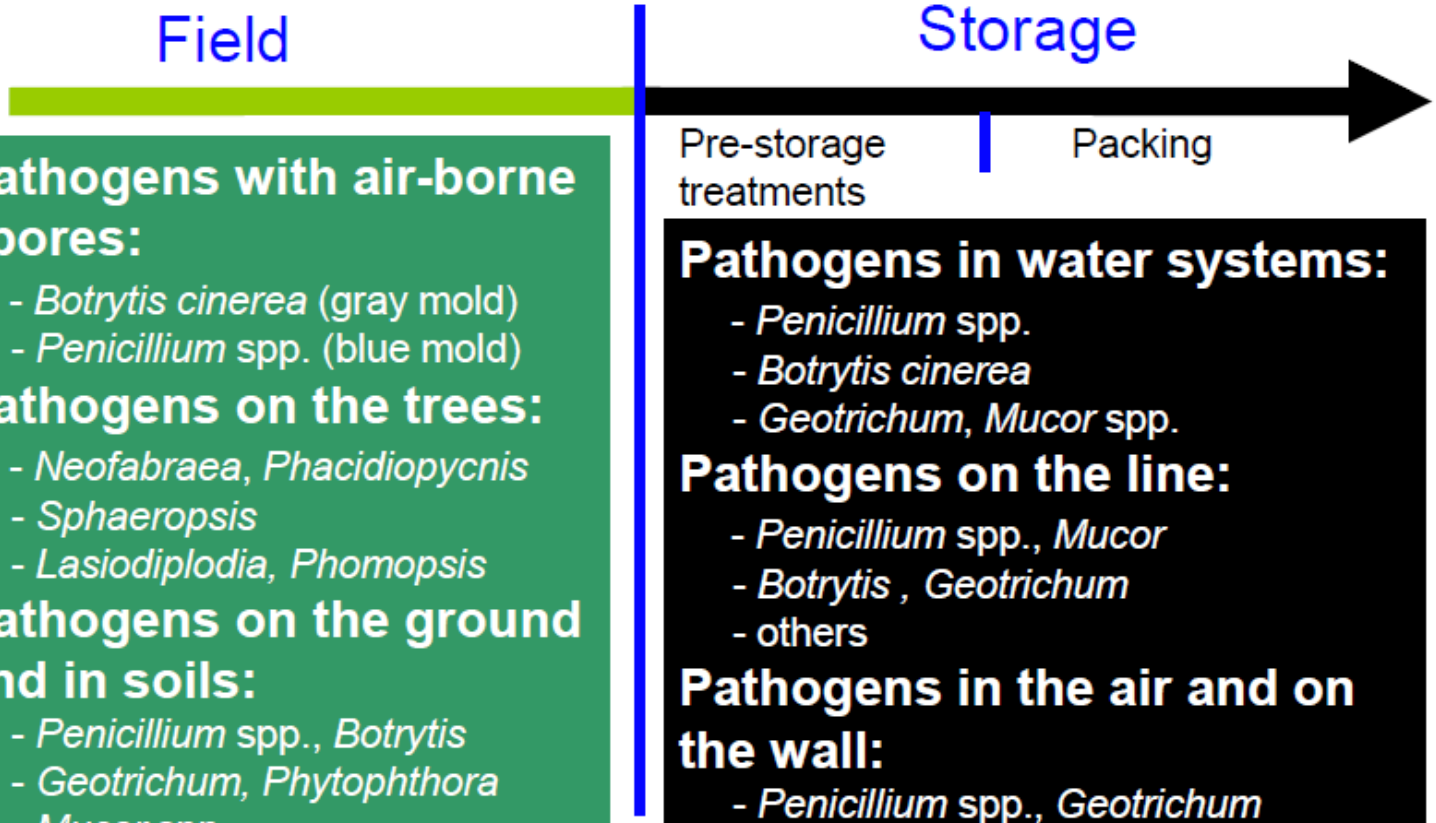
6th Lesson, Pathology

Principles of Postharvest Plant Disease Management

The basis for the control of postharvest diseases is based in the time and mechanism for the inhibition of fungal infection

Sources of decay-causing pathogens



Control of diseases by prevention of development

Physical factors reducing the pathogen development after harvest

Modification of the physical environment after harvest

Removal of heat by rapid cooling systems (as hydro cooling or forced air cooling) reduce fungal attack will reduce ripening as well as microorganism initiation of development.

Inhibition of disease development by physical treatment

- **Temperature**
  Controlled Atmosphere
  Modified Atmosphere
  Hypobaric conditions

Cold temperature storage

The simplest way to reduced disease development is by modulating fruit ripening by reducing temperature

The effect of temperature after harvest may affect three factors:

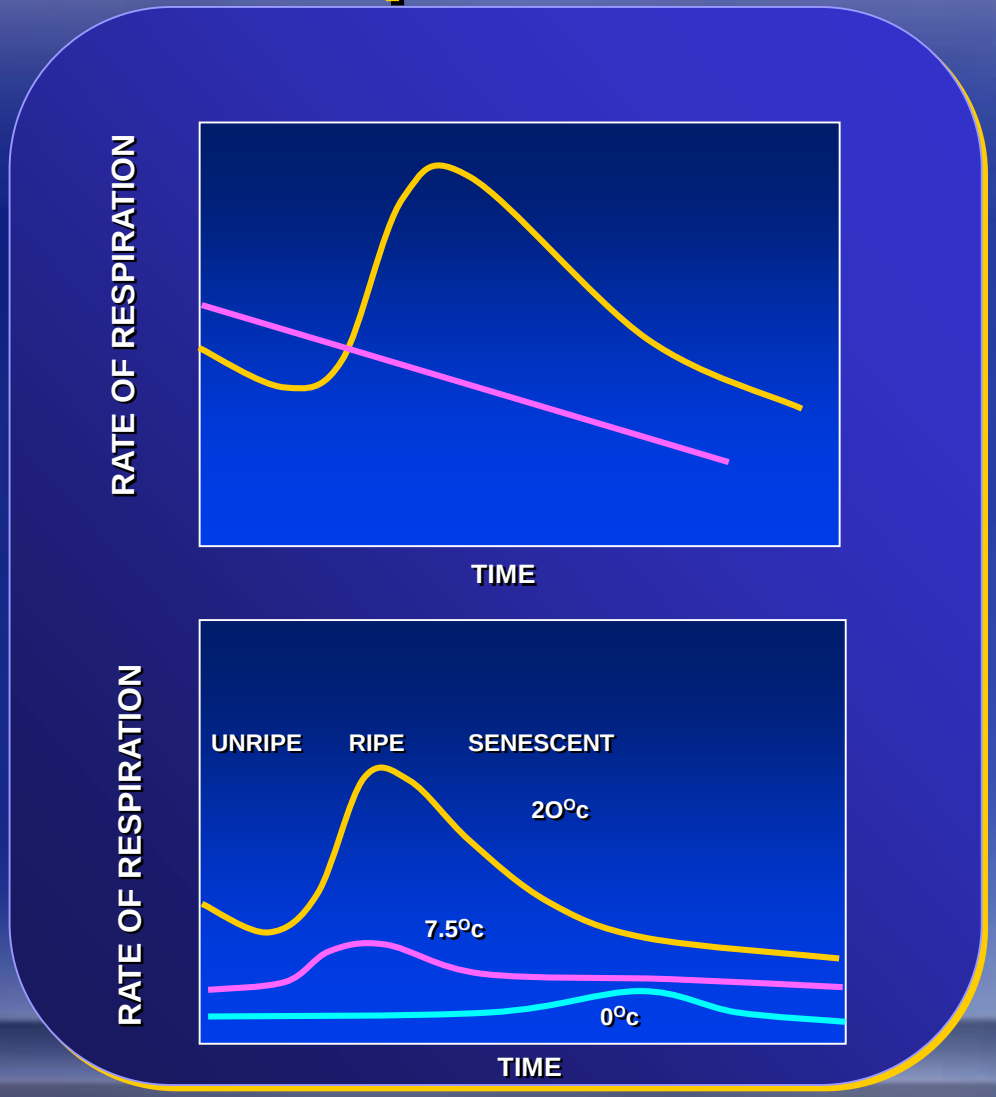
- Fruit ripening
- Spore germination
- Disease and symptoms development

Effect of temperature on the host and symptom development

Effect of temperature on fruits

- Effect temperature on the rate of respiration
- Effect on the sigmoid disease curve
- Effect of temperature on symptom development
- Effect of initial time of storage on decay

Effect temperature on the rate of respiration

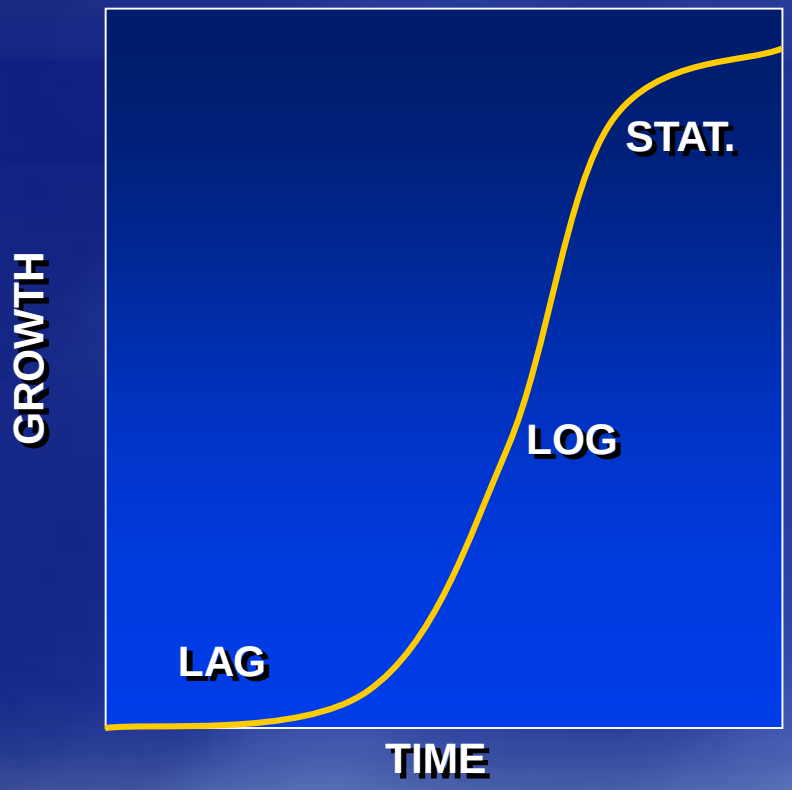


The effect of temperature on fungal germination and growth

Effect of temperature on pathogens

- Optimal temperature 20-25 C
- Maximal temperature 30-38 C
- Minimal temperature 2-0 C

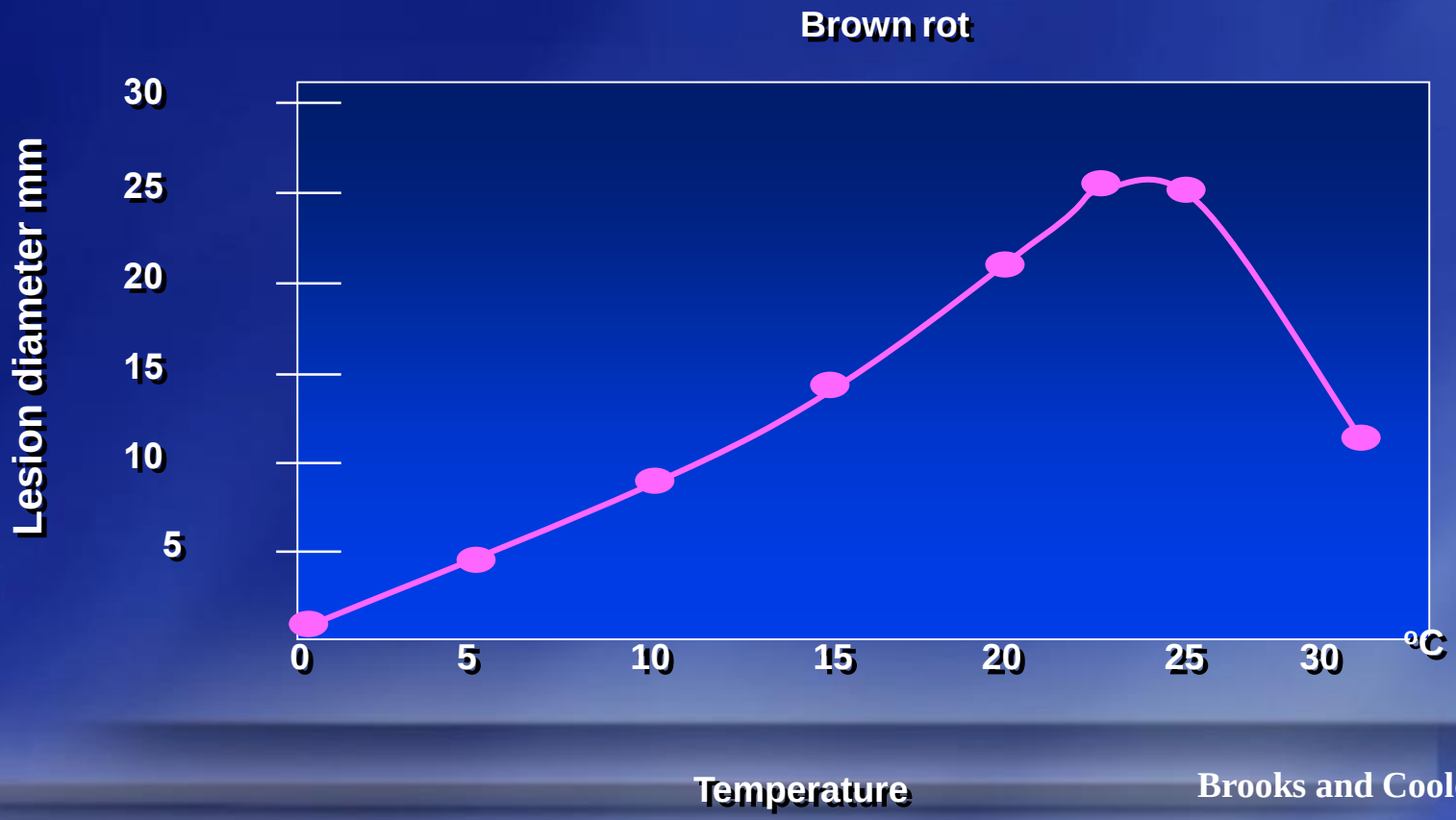
Effect temperature on the sigmoid disease curve



Sigmoid curve of rot development

Effect of temperature on symptom of diseases development

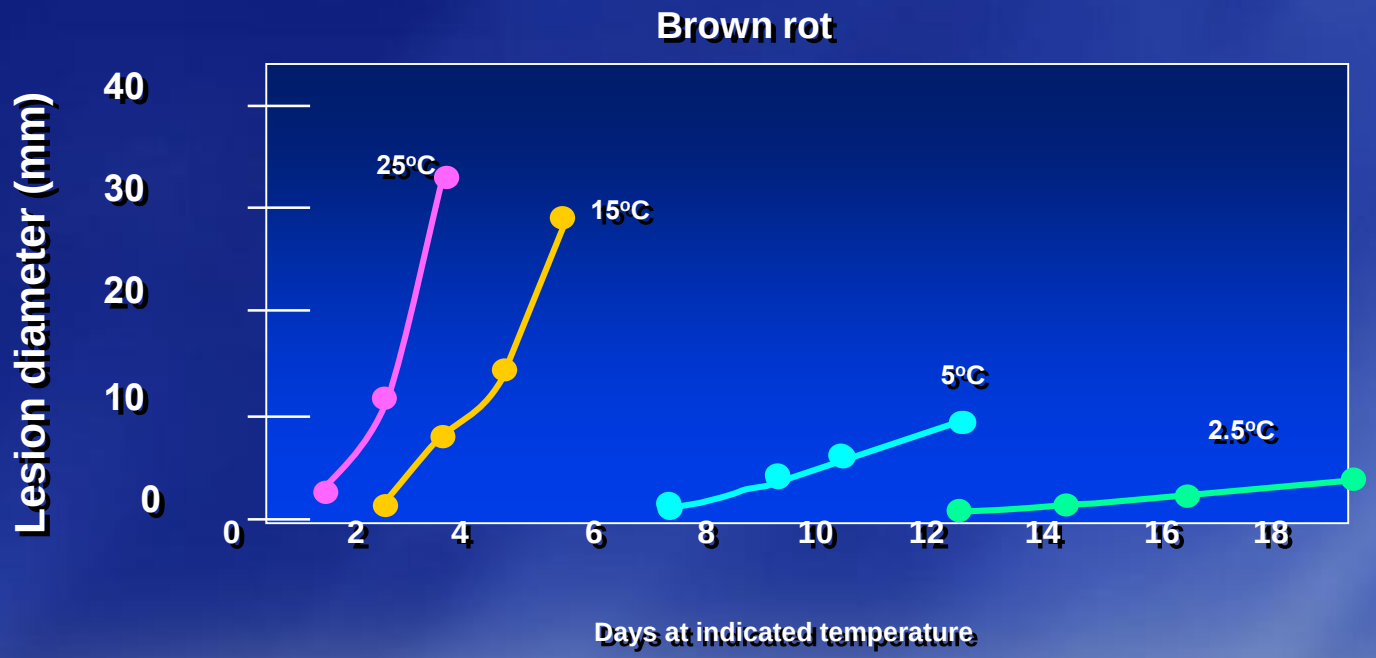
Inoculated fruits were stored a different temperatures and evaluated after 8 days of storage at each temperature



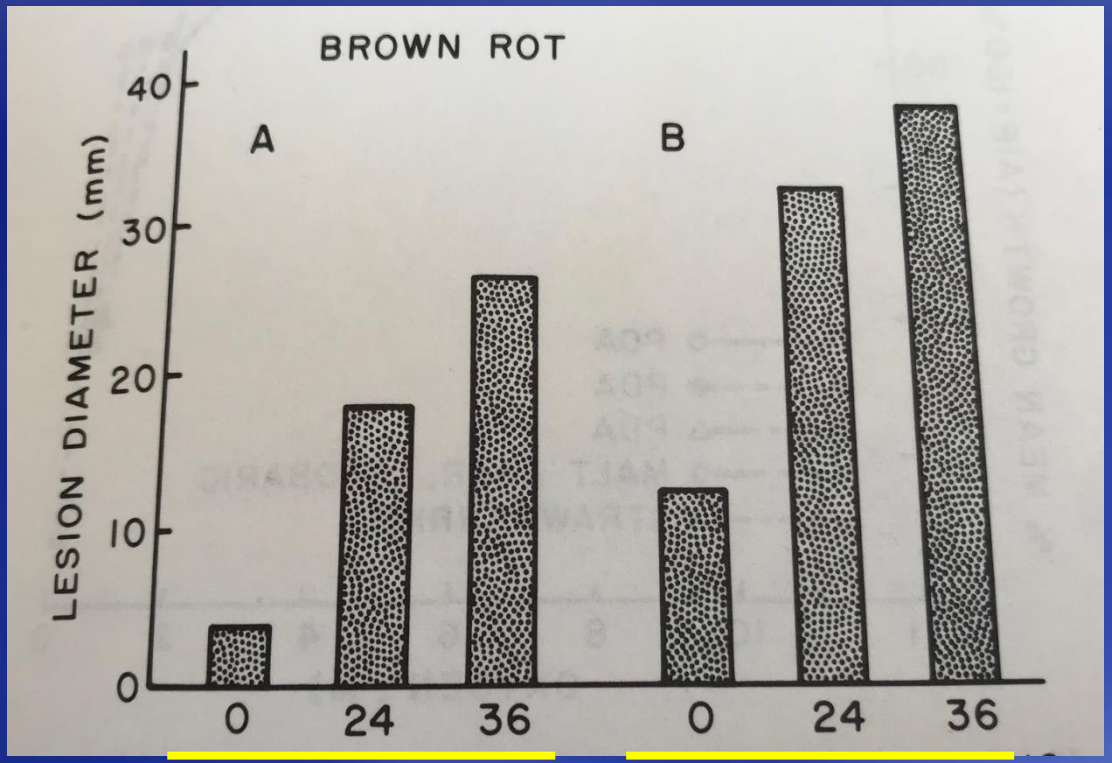
Brooks and Cooley, 1928

Effect of temperature on symptom of disease development

Inoculated fruits were stored a different temperatures and evaluated after every day at each temperature temperature



Effect of initiation of decay during of storage of peaches at 0 C



3 days **6 days**

Delay the intitation of cooling for 3 (A) or 6 (B) days affects the decay development

Inhibition of disease development by physical treatment

- Temperature
- Controlled Atmosphere
- Modified Atmosphere
- Hypobaric conditions

The effect of low O_2 and high CO_2 are considered to be **additive** to the effect of temperature

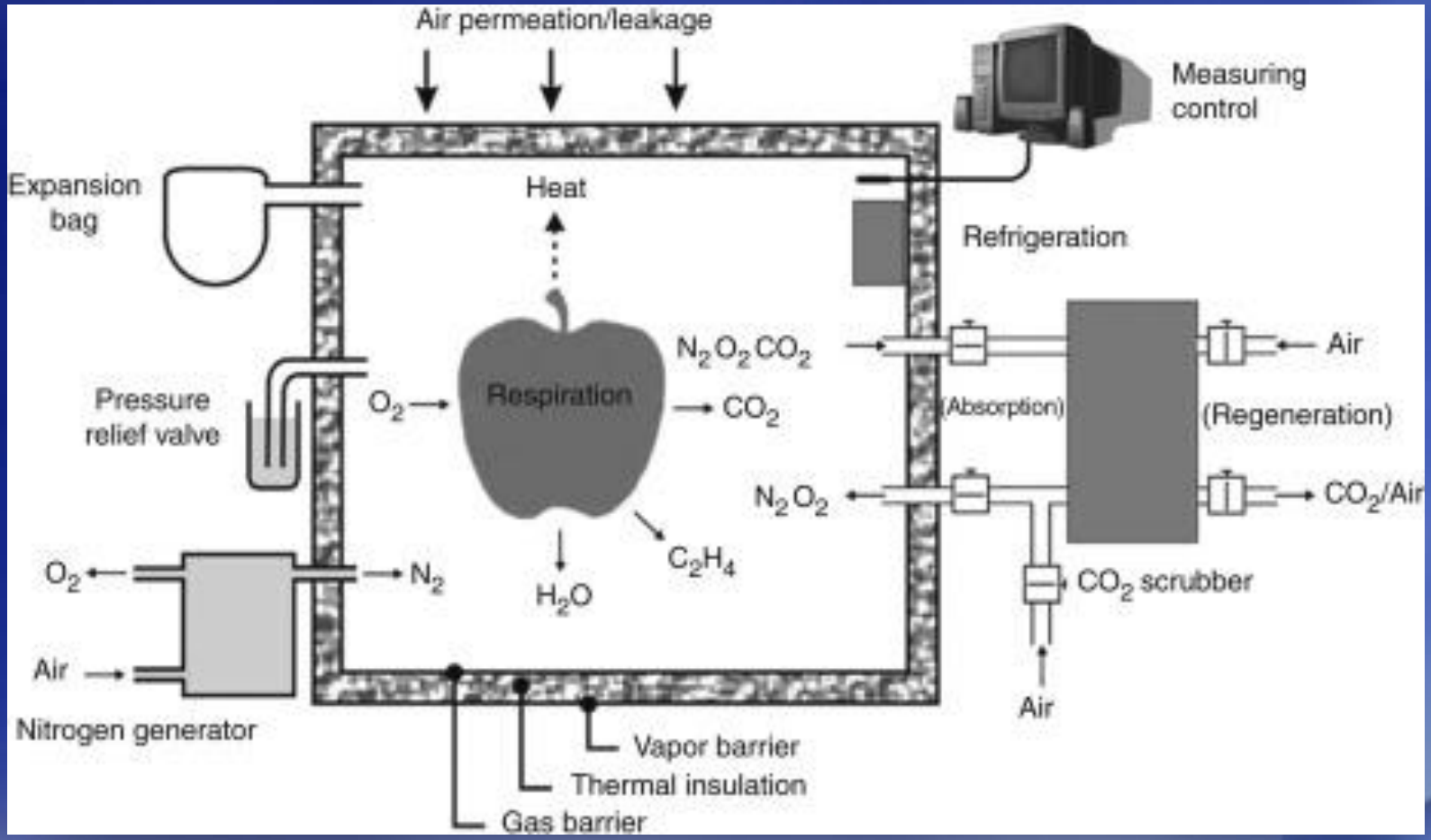
Control atmosphere (CA) – generally refers to decreased O_2 and increased CO_2 concentrations, by a precise control of the gas composition.

Modified atmosphere (MA) – is used when the control of the storage atmosphere is not closely controlled, such as in plastic film packaging.

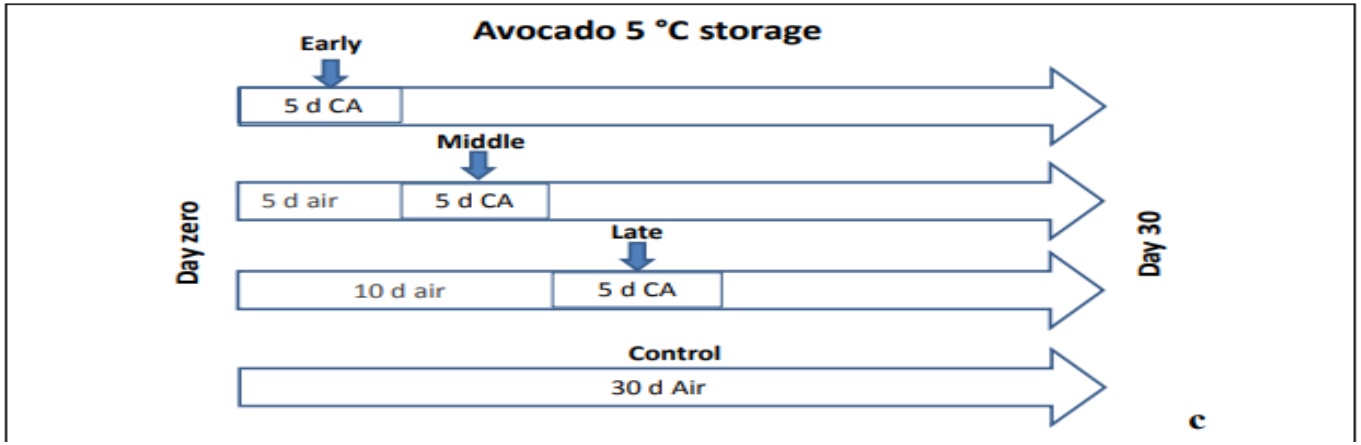
Corridor of CA storage rooms

China 2007

The Controlled atmosphere system



Schematic response to CA on ripening of avocado



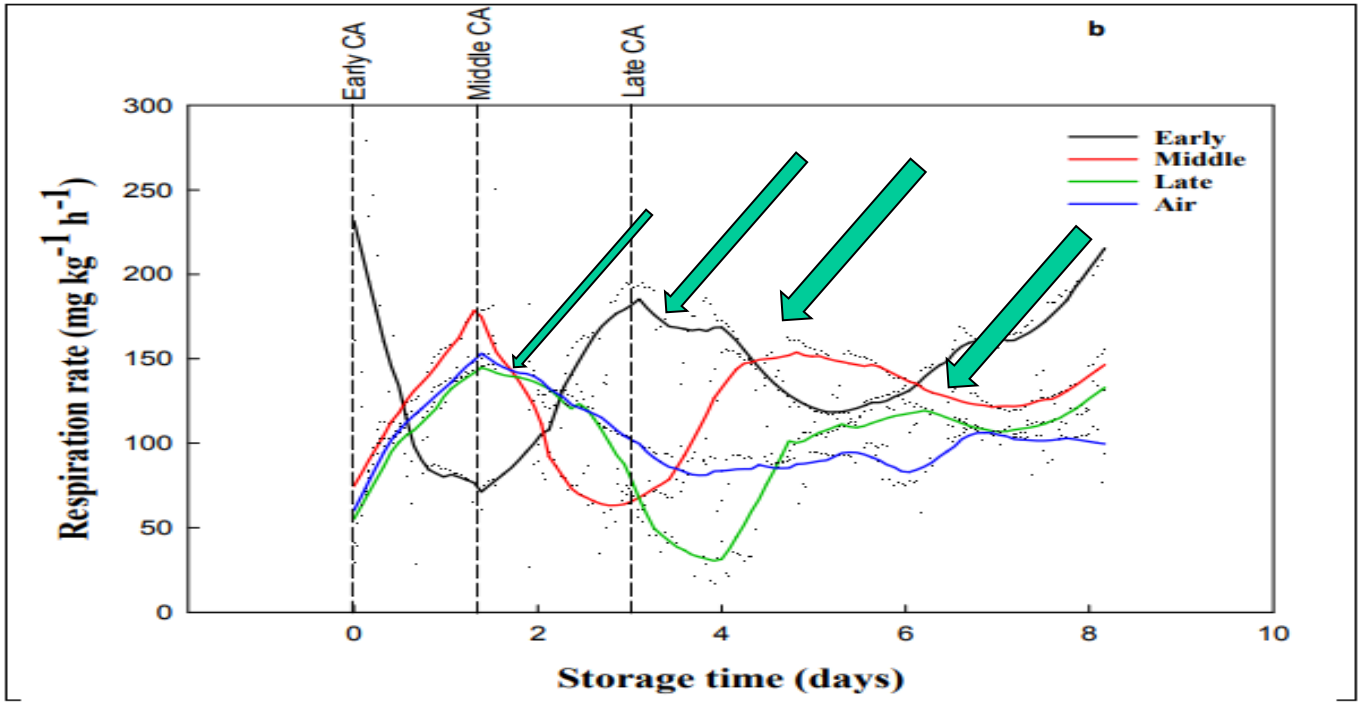
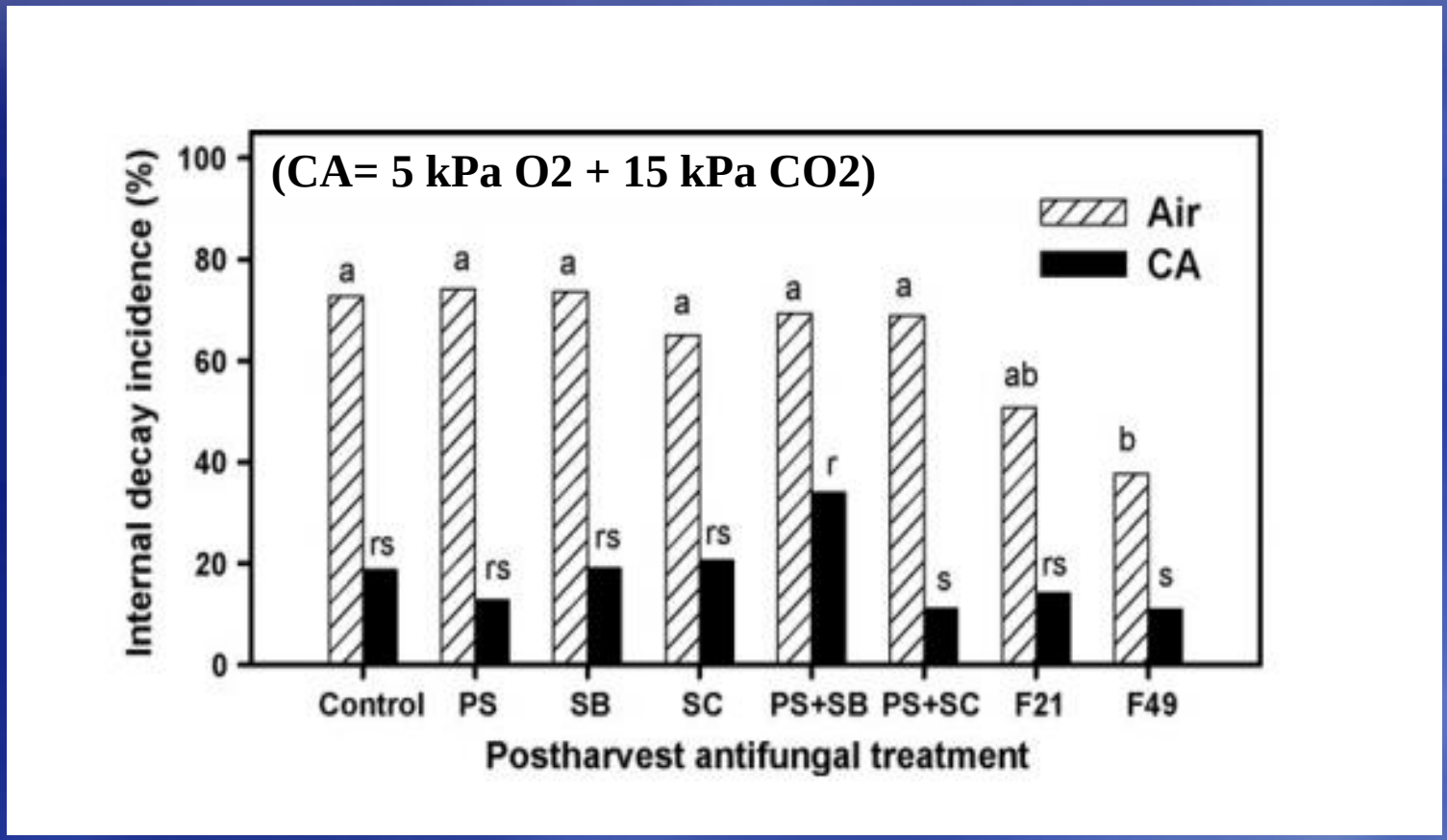


Table 1. General Summary of CA recommendations for fruits other than apples and pears

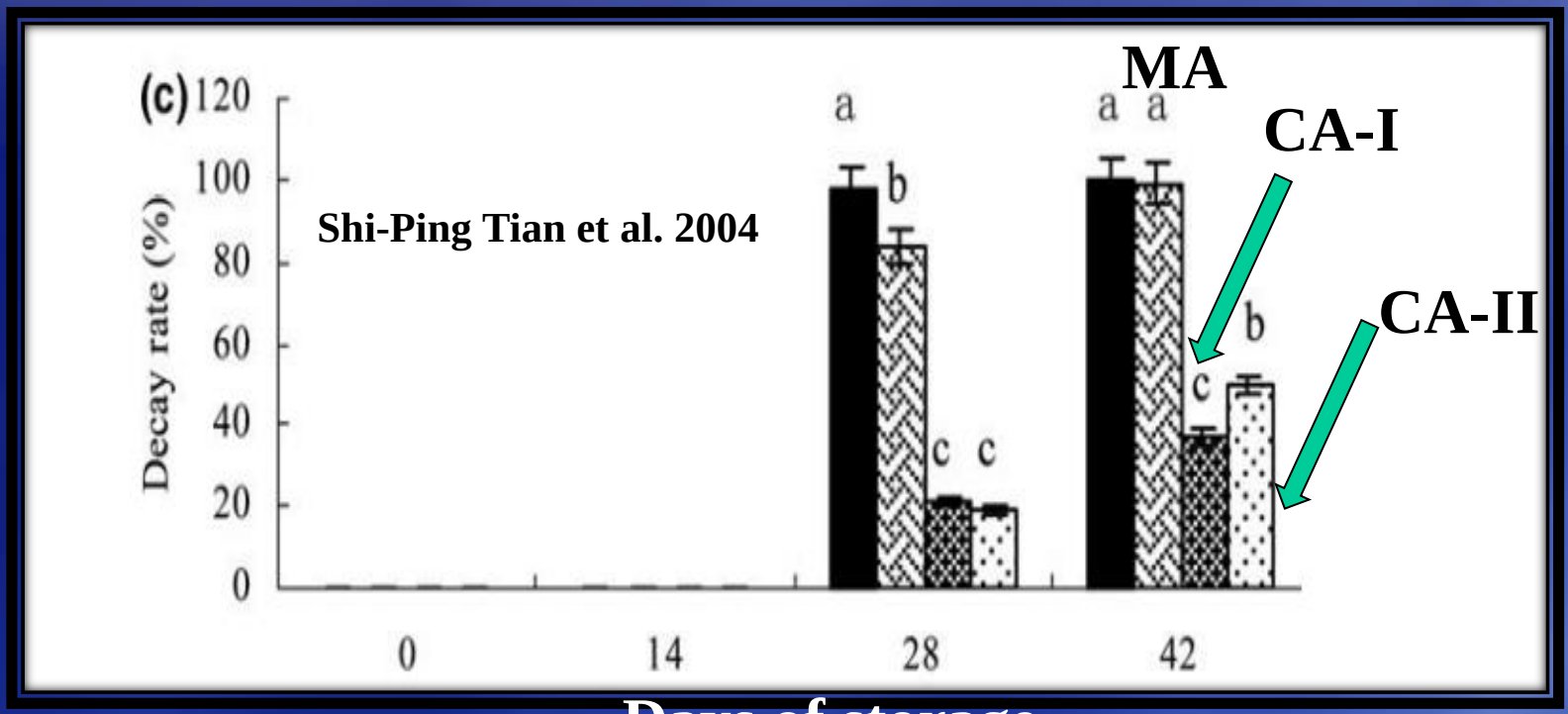
Commodity	Temperature Range[1] (°C)	CA[2] % O_2	CA[2] % CO_2	Commercial use as of June, 2001
Apricot	0-5	2-3	2-3	
Asian pear	0-5	2-4	0-1	Limited use on some cultivars
Avocado	5-13	2-5	3-10	Used during marine transport
Banana	12-16	2-5	2-5	Used during marine transport
Blackberry	0-5	5-10	15-20	Used within pallet covers during transport
Blueberry	0-5	2-5	12-20	Limited use during transport
Cactus pear	5-10	2-3	2-5	
Cherimoya & Atemoya	8-15	3-5	5-10	
Cherry, sweet	0-5	3-10	10-15	Used within pallet covers or marine containers during transport
Cranberry	2-5	1-2	0-5	
Durian	12-20	3-5	5-15	
Fig	0-5	5-10	15-20	Limited use during transport
Grape	0-5	2-5	1-3	Incompatible with SO_2 fumigation
		or		
		5-10	15-20	Limited use instead of SO_2 for decay control during transport up to 4 weeks
Grapefruit	10-15	3-10	5-10	
Guava	5-15	2-5	0-1	
Kiwifruit	0-5	1-2	3-5	Expanding use during transport and storage; C_2H_4 must be maintained below 20 ppb
Lemon	10-15	5-10	0-10	
Lime	10-15	5-10	0-10	
Loquat	0-5	2-4	0-1	
Lychee (litchi)	5-12	3-5	3-5	
Mango	10-15	3-7	5-8	Increasing use during marine transport
Nectarine	0-5	1-2	3-5	Limited use during marine transport
		or		
		4-6	15-17	Used to reduce chilling injury (internal breakdown) of some cultivars
Olive	5-10	2-3	0-1	Limited use to extend processing season
Orange	5-10	5-10	0-5	
Papaya	10-15	2-5	5-8	
Peach, clingstone	0-5	1-2	3-5	Limited use to extend canning season
Peach, freestone	0-5	1-2	3-5	Limited use during marine transport
		or		
		4-6	15-17	Used to reduce incidence and severity of

Influence of postharvest antifungal treatment and CA on the incidence of internal decay on ‘Wonderful’ pomegranates *(inoculated in the crown with Botrytis cinerea (Tahiland)*



Influence of antifungal treatment, potassium sorbate (PS), sodium bicarbonate (SB), sodium carbonate (SC), mixture of PS and SB (PS + SB), mixture of PS and SC (PS + SC), fludioxonil at 21 ◦C (F21), and fludioxonil at 49 ◦C (F49) on the incidence of internal decay

Effects of different storage conditions on decay of lychee fruit (China)

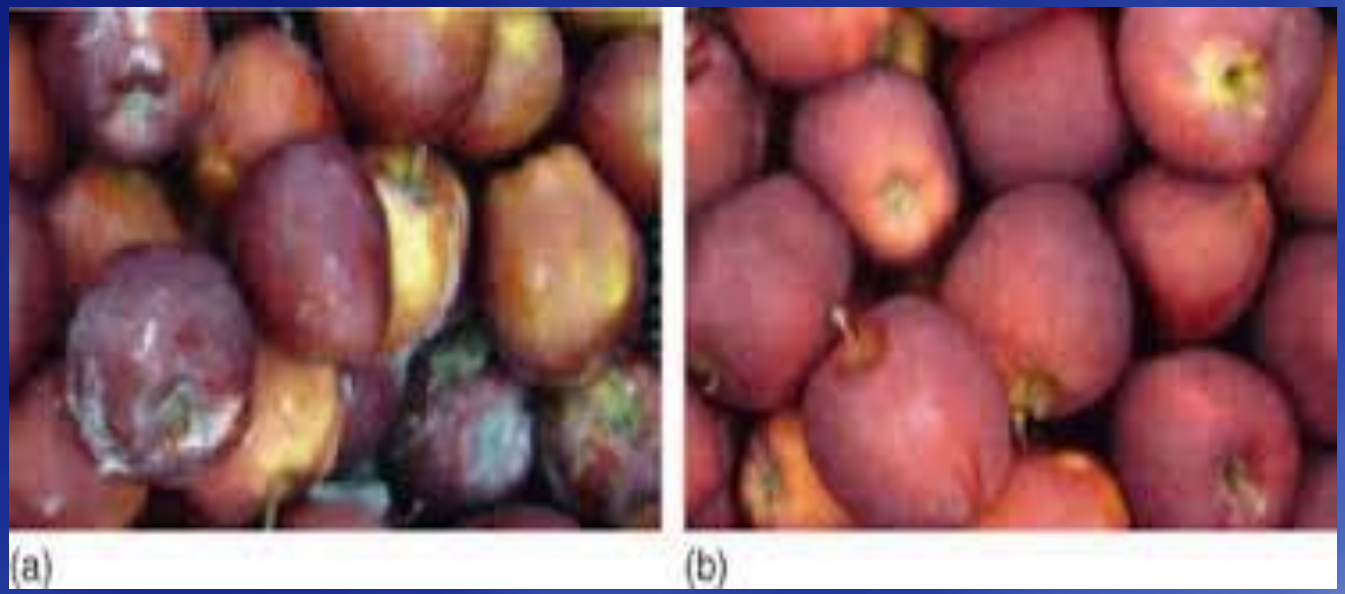


MAP, 0.03 mm thick polyethylene film bag (25 · 35 mm for 1 kg fruit, 15–19% O2 + 2–4% CO2);

CA-I, 5% O2 + 5% CO2;

CA-II, fruit were stored in the high oxygen concentration atmosphere (70% O2 + 0% CO2) for the first week, then kept in 5% O2 + 5% CO2

Effect of CA on disease development



Control **After 11 months**

Factors affected by CA and MA on the fruit and disease development after harvest

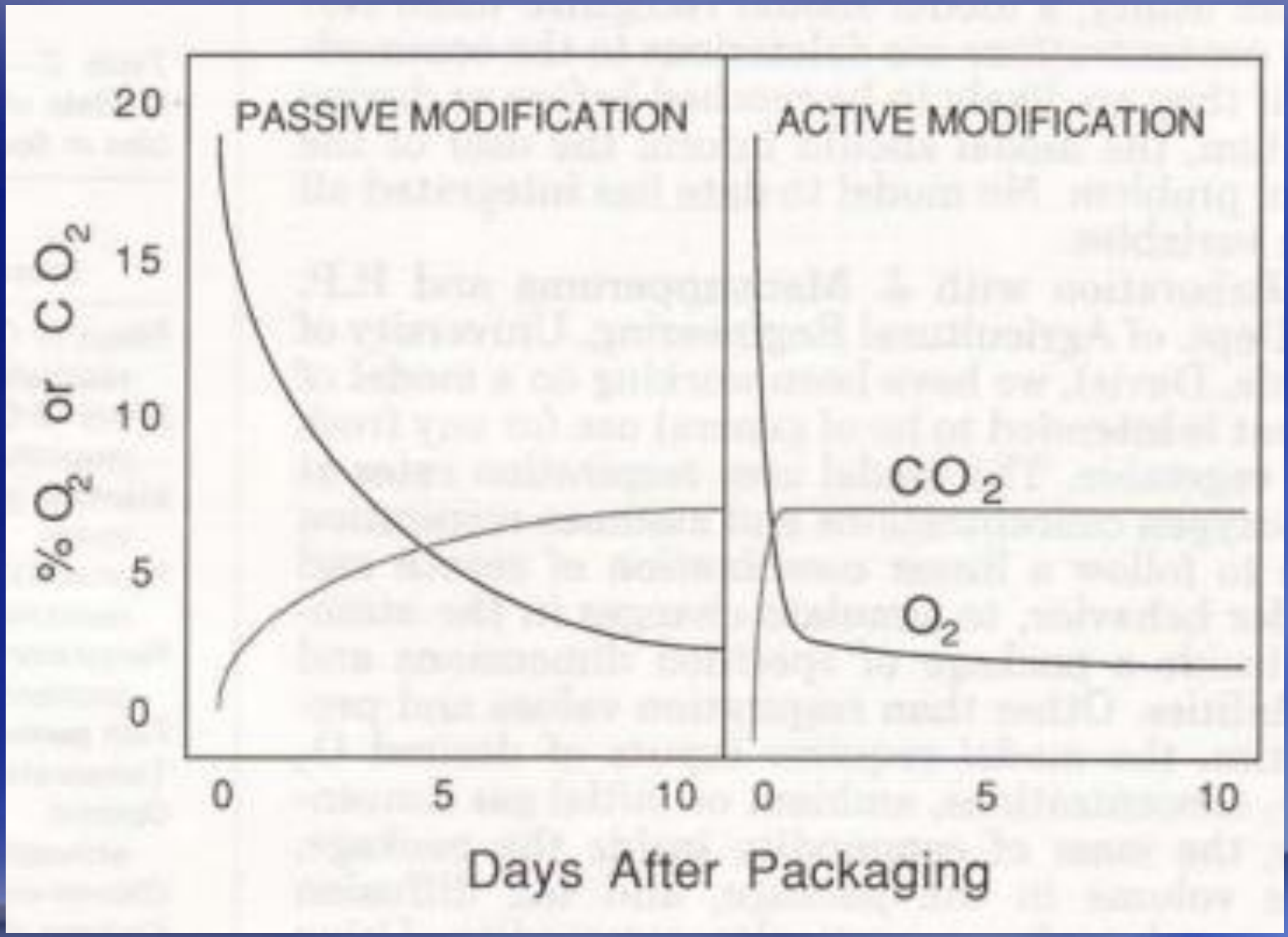
General effects:

1. Direct way: prevention of ripening, reduced ethylene and reduced respiration
2. Indirect way: percent decay, inhibition of germination and growth

Control atmosphere (CA) – generally refers to decreased O_2 and increased CO_2 concentrations, by a precise control of the gas composition.

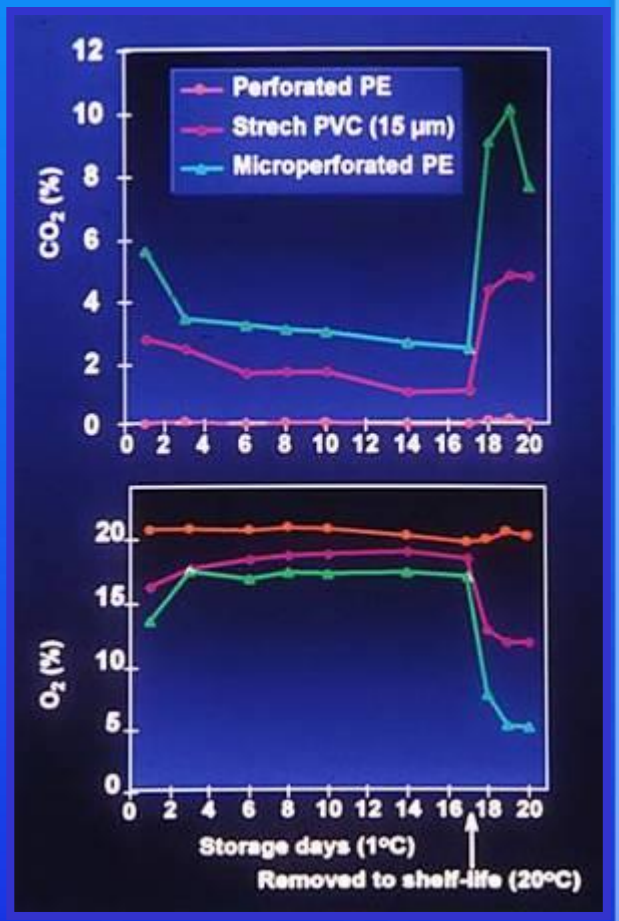
Modified atmosphere (MA) – is used when the control of the storage atmosphere is not closely controlled, such as in plastic film packaging.

Development of Modified Atmosphere



MAP applied to individual inflorescence

Broccoli



Commercial MAP of broccoli

Delay of yellowing in parsley leaves by MAP

Parseley

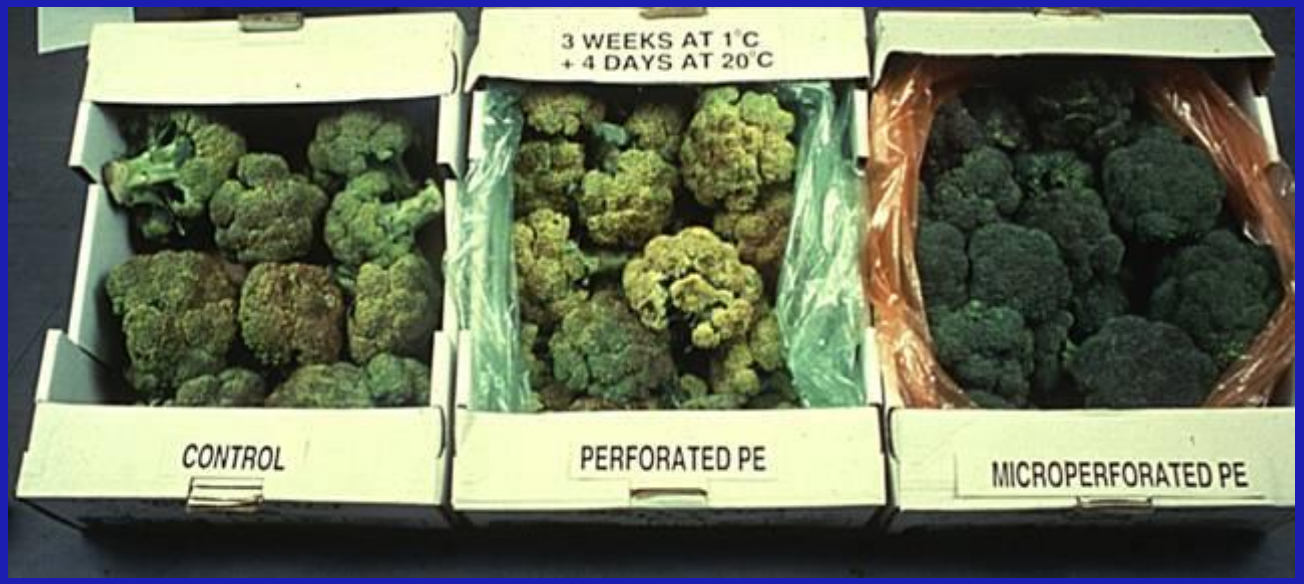
6d at 6 C
+4 d at 12C

Sealed

Perforated

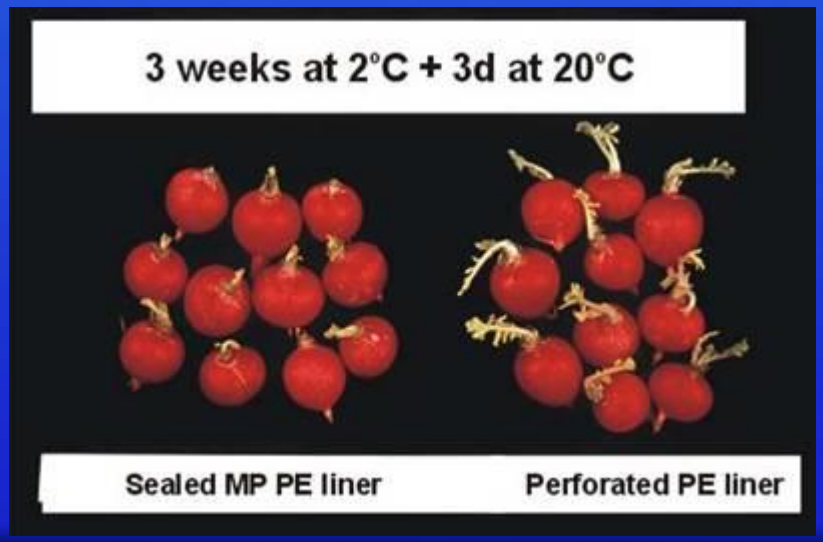
Suppression of leaf re-growth and curving in green onion

MAP applied to bulk broccoli



Prevention of decay and yellowing

Suppression of leaf sprouting in radishes



Commercial MAP of kiwi

Transportation of strawberries in CO_2 – enriched atmosphere – TransFresh (Tectroll) technology

Factors affecting disease development after harvest

Post-harvest treatments

- Effect of modified atmosphere

General effects:

1. Indirect way: prevention of ripening, reduced ethylene and reduced respiration.
2. Physiological disorders

Effect of Oxygen on fungal development

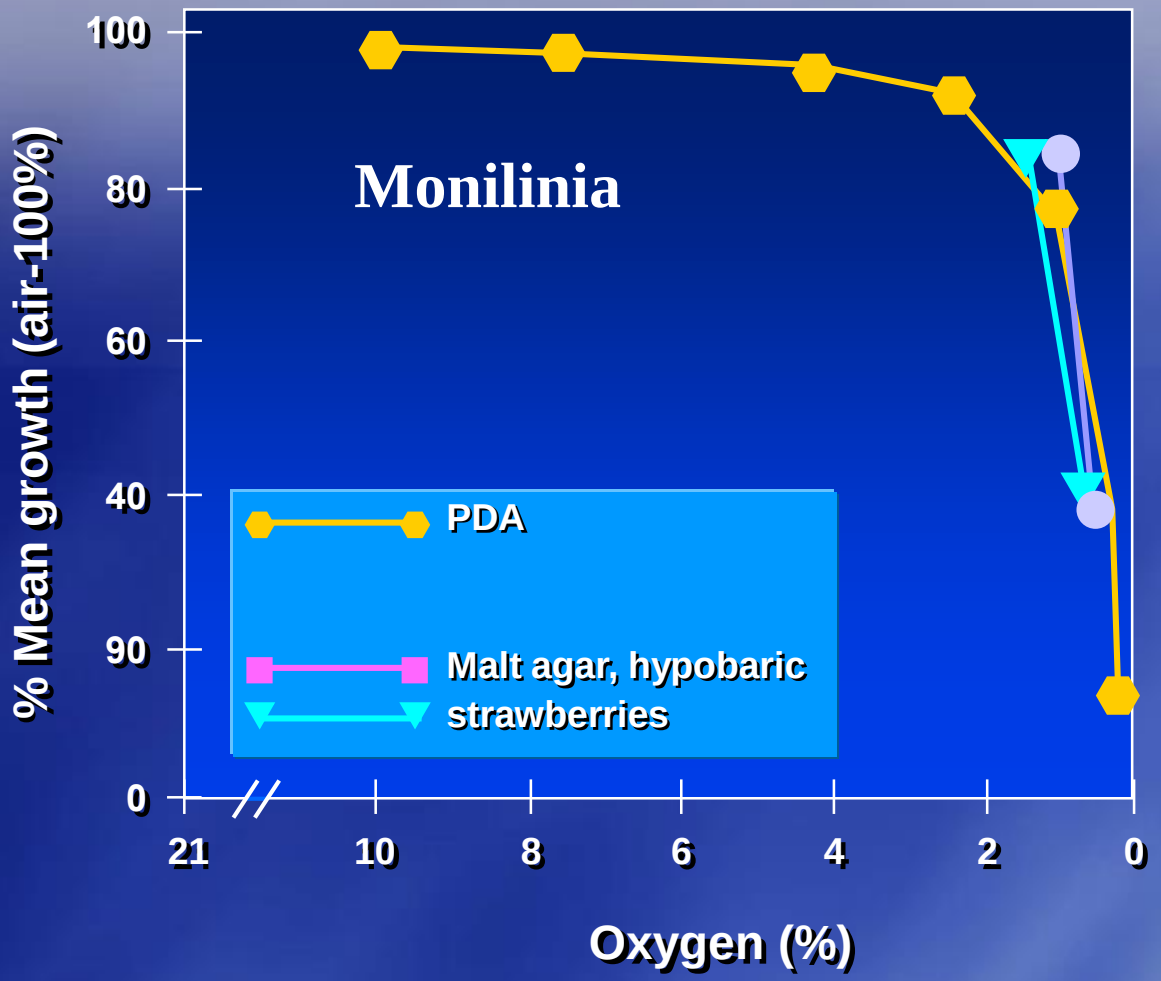
Effect of gases on fungal development

Effect of low oxygen

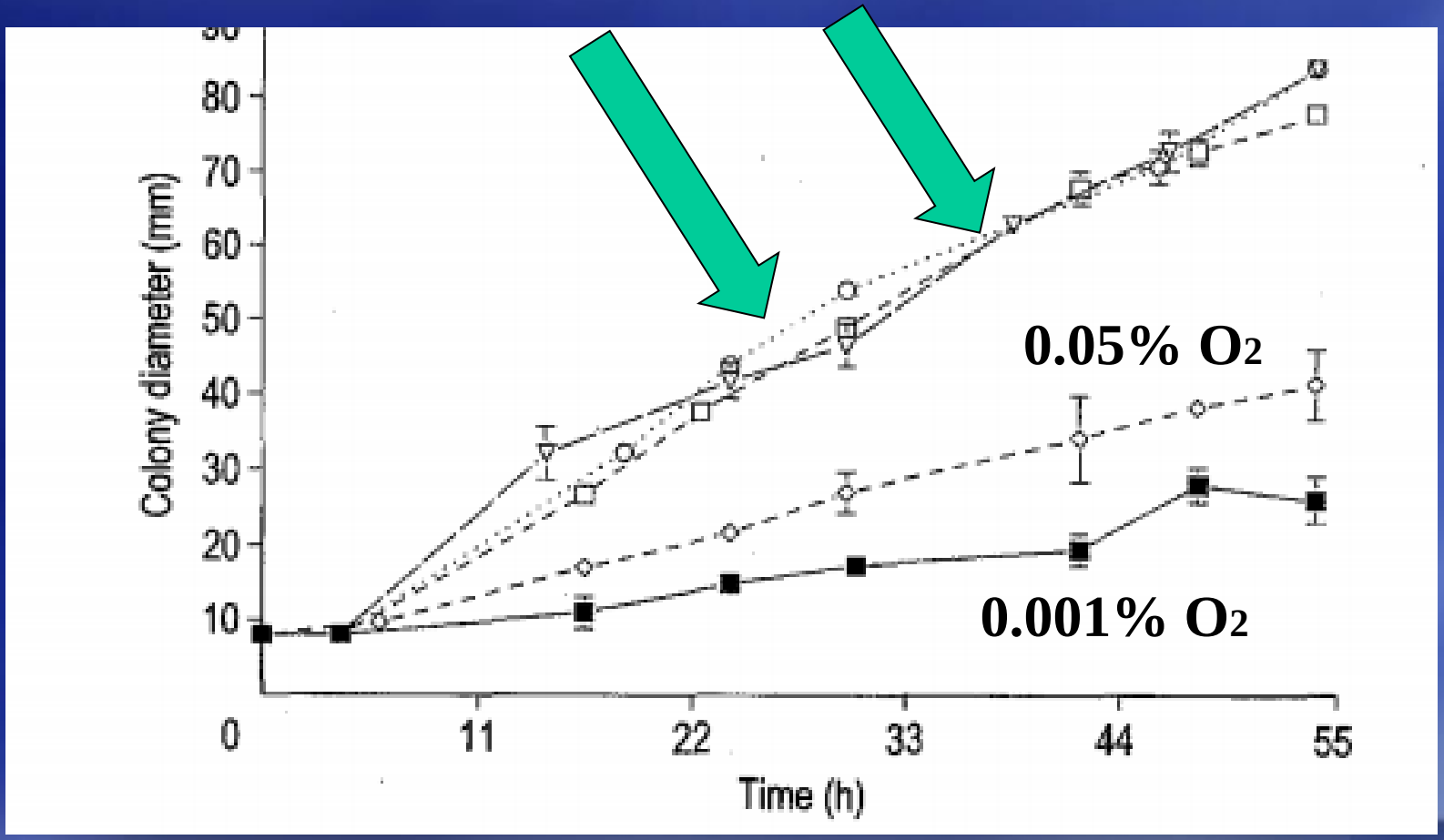
1. Under 4% O_2 fungal mycelium are affected
2. Under 1% oxygen the decay development is inhibited
3. Under 1% oxygen there are physiological effect on the fruit

Effect of low oxygen on growth of Botrytis in culture and in fruit.

All the tests were conducted at normal barometric pressure in an atmosphere of low oxygen



Colony diameter during growth of Rhizopus on malt extract, soya peptone, and agar (MESPA1) at constant oxygen concentrations ■ 0.001%, ◊ 0.5% oxygen, ○ 1.0% oxygen, ▼, 5.0% oxygen, □, 21% oxygen (Spain)



De Reu et al., 1995

Effect of high CO_2

Effect of high CO_2 on the development of postharvest disease

Factors affecting disease development after harvest

- Botrytis is inhibited by CO_2 higher than 10%
- Monilinia is inhibited by CO_2 levels between 30-50%
- The concentrations used range between 10-20%. Higher concentrations may affect the taste of the fruits (nectarins) or the color of the fruit (grapes)

Effect of CO_2 on Alternaria in persimmon fruits

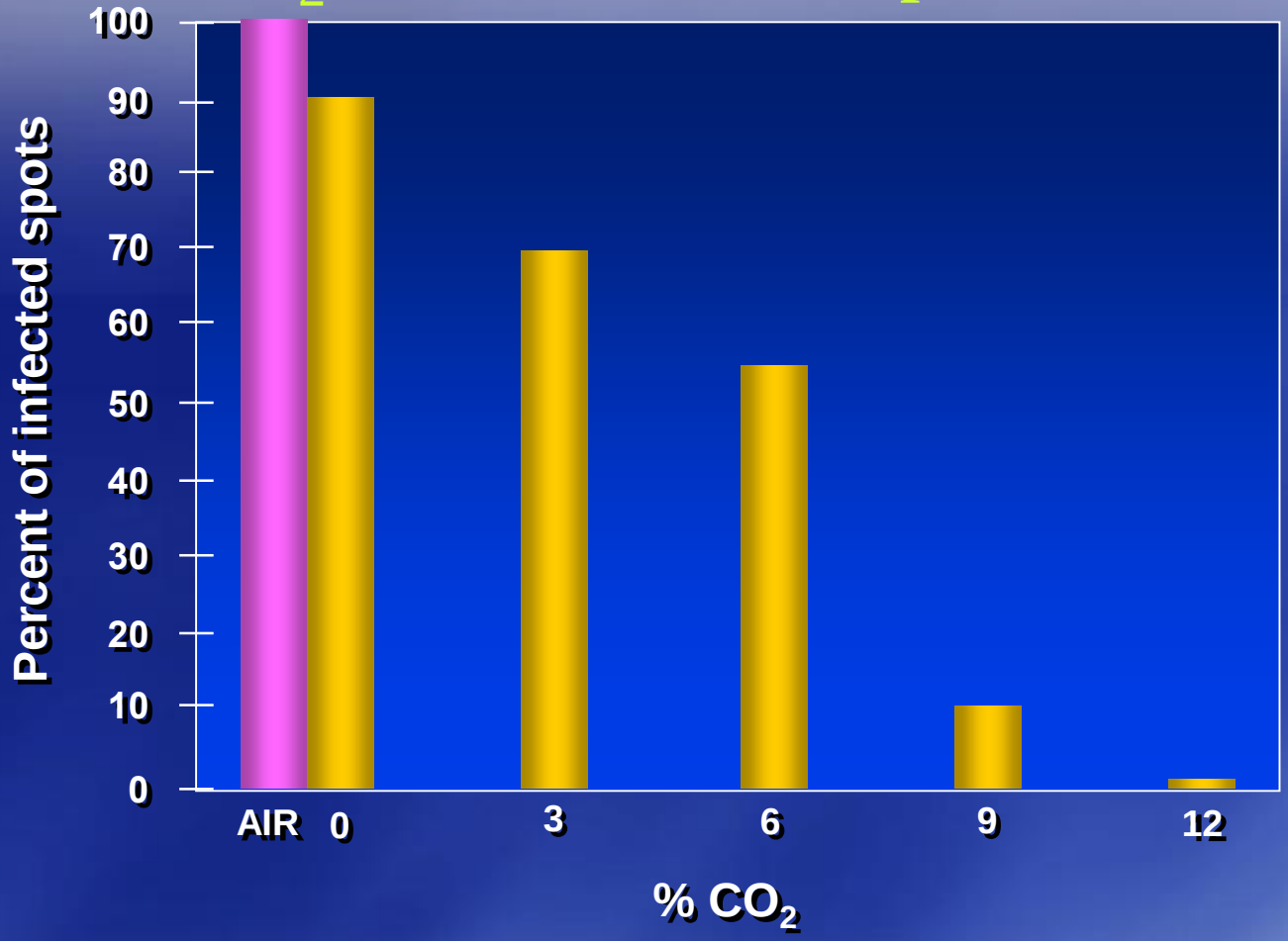


Fig 8. Effect of CO_2 concentration during 4 months of controlled-atmosphere storage at 0°C on decay development (percentage) on persimmon cv. Triumph fruits inoculated with *Alternaria alternata* prior to storage. SE = 4.3 ($P \leq 0.05$). Results illustrated were from one experiment.

Combination of gases affecting disease development after harvest

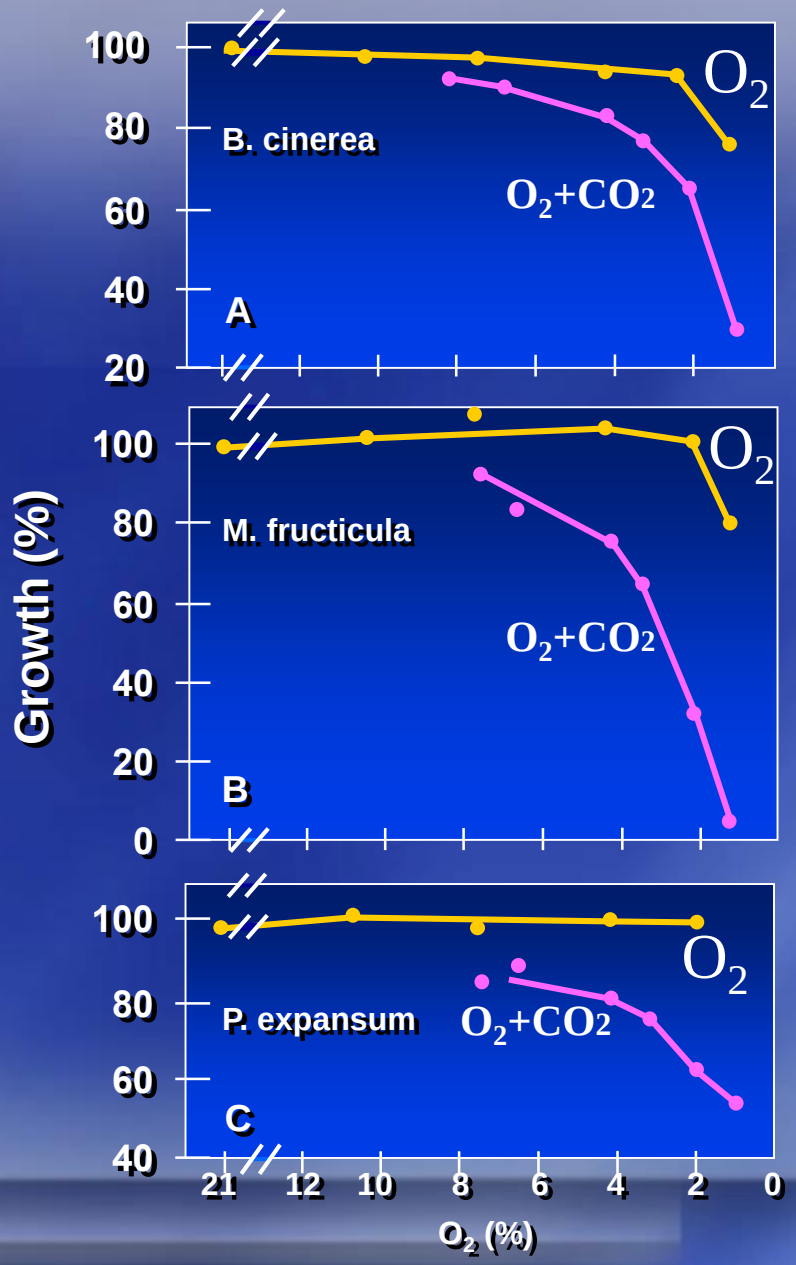
- Combination of low O_2 / high CO_2
- Additive effect
- The concentrations used ranged between

  2-4% O_2

  5-7% CO_2

  This combinations inhibit, respiration, delay ripening, and prevent decay development.

Suppression of postharvest pathogens by oxygen (yellow) or combined with 10% carbon dioxide (red)



Inhibition of disease development by physical treatment

- Temperature
- Controlled Atmosphere
- Modified Atmosphere
- Hypobaric conditions

Storage at Hypobaric atmosphere treatment

Post-harvest treatments using Hypobaric atmospheres

- **760 mmHg to 76 mmHg**
- **This will result in a decrease in reduction of O_2 from 21% to 2%**
- **This effect will result in the delay of ripening and decay development.**

Summary:

Inhibition of disease development by physical treatment is not so easy!!!

Temperature

Controlled Atmosphere

Modified Atmosphere

Hypobaric conditions

Inhibition of disease development by physical treatment is not enough

Physical Factors affecting disease development after harvest

Complicated because dependent on the pathogen, period of infection, concentration of the pathogen

1. Physical Factors affecting disease development after harvest

2. Prevention of diseases development