POSTHARVEST PHYSIOLOGY

OF

HORTICULTURAL CROPS

Errol W. Hewett
Professor of Horticultural Science
Massey University
Palmerston North

November 1995

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Errol W. Hewett PhD
PROFESSOR OF HORTICULTURAL SCIENCE
(POSTHARVEST PHYSIOLOGIST)

Department of Plant Science
Massey University
Palmerston North Telephone: (06) 356-9099
NEW ZEALAND Facsimile: (06) 350-5679
E.Mail Address: E.W. Hewett @ massey.ac.nz

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DETERIORATION

Three main types:

Physical
* mechanical damage
* cuts, bruises, abrasions
* freezing damage

Physiological
* disorders
* temperature - chilling
  - heat
* nutritional imbalance
* atmosphere
* ethylene

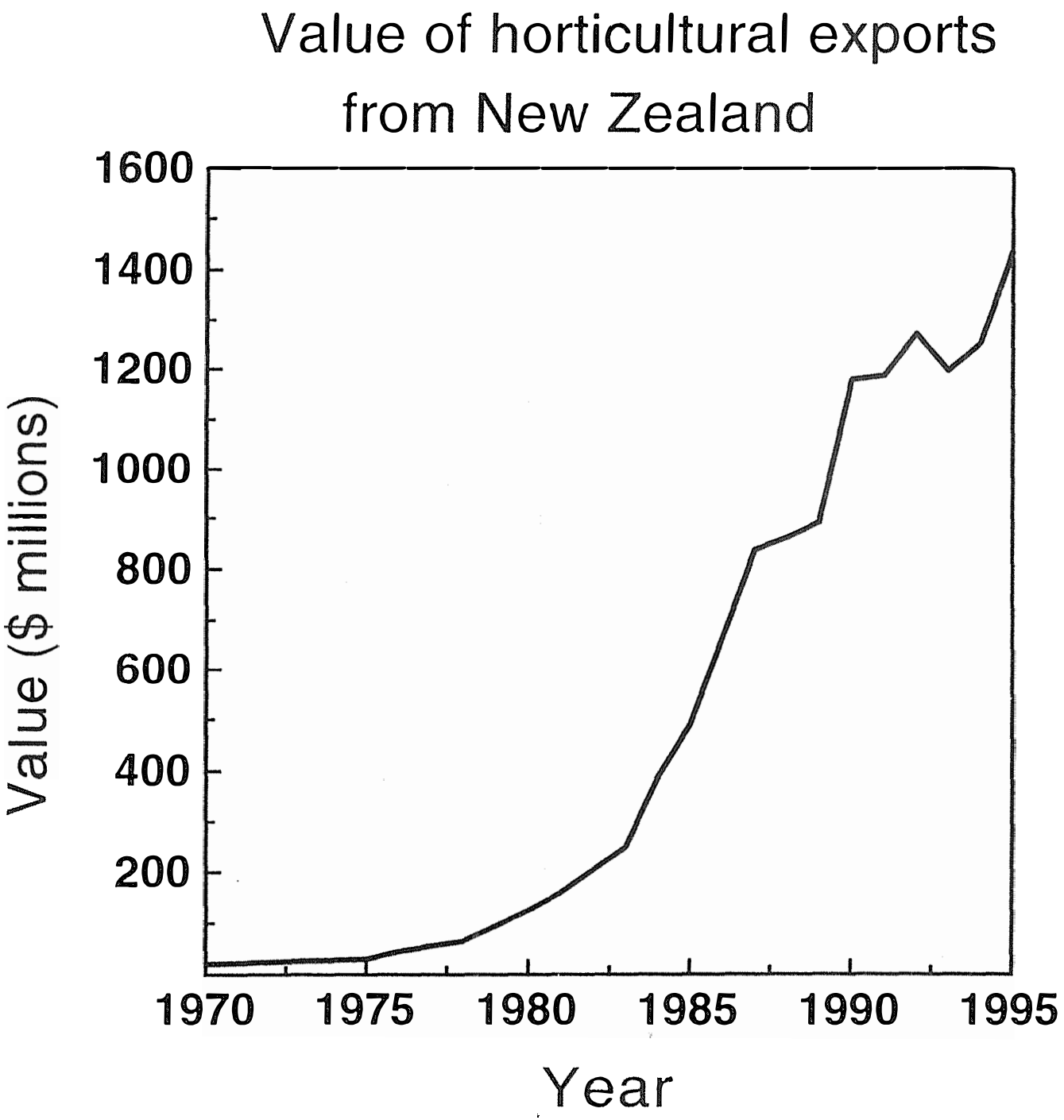
Pathological
* fungi, bacteria

OUTLINE

- NZ horticultural industry
- Why postharvest physiology?
- Factors affecting quality
  - preharvest
  - temperature
  - ethylene
  - gas atmosphere
- New opportunities

Horticultural exports from New Zealand 1995

	$million	%
Fresh fruit	869	60.5
Processed fruit	131	9.1
Fresh vegetables	194	13.5
Processed vegetables	151	10.5
Flowers/foliage	50	3.5
Seeds/plants	41	2.9
Total	$1.436 million	100%


Value of horticultural exports
from New Zealand
Value ($ millions)
1600
1400
1200
1000
800
600
400
200
1970
1975
1980
1985
1990
1995
Year

VALUE OF MAJOR HORTICULTURAL EXPORTS IN YEAR ENDING 30 JUNE, 1995

Crop type	Value($million)
Apples	482
Kiwifruit	321
Onions	93
Squash	58
Grape wines	42
Fruit and vegetable juice	35
Peas, frozen	34
Mixed vegetables, frozen	26
Sweetcorn, frozen	23
Jams	20
Tomatoes, processed	18
Sphagnum	17
Orchids	15
Potatoes, fresh	14
Potatoes, frozen	14
Apples, processed	13
Pears	12

QUALITY OF HORTICULTURAL PRODUCTS

Quality

- freedom from defects
- attractive appearance
  - colour
  - shape
- texture
  - crispness
  - juiciness
- consistency/uniformity in taste, flavour
- adequate shelf life
- freedom from chemical residues

The Challenge

To satisfy increasingly demanding consumer requirements, keeping ahead of international competitors

HORTICULTURAL PRODUCTS - LIVING ENTITIES

- harvest - catastrophic disruption
- water loss continues - transpiration
- metabolic activity continues - respiration
- deterioration of living tissue inevitable

  ripening → senescence → death

- postharvest physiology - understanding physiological and biochemical processes
- postharvest technology - procedures to slow rate of deterioration

DETERIORATION

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FACTORS AFFECTING DETERIORATION

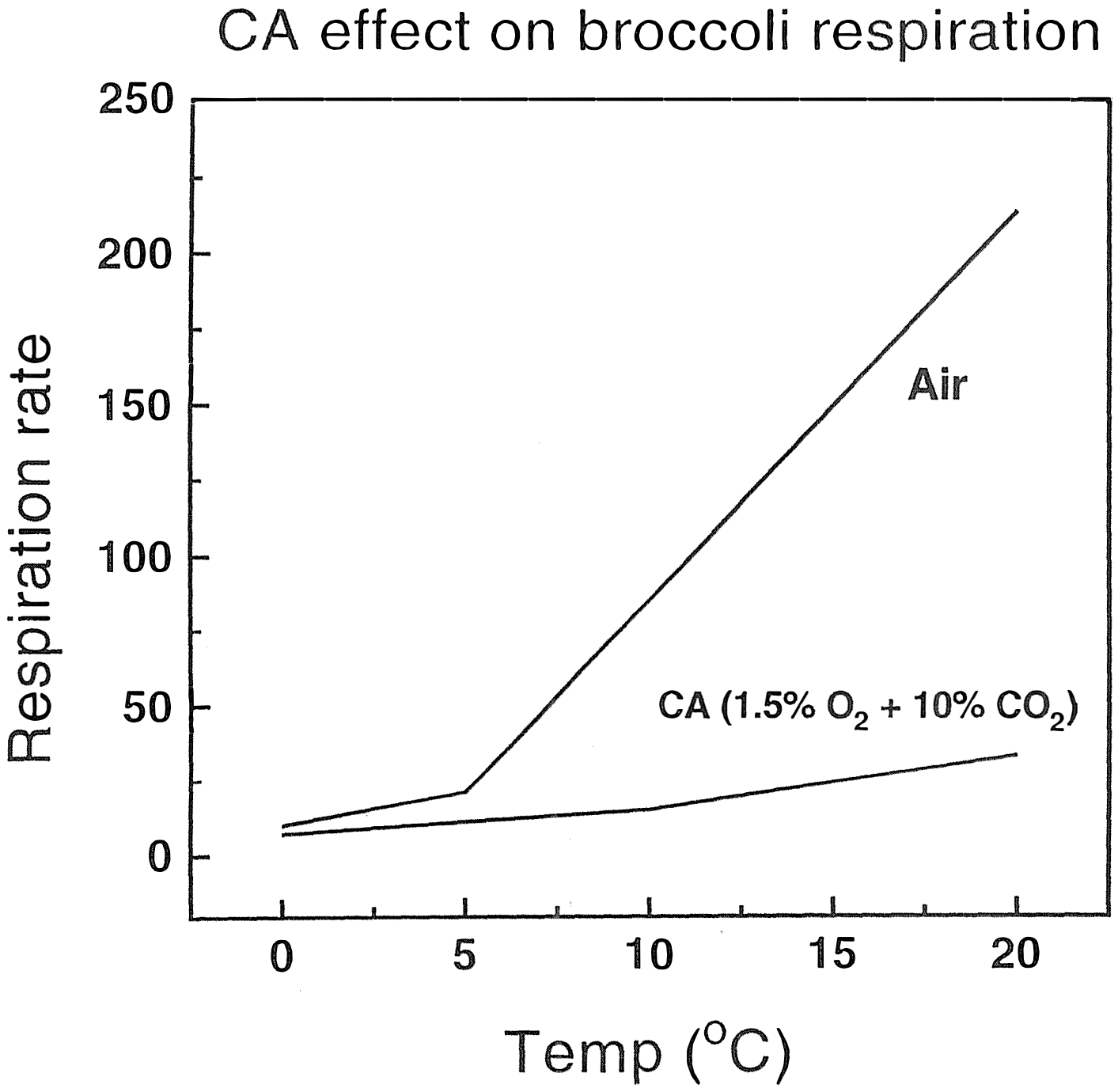
Respiration

$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + \text{heat}$

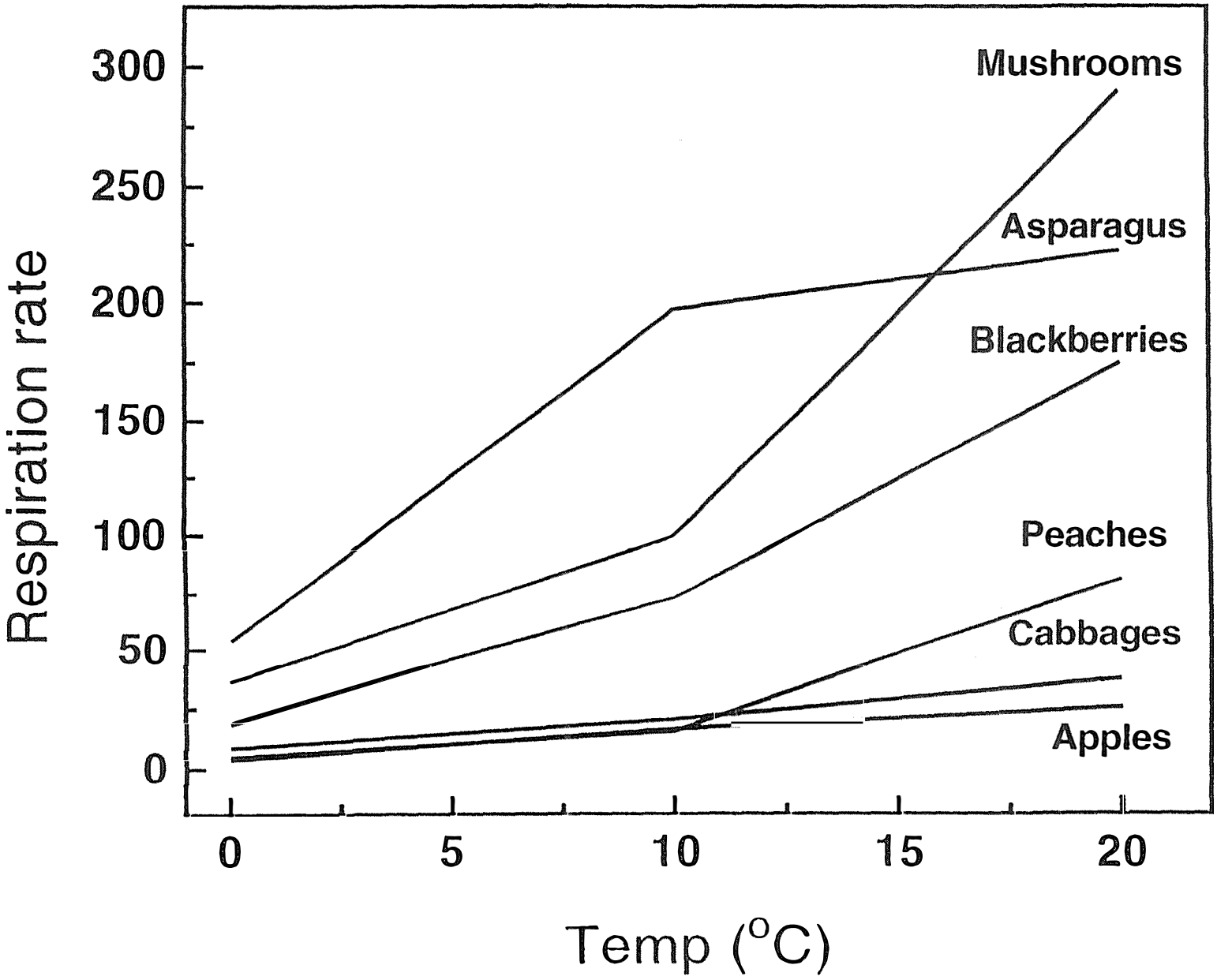
sugar oxygen carbon dioxide water

- respiration temperature dependent
- deterioration a function of respiration
- shelf life a feature of deterioration rate

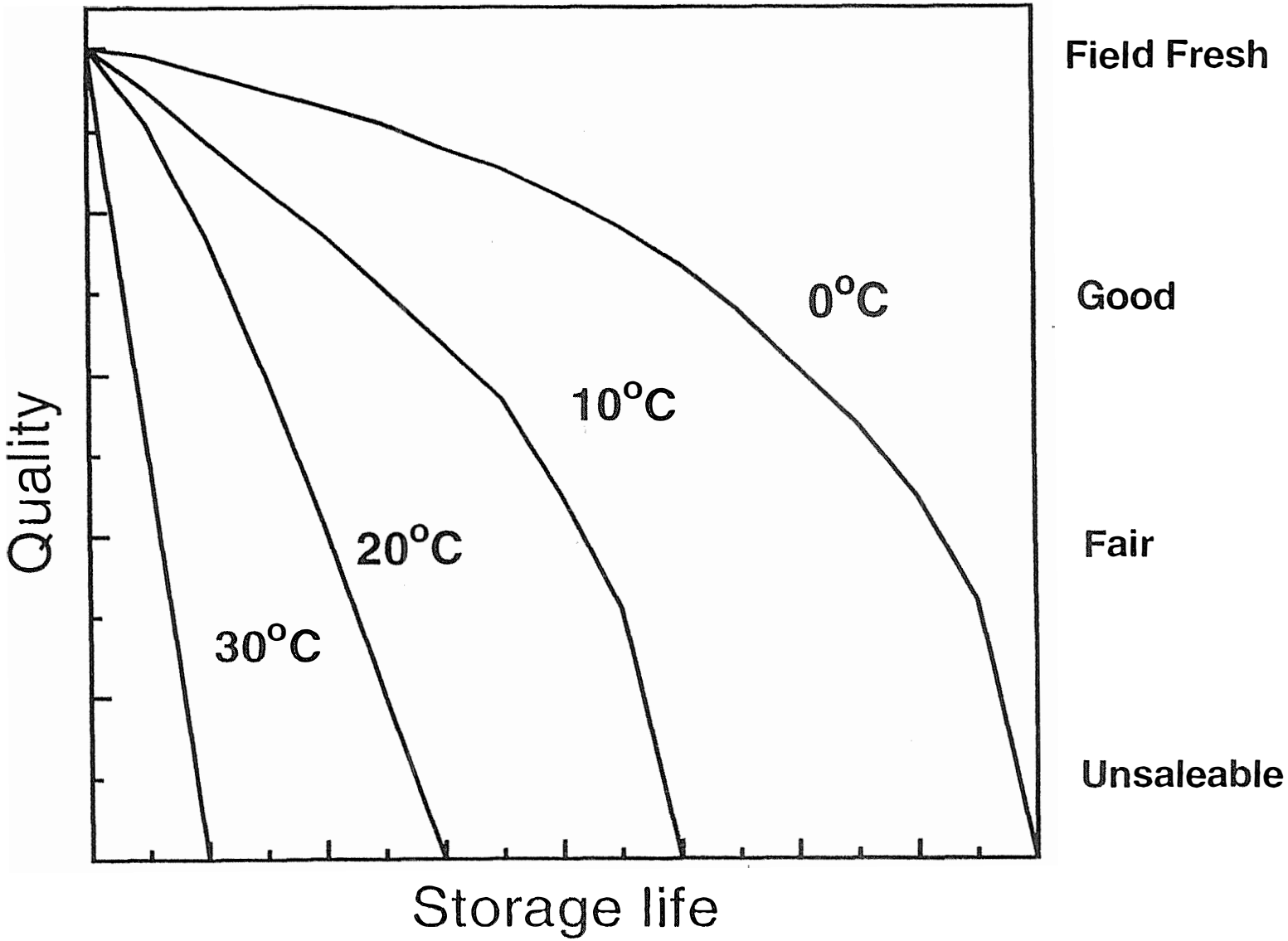
Hence rational for low temperature storage


CA effect on broccoli respiration
Respiration rate
250
200
150
100
50
0
Air
CA (1.5% O_2 + 10% CO_2)
0
5
10
15
20
Temp (°C)

Temperature effect on respiration rate



Temperature effects on quality and storage life



TEMPERATURE EFFECTS

Low temperatures in coolchain

- reduce respiration
- reduce water loss
- reduce nutritional loss
- reduce decay organisms

Freezing * -0.7 to -2.0°C
* cell breakdown, death, decay

Heat - above 35°C
- metabolic disruption, HSP
- delayed/uneven ripening

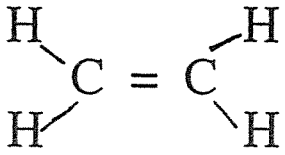
Chilling - 4 to 10°C
- chilling injury, decay, death

CHILLING INJURY

- Serious problem for tropical and subtropical but also temperate crops
- critical temperature above freezing
- time/temperature dependent
- symptons
  - varied
  - spotting
  - surface pitting
  - external and internal browning
  - mealiness or woolliness
  - water soaking
  - decay
  - death

ETHYLENE IN POSTHARVEST

Simple naturally occurring gaseous hormone



Sources include

- ripening fruit
- decaying vegetation
- internal combustion engines
- aircraft exhausts
- cigarette smoke
- ballast from fluorescent lights

ETHYLENE - GOOD AND BAD NEWS

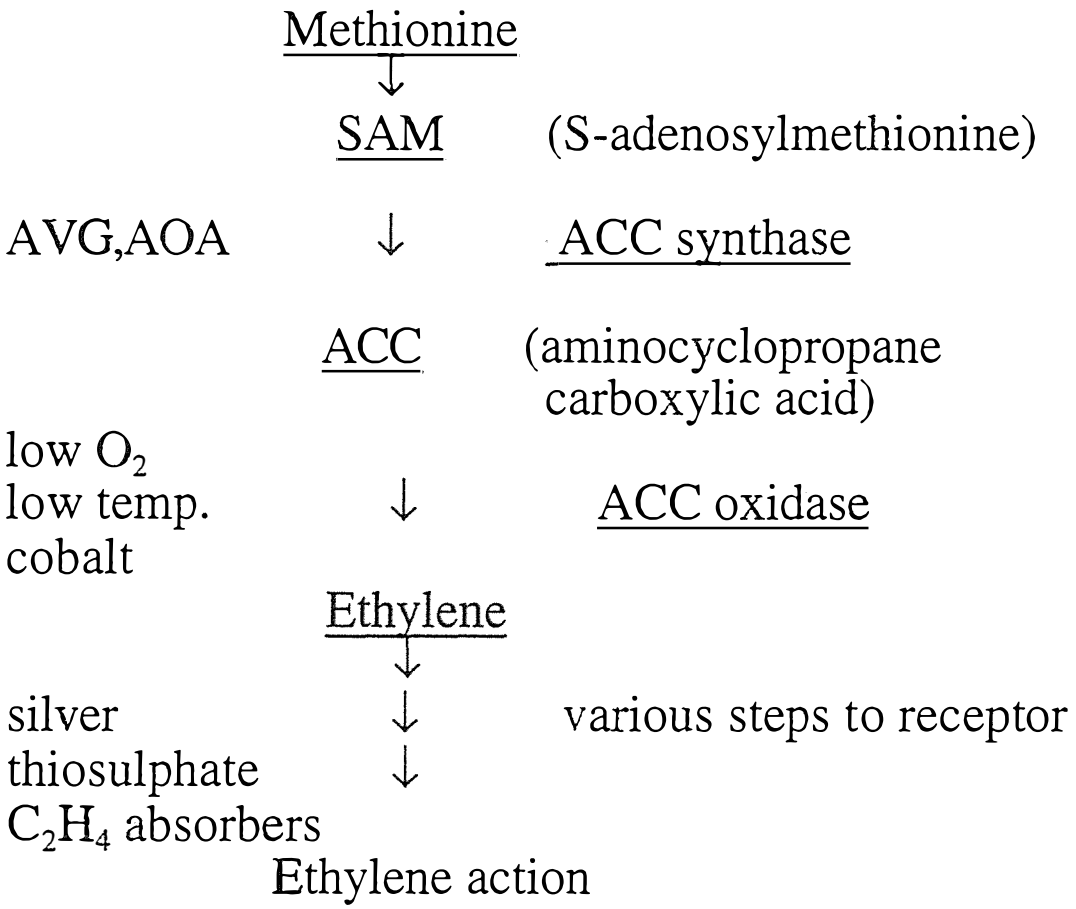
Benefits of ethylene

- essential for normal ripening
- induces abscission, colour changes, softening, flavour development
- promotes uniform ripening
- widespread use for bananas, tomatoes and kiwifruit

Problems with ethylene

- accelerated ripening and senescence even at low temperatures
- loss of green colour
- increased softening
- some disorder induction

ETHYLENE BIOSYNTHESIS



CONTROLLED/MODIFIED ATMOSPHERE STORAGE

$C_6H_{12}O_6 + 6O_2 \rightarrow 6\,CO_2 + 6\,H_2O + \text{heat}$

- decreased O_2 } increased CO_2 } → reduced respiration and ethylene
- increased use in New Zealand
- supplements temperature management
- reduces ripening rate
- reduces some chilling injury, rots
- tool for insect control
- minimally processed foods

POSTHARVEST PATHOLOGY

- few pathogens cause large losses
  - Botrytis, Alternaria, Colletotrichum
- reduce sources of inoculum
  - hygiene
  - optimise plant health
- minimise handling damage
- cool rapidly to optimum product temperature
  - avoid chilling injury
- postharvest chemicals?
  - generally to be avoided

NEW OPPORTUNITIES

- transportable CA storage systems
  - computer controlled modulated storage regimes manipulated en route
  - intermittent shock treatments
- active packaging and/or skin coatings to optimise internal atmospheres
- non-destructive quality assessment
- genetic manipulation
  - long life naturally occurring mutants
  - transgenic plants; Flavr Savr®
  - eco-foods; functional foods
  - antisense technology for
    - polygalacturonase
    - ACC synthase, ACC oxidase

CONCLUSIONS

Postharvest physiologists

- elucidated causes of many physiological disorders and recommended treatments e.g. calcium and bitter pit
- unravelled ethylene biosynthetic pathway and cell wall structure
- characterised temperature and ethylene responses
- developed recommendations for optimal postharvest technologies
- working closely with industry to optimise quality of NZ products internationally