationship between temperature and respiration and shelf-life (approximation)

TEMP °C	ASSUMED Q_{10}	RELATIVE VELOCITY	RELATIVE SHELF LIFE
0	2.0	1.0 unit	
10	2.0	2.0	
20	2.0	4.0	
30	2.0	8.0	
40	2.0	16.0	

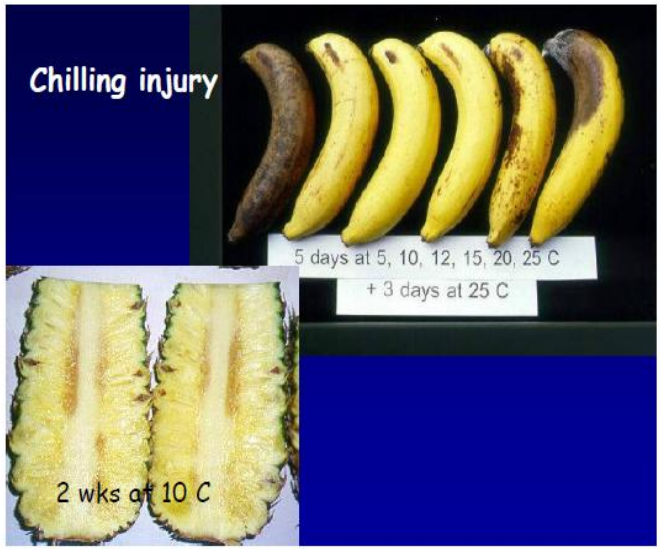
Relationship between temperature and respiration and shelf-life (approximation)

TEMP °C	ASSUMED Q_{10}	RELATIVE VELOCITY	RELATIVE SHELF LIFE
0	2.0	1.0 unit	100 days
10	2.0	2.0	50
20	2.0	4.0	25
30	2.0	8.0	12.5
40	2.0	16.0	6.25

Relation between Temperature and shelf life

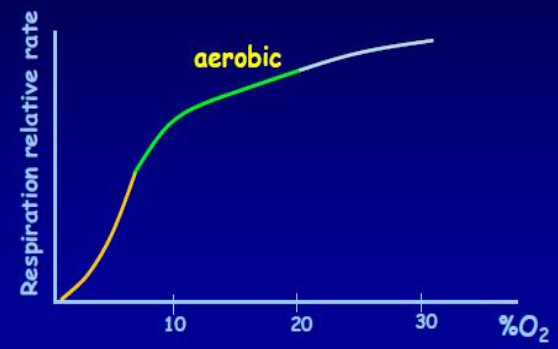
TEMP °C	ASSUMED Q_{10}	RELATIVE VELOCITY OF DETERIORATION	RELATIVE SHELF LIFE
0		1.0 unit	100 days
10	3.0	3.0	33
20	2.5	7.5	13
30	2.0	15.0	7
40	1.5	22.0	4

Chilling injury



2. ATMOSPHERIC COMPOSITION

2.1 oxygen



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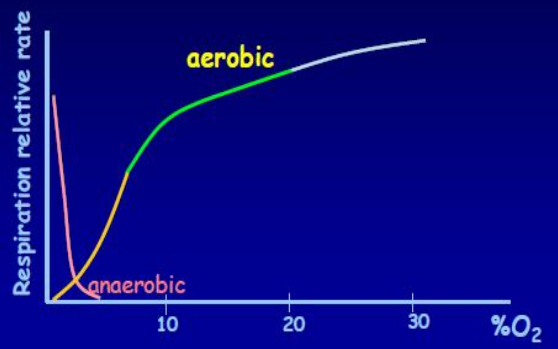

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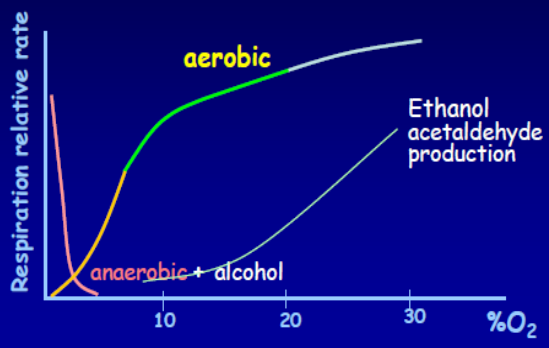
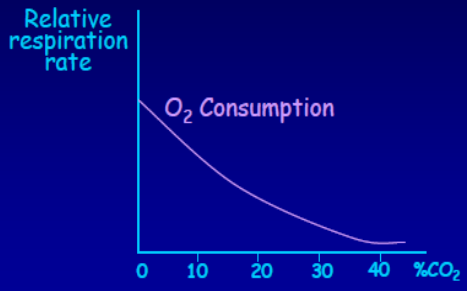


2.2 Carbon dioxide



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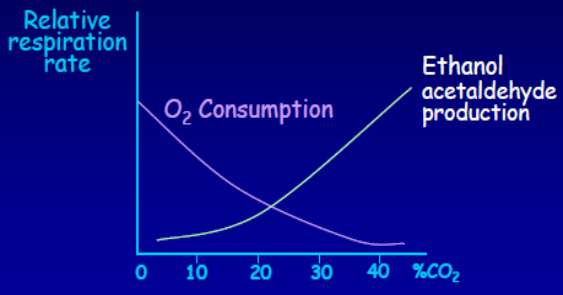
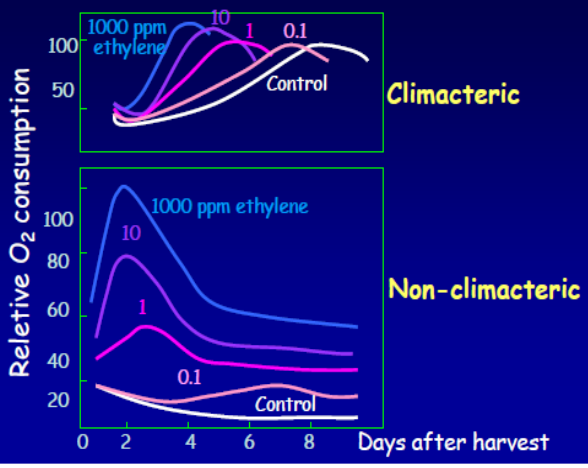
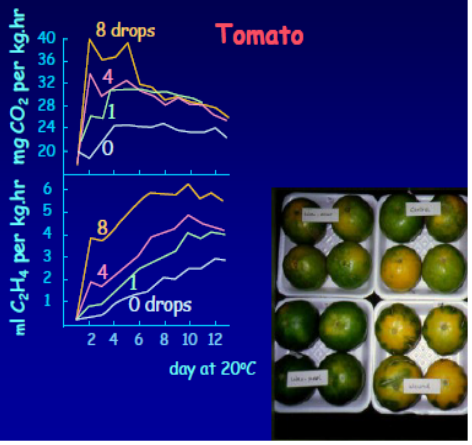


2.3 ETHYLENE



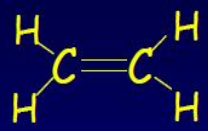
3. Physical stress



REDUCING RESPIRATION

- LOWER TEMPERATURE
- LOWER OXYGEN
- AVOID ETHYLENE
- AVOID DAMAGE

III. ETHYLENE



- NATURAL HORMONE INDUCE RIPENING AND SENESCENCE

- ALL PLANT TISSUE CAN PRODUCE ETHYLENE

- PHYSIOLOGICALLY ACTIVE AT LOW Conc. (0.1 ppm)

SOURCE

- NATURE : PLANT, MICROBE, NATURAL GAS FIRE

- HUMAN : FACTORY, AUTOMOBILE, BALLAST, SMOKING, PLASTIC etc.

CLASSIFICATION OF HORTICULTURAL COMMODITIES ACCORDING TO THEIR ETHYLENE PRODUCTION

Class	ul C_2H_4/Kg.hr range at 20 C	Commodities
Very low	0.01-0.1	Citrus, grape, jujube, strawberry, pomegranate, leafy, vegetables, root vegetable, potatoes, cut flowers
Low	0.1-1.0	Cucumber, longan, lychee, longkong okra, peppers, pineapple, rambutan
Moderate	1.0-10.0	Banana, durian, melon, mango, tomato
High	10.1-100.0	Apple, papaya, peach, pear, plum
Very high	>100.0	Mangosteen, sapodilla,

Effect of ethylene

-ripening, coloring, softening

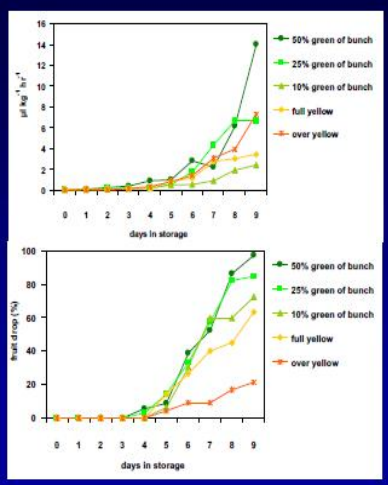
Effect of ethylene

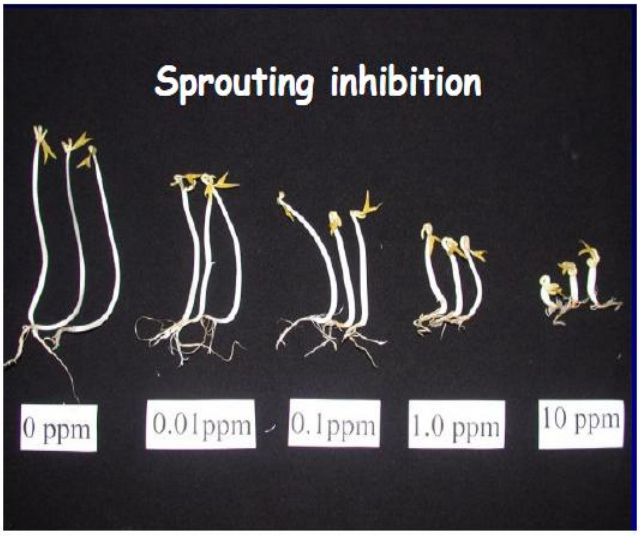
abscission

Longkong

Ethylene Production

Fruit drop





EFFECT OF ETHYLENE IN COMPARISON WITH ANALOGS

COMPOUND	PEA STEM INHIBITION	ABSCISSION
$CH_2=CH_2$ ethylene	1	1
$CH_2=CH=CH_3$ propylene	100	60
C=O carbon monoxide	2700	1250
CH=CH (CaC_2) acetylene	2800	1250

ETHYLENE BIOSYNTHESIS

METHIONINE (MET)

↓

S-adenosyl methionine (SAM)

↓ ACC synthase

1-amino cyclopropane carboxylic acid (ACC)

↓ ACC oxidase, O_2

ETHYLENE

ETHYLENE SYNTHESIS INHIBITION

METHIONINE (MET)

↓

S-adenosyl methionine (SAM)

↓ AVG, AOA

1-amino cyclopropane carboxylic acid (ACC)

↓ O_2, cobalt ion, >35 C

ETHYLENE

ETHYLENE SYNTHESIS INHIBITORS

- AVG (2-amino-4-aminoethoxy - trans-3-butenoic acid)
- AOA (Aminooxyacetic acid)

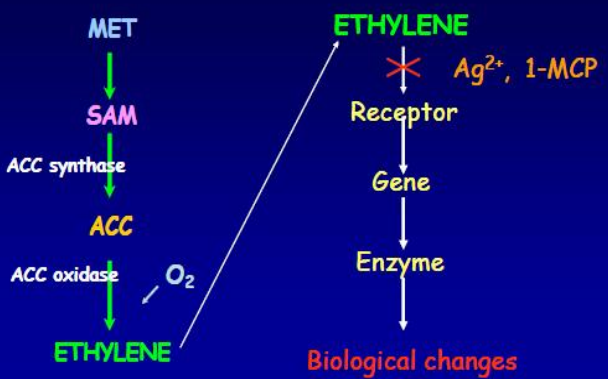
ETHYLENE ACTION INHIBITORS

- Ag^{++}
- NDB (Norbonadiene)
- 1-MCP (1-methyl cyclopropene)
- CO_2

Source: Imsabai

Control Ethylene 0.4 ppm for 24 h

Ethylene action



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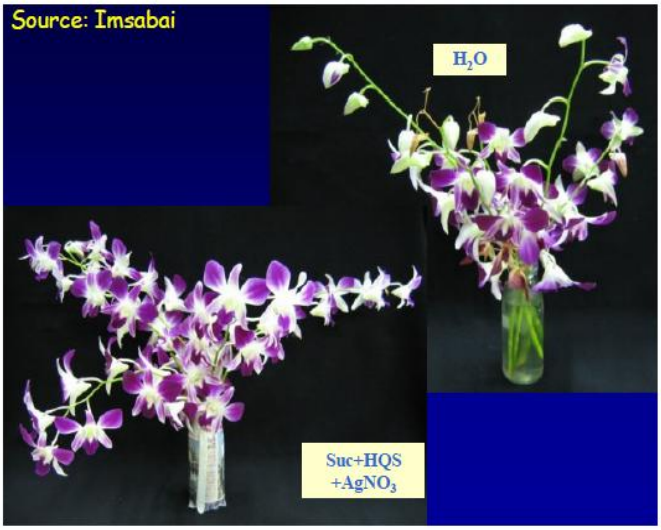

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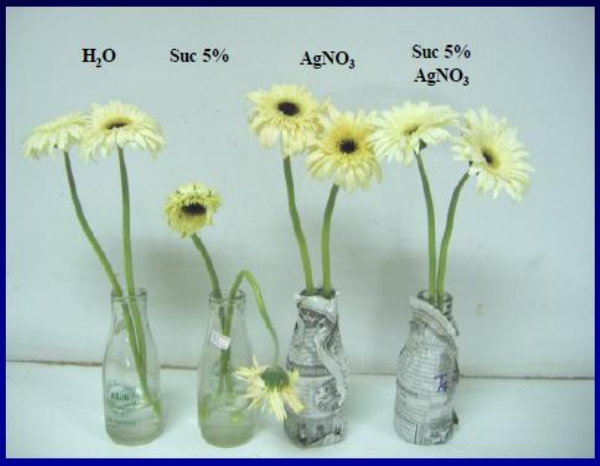

1-MCP FUMIGATION

AVOIDING EXPOSURE TO ETHYLENE

A. EXCLUSION OF ETHYLENE

1. USE OF ELECTRIC FORK-LIFTS
2. USE OF ETHYLENE-ABSORBER on fork lift
3. AVOIDING OTHER POLLUTION SOURCES
4. AVOIDING MIXING C_2H_4-PRODUCING COMMODITIES WITH THOSE WHICH ARE SENTITIVE TO C_2H_4

B. REMOVAL OF ETHYLENE

1. ADEQUATE VENTILATION
2. USE OF ETHYLENE ABSORBERS
   - POTASSIUM PERMANGANATE
   - ACTIVATED CHARCOAL
3. USE OF OZONE OR UV TO OXIDIZE ETHYLENE
4. USE OF LOW PRESSURE SYSTEM

$KMnO_4$ with Banana

Extension of fruit vegetable and flower

- **Lower temperature**
- **Increase humidity**
- **Lower O_2 increase CO_2**
- **Eliminate ethylene**
- **Keep clean**
- **Tender but sooner**

Chemical composition changes

Carbohydrate	
starch	taste
sugar	taste
cell wall	
cellulose, pectin, hemicellulose	texture
Organic acid	taste
Protein	overall
Lipid	
surface	appearance
storage	taste
membrane	appearance

Phenolics

polymerization — taste, appearance

Pigment

chlorophyll, carotenoids, anthocyanin — appearance

Vitamin

ascorbic acid — nutrition

Volatile

aldehyde, alcohol, ester etc. — aroma

Thank you