Protected Agriculture in Mild Climate

COST TRAINING SCHOLE

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Israel Plant Board

My delivery….

- Greenhouse Structure:
  - General aspects of the industry
  - Milestones in protected agriculture
  - Controlled and passive GH - The differences between the ”North” and ” South ”
  - Optimal plant environment
  - Different structures – Greenhouses, Tunnels and Net houses
  - Matching technologies to crops and economical needs
  - Climate Control
  - Other considerations for GH project
- Covering materials

Greenhouse crops

- Cultivation in greenhouse allows for production of quality products throughout all year round with efficient use of inputs (water, fertilizers, pesticides, energy and labor).
- In many areas, especially in the Mediterranean, greenhouse products are produced at low cost even in a very simple greenhouses.

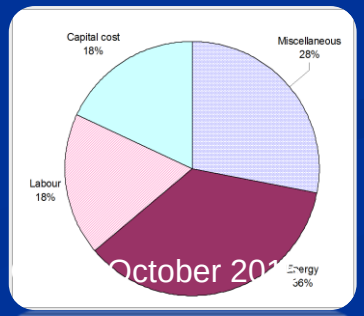
Our approach…

- Adopting the plant to the existing environment conditions (not necessarily the optimal by using the most **economical** technologies) versus optimizing the microclimate environment/conditions to the plants needs.

- For this approach, the importance of the biological material, agro technics and production skills are playing a significant role.

The aims & directions for the Israeli Protected Cultivation (1)

- **NO OR MINIMUM ENERGY INPUT.**
  - Adjusting the plant/crop/production to the existing conditions (versus adjusting the conditions to the plant needs-North countries approach with highly advance greenhouses technologies)
  - To find ways which meet both needs: improving energy efficiency combined with an absolute reduction of the energy consumption in year around production
  - During fall/winter to maximize the radiation quantity and minimize the energy loss
  - During the spring/summer to reduce high temperatures/radiation (in minimum cost)



The aims & directions for the Israeli Protected Cultivation (2)

- Supplying year around high quality produce
- Exporting vegetables/fruit/flowers to the top market niche.
- Minimalizing the investment and production cost.
- Adopting different technologies for different seasons.
- Water saving.
- Minimizing the use of chemical.
- Meeting international, environmental and production standards (GAP, BRC, ISO).

Milestones in the greenhouse Industry:

- Started intensively in the 70's
- Roof opening GH – helped increasing GH units size (mid 80's)
- Development of insects proof nets and net houses (end of the 80's)
- In the mid 80's, 60% of the GH industry were flowers, in the last years 75% are vegetables
- Thermic films with advance characteristics (+ AD, AF, UVA…) (early 80's) = now days 100% are thermic films
- Exporting agricultural produce to Europe and other international markets and local market demands
- Bees as pollinators (80's)
- Water shortage – allocating the water for agriculture drooped by 50% in the last 10 years

Climate diversity in Israel

Mediterranean Climate

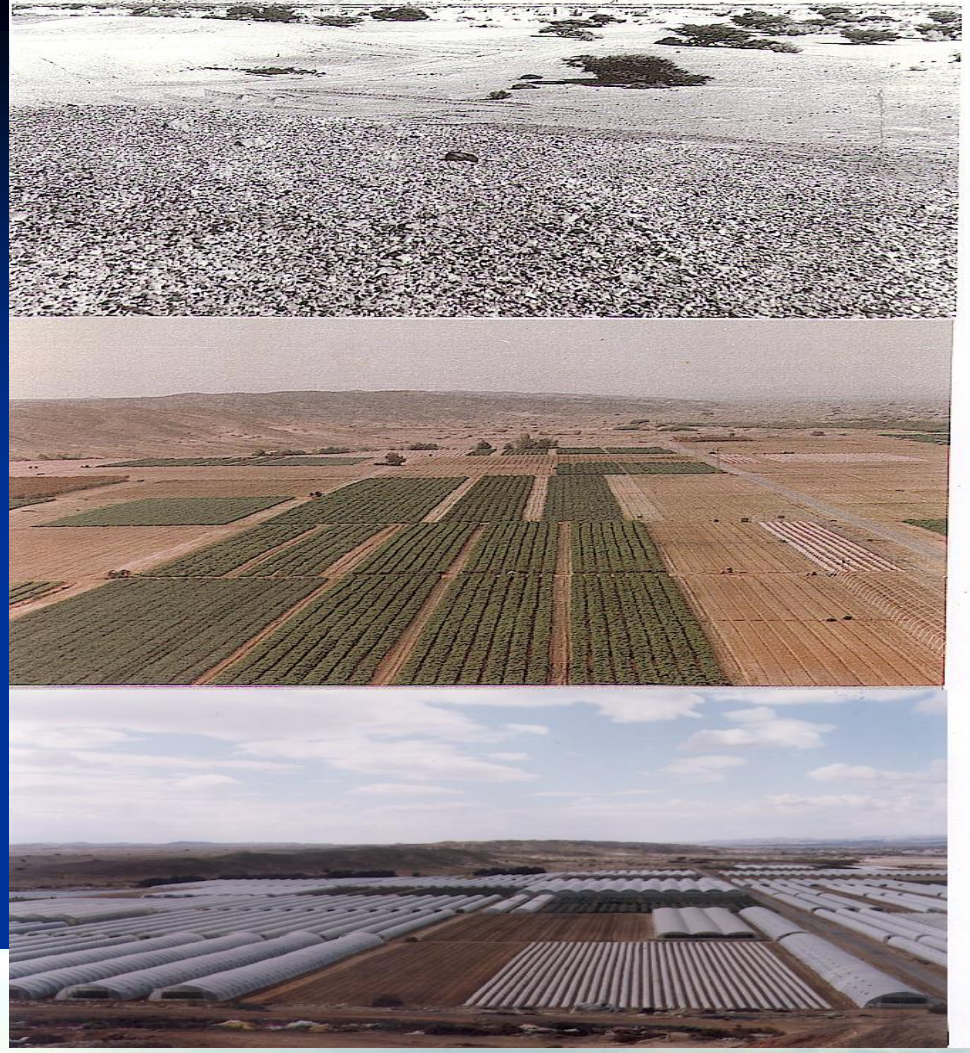
Sub tropical Climate

Semi-Arid Climate

Desert Climate

No summer rain

Milestones in the Israeli protected agriculture in the desert area



Arava Valley, Israel

Arava Valley – Along the Syrian-African rift valley

Thanks to Dr. I. Elad

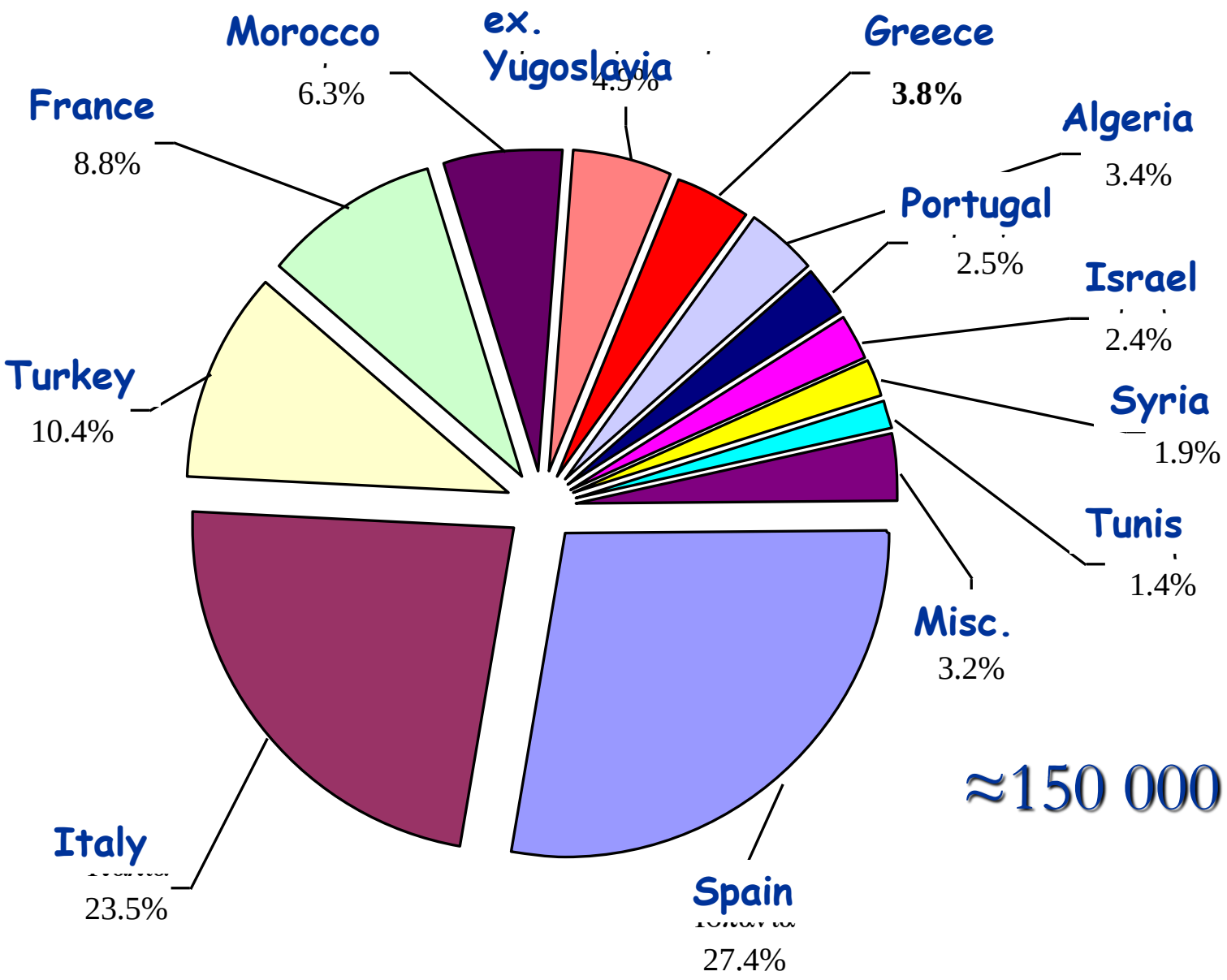
Moshav Ahituv, Israel

Almeria Spain

Ierapetra Crete

Sicily

Greenhouses in the Mediterranean



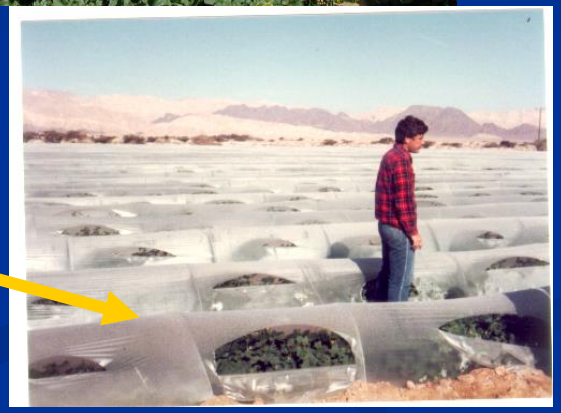
≈150 000 ha

In mild Climate it is Easy (relatively) to Grow but Hard to Protected (from diseases and Insects)

Melon: Growing Methods

Open field

Low tunnels



Walk-in tunnels

Trellising

Spread

High walk-in tunnels

Melons trellised with string

Central Arava Valley

Technology of pepper growing


Net House Pepper
70% of the pepper fields in the Arava are double-net, net houses

Walk-in Tunnel Pepper in the Arava - 15%


Arava:
1% only, of the pepper area
is climate controlled

Fresh Herbs









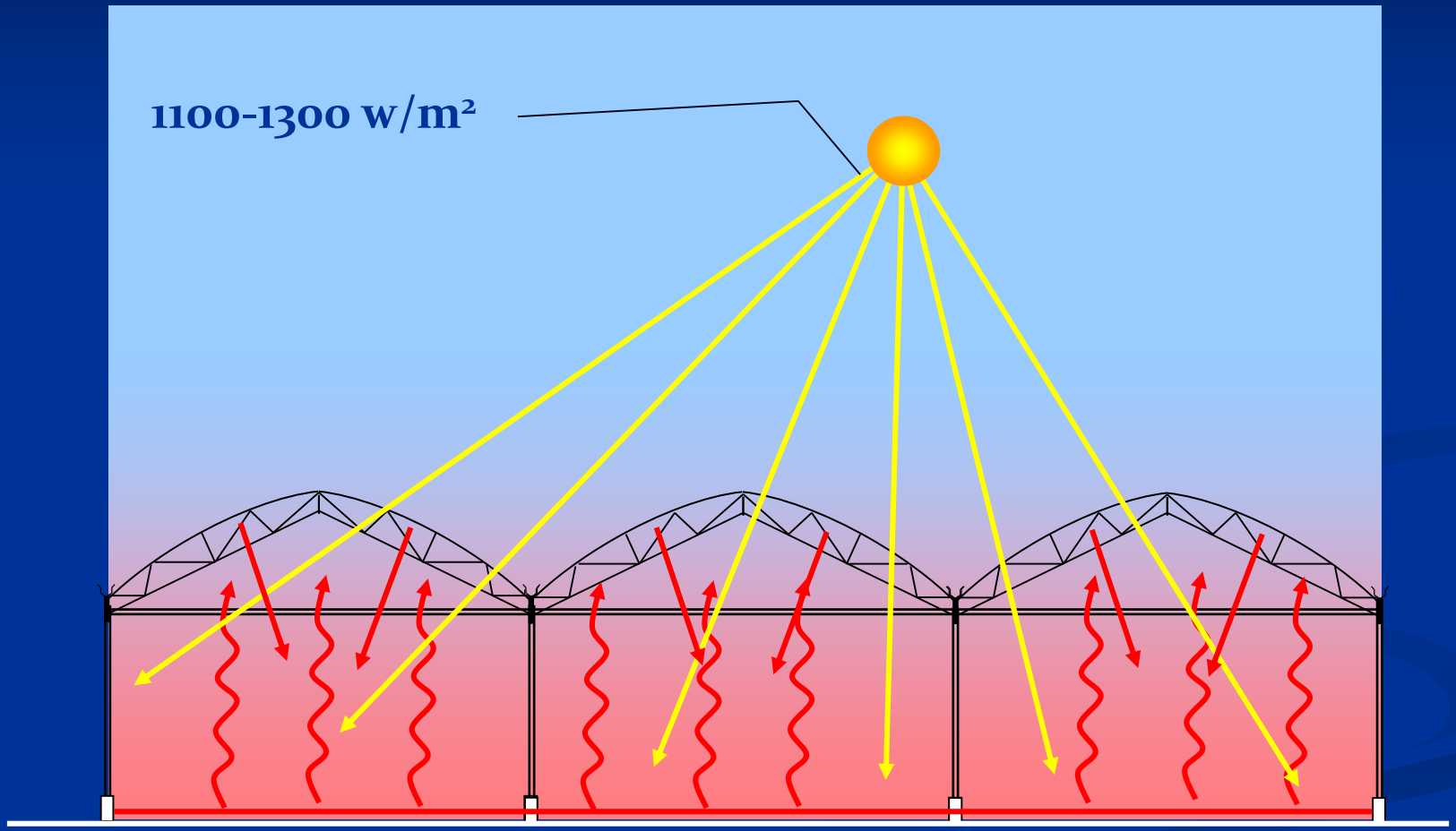
חממה, תנור ומסך טרמי חורף:

חממה, רשת צל קיץ:

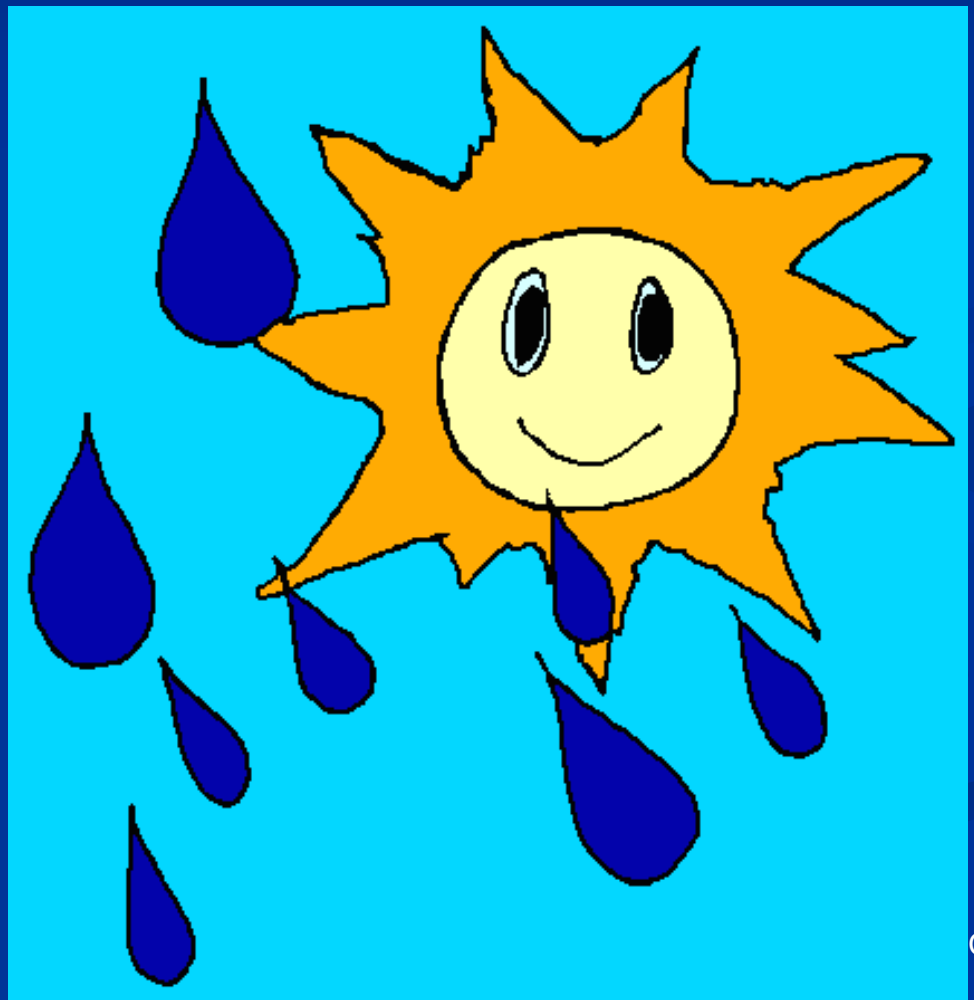
Adopting different technologies to different regions, crops, seasons, needs, markets and economical constrains

Protected Agriculture Technologies

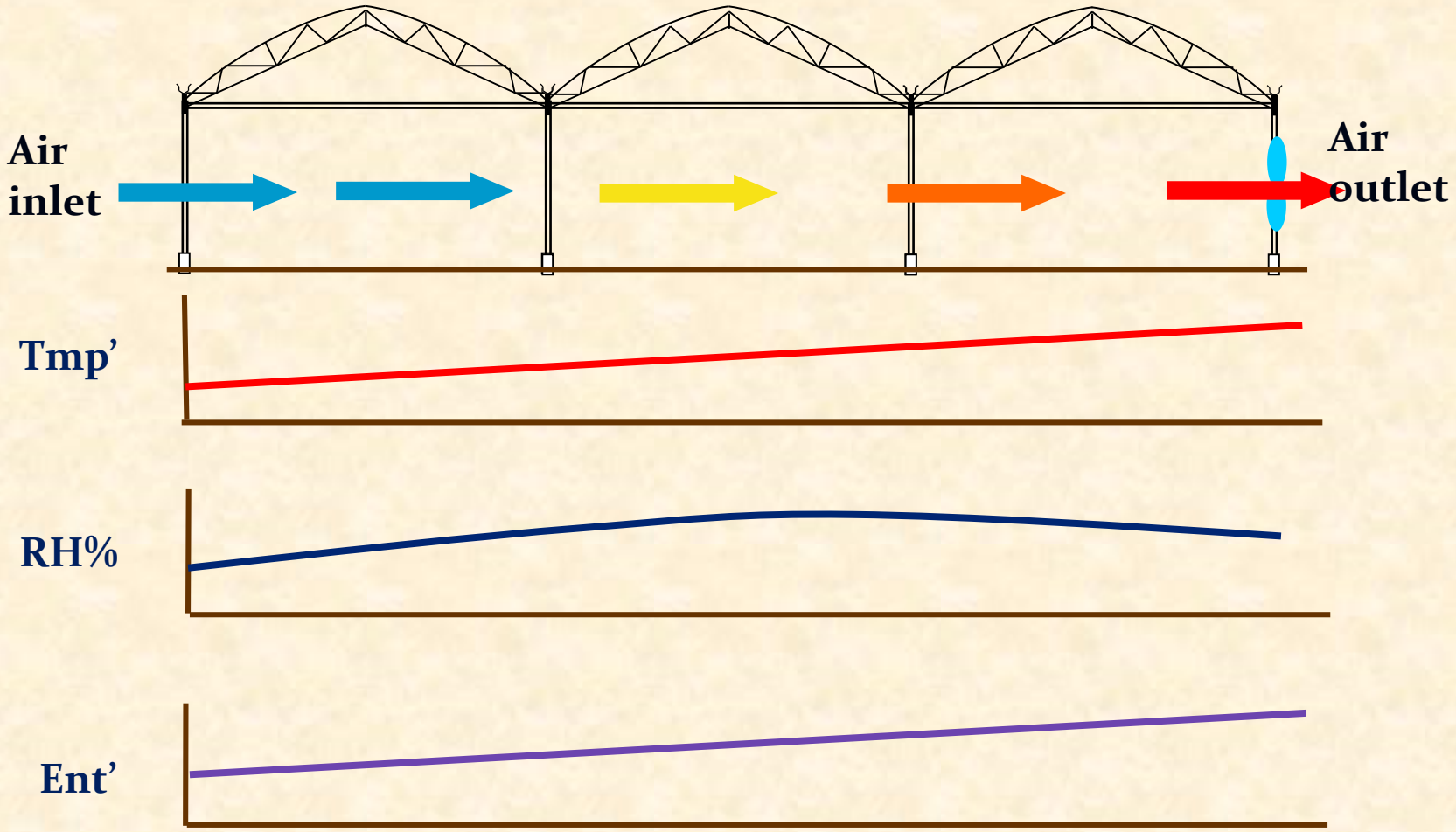
Greenhouse Effect



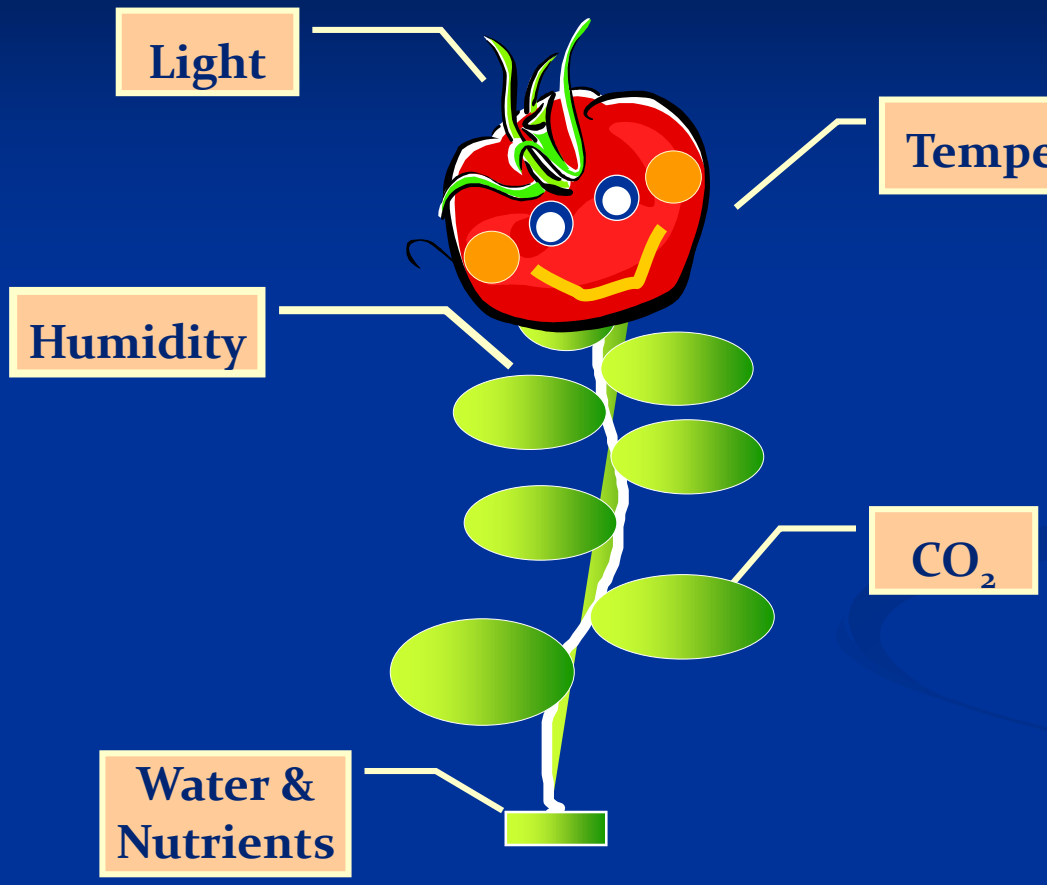
The main problem is the humidity not the heat



The behavior of Temp. RH and enthalpy in the GH

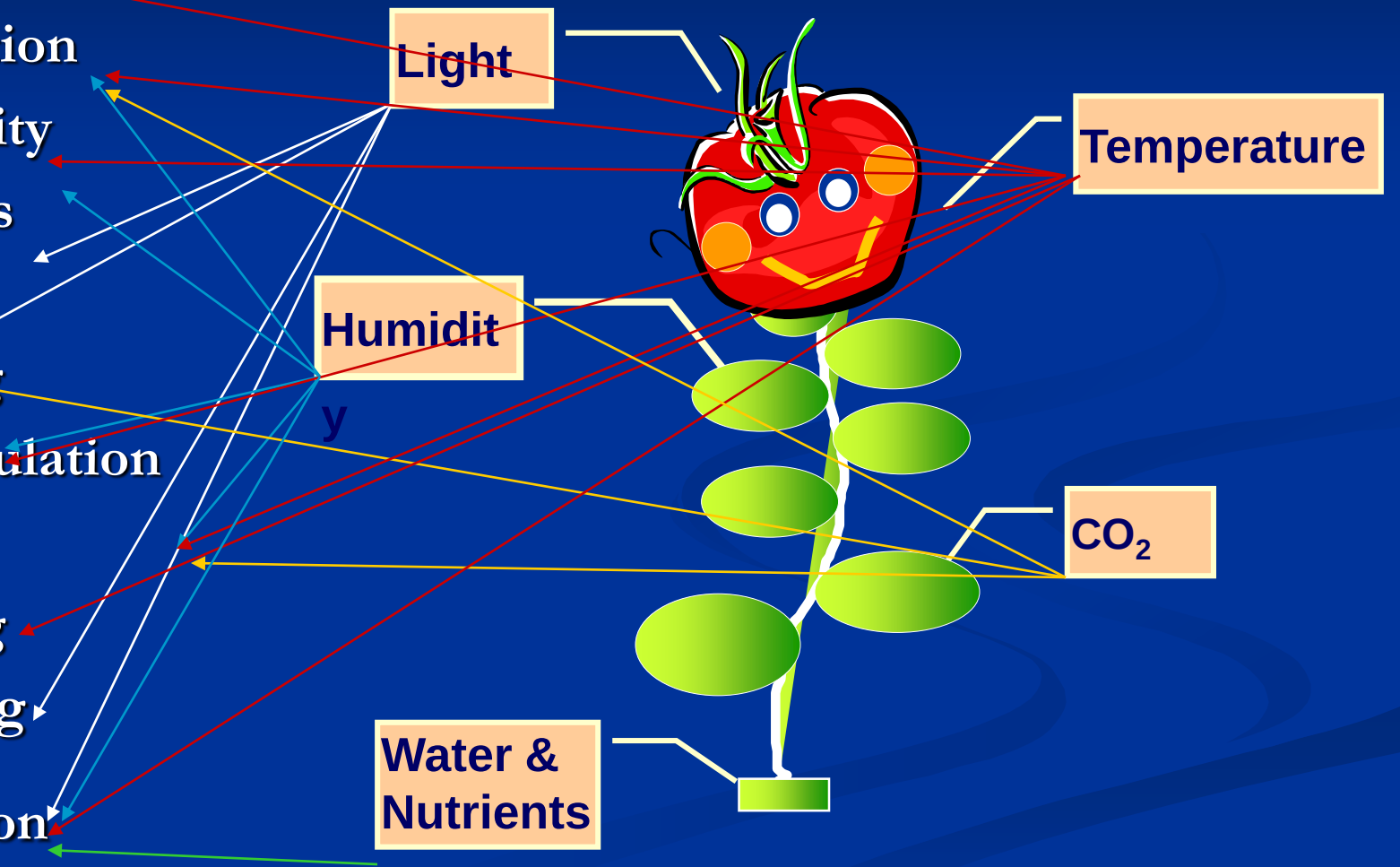


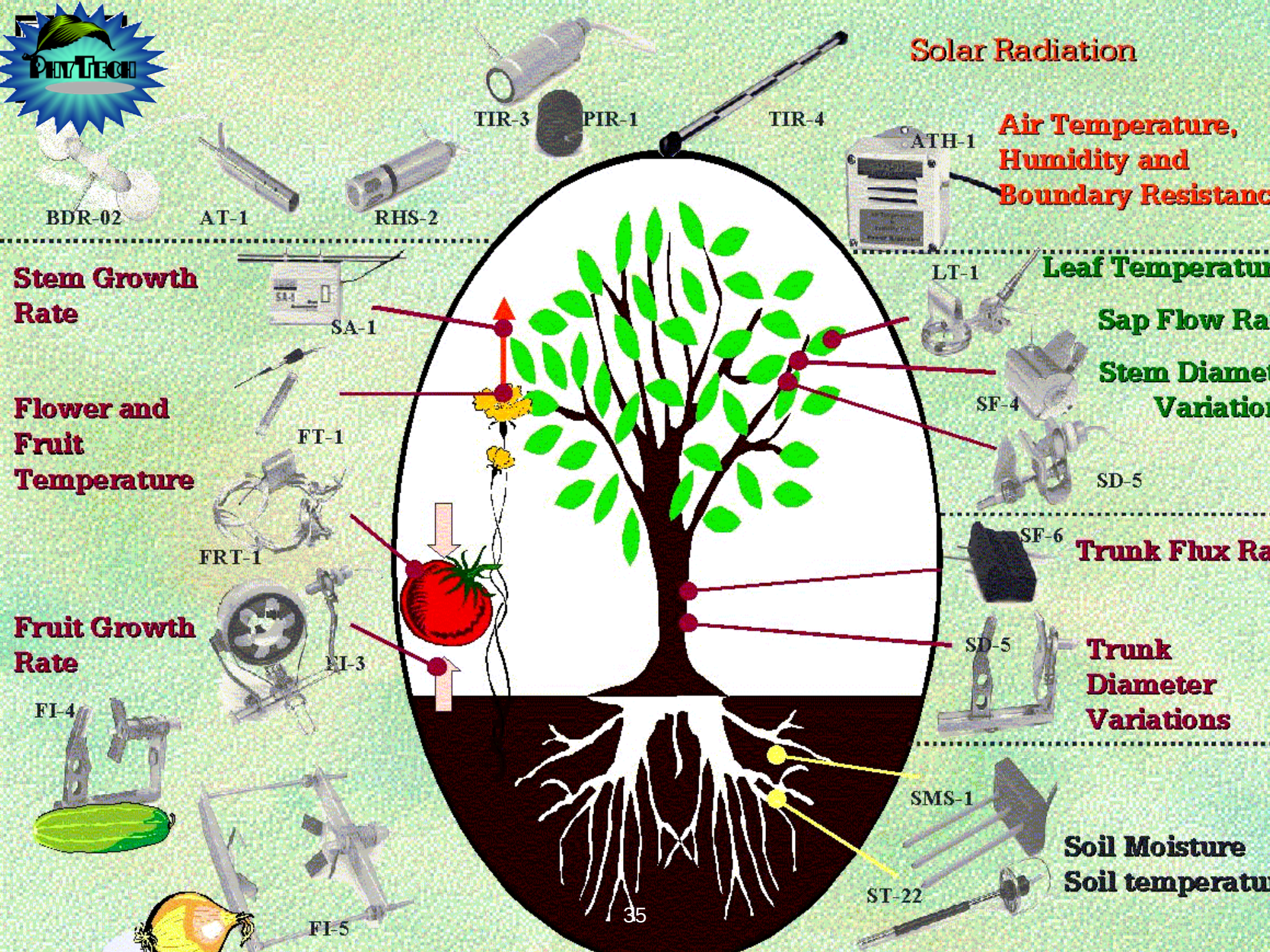
Optimal Plant Environment



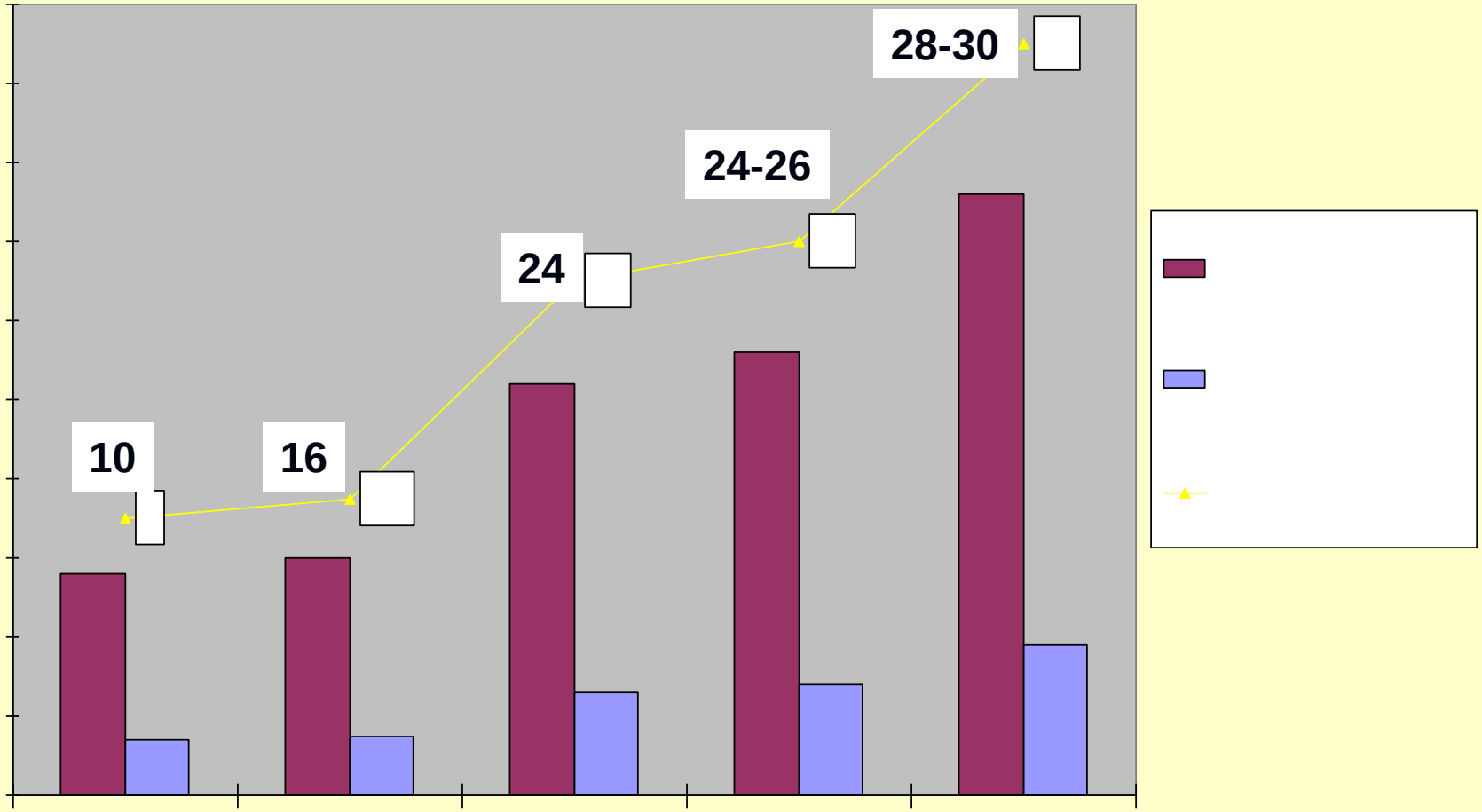
Plant-Environment & Sub-Systems

- Heating
- Ventilation
- Humidity
- Screens
- CO_2
- Misting
- Air circulation
- Cooling
- Lighting
- Irrigation




Solar Radiation
TIR-3
PIR-1
TIR-4
ATH-1
Air Temperature, Humidity and Boundary Resistanc
BDR-02
AT-1
RHS-2
Stem Growth Rate
SA-1
LT-1
Leaf Temperatu
Sap Flow Ra
Stem Diamet Variatio
SF-4
Flower and Fruit Temperature
FT-1
SD-5
SF-6
FRT-1
Trunk Flux Ra
Fruit Growth Rate
FI-3
SD-5
Trunk Diameter Variations
FI-4
SMS-1
Soil Moisture
Soil temperatu
ST-22
FI-5

Pepper production under different Technologies



CRITERIA FOR GREENHOUSES DESIGN

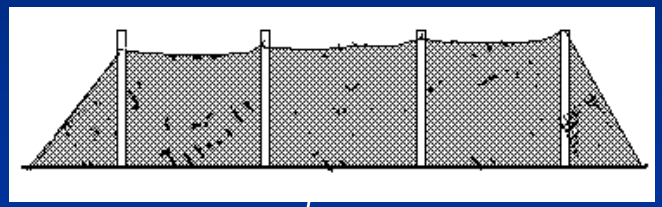
- **GREENHOUSE RADIATION CONTROL** :
  - DESIGN OF THE STRUCTURE
    - Geometry
    - Orientation
    - Equipment
    - Cultural practices
  - COVERING MATERIAL
    - Transmissivity
    - Absorption
    - Reflection

Protected agriculture

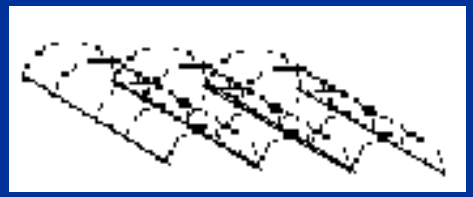
Tunnels

Net House

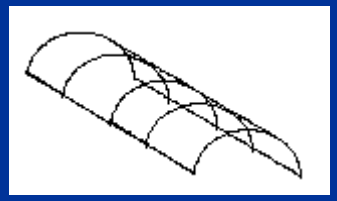
Greenhouses

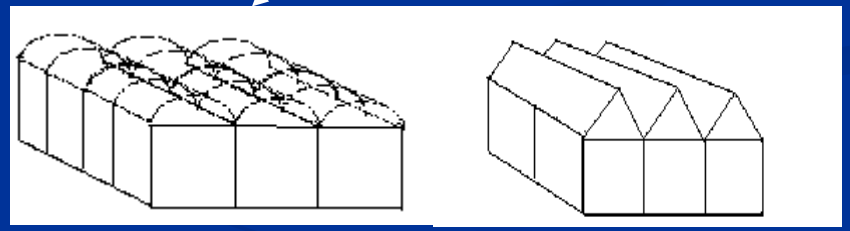


Law Tunnels



Walk-In Tunnels





Cover - Plastic

Covers Plastic or Net

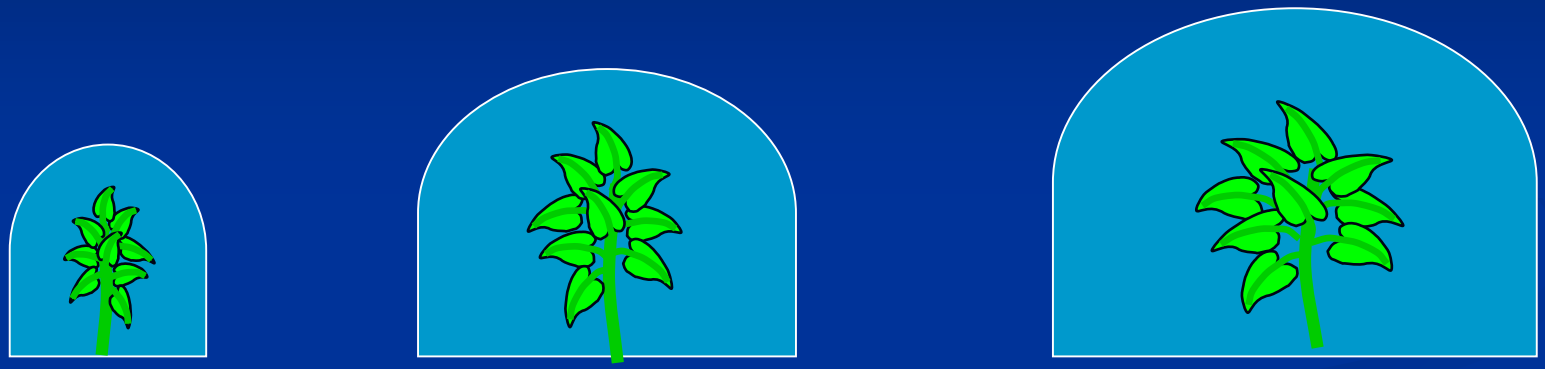
Covers: Shade net or insect proof net

Covers: Plastic Or net

Covers: Glass, Polycarbonate

LOW TUNNELS

Type of Tunnels- Low Tunnels



1.2 m’

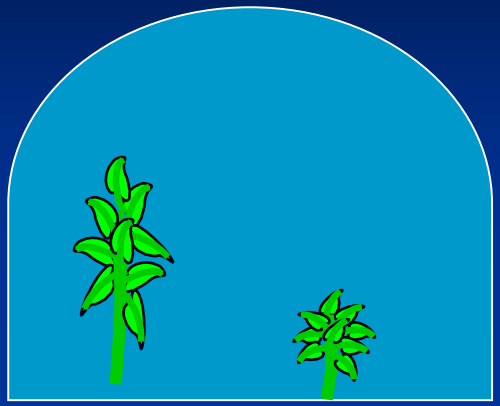
1.6 m’

2.4 m’

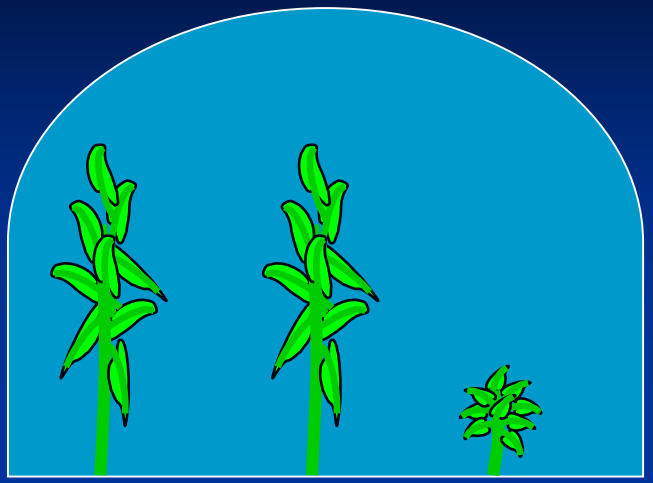
Early planting

Types of Walk-in Tunnels

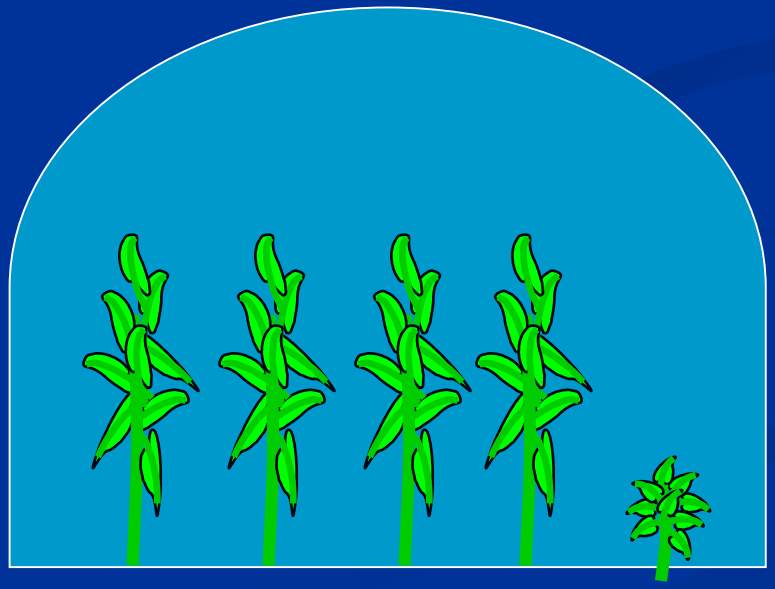
Type of Walk-in Tunnels



½’ – 4 m’



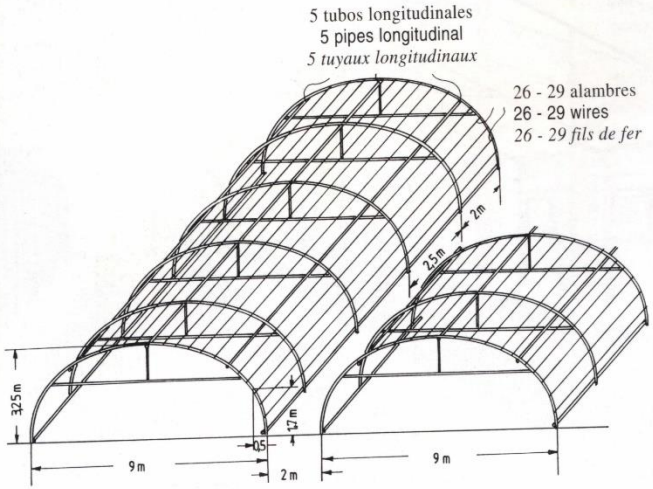
1- 1.5’ 6 m’



2-3’ 8-10m’

Walk-in Tunnels

Figura 3: Invernadero de túnel con cubierta redondeada.
Figure 3: Round arched, single span tunnel greenhouse.
Figure 3: Tunnel simple arrondi.



10 Meter

6 Meter

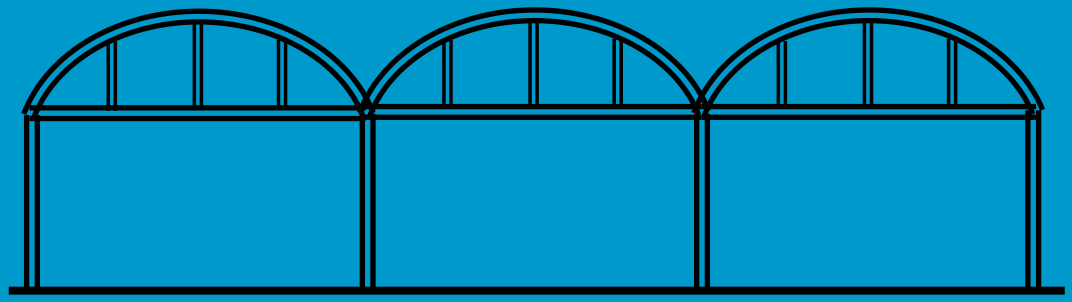

4.8 Meter


10 Meter

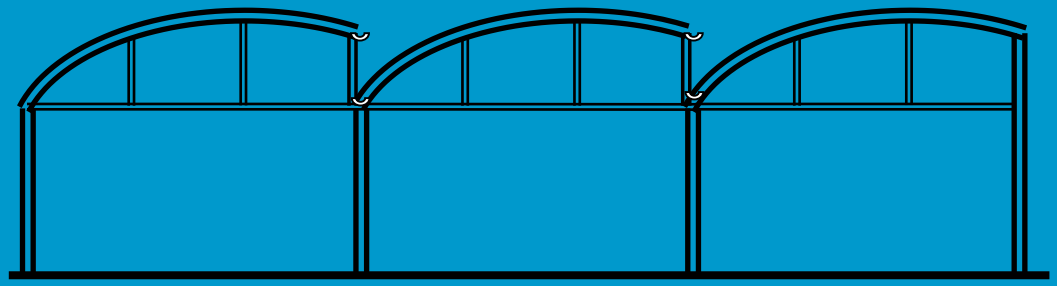
Structures evolution (Israel)

Standardization

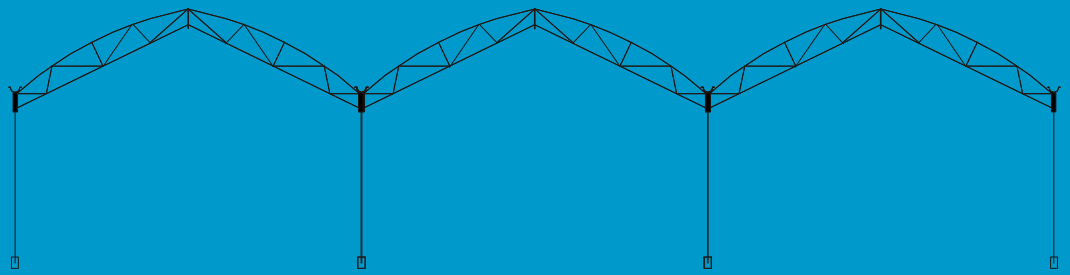
Arch Type



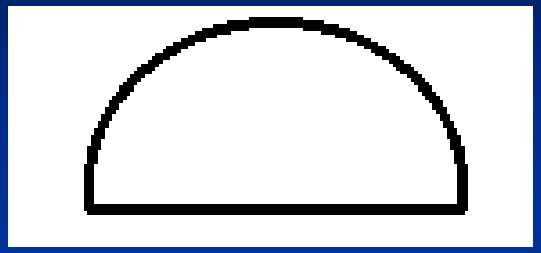
Saw-Tooth

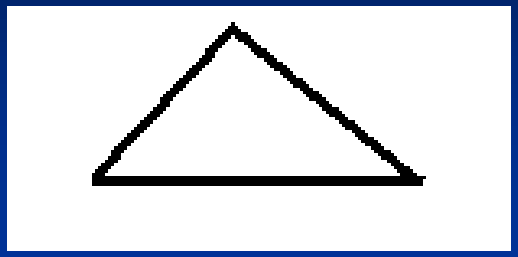


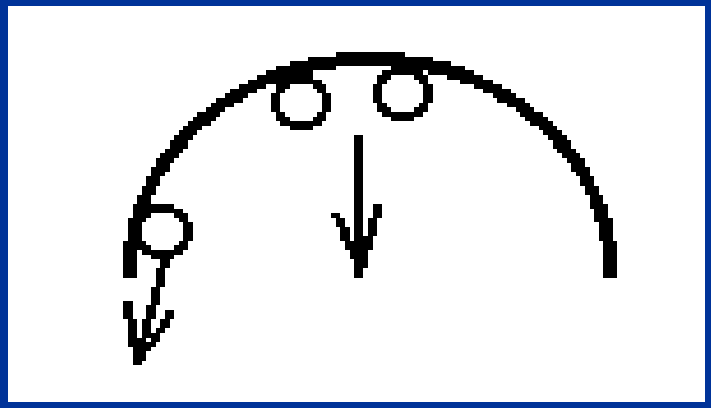
Gothic Type



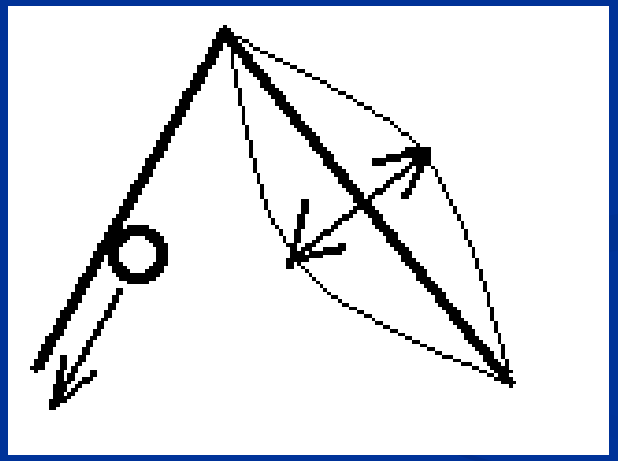
The effects of the plastic cover on the roof type





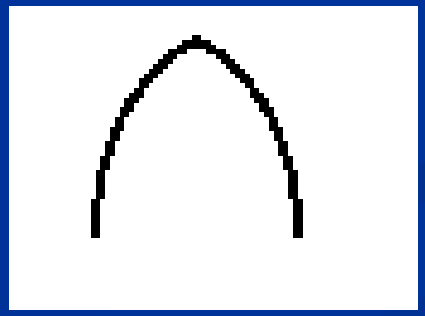


Water condense



“flapping”

Gothic






Net Houses

TYLCV

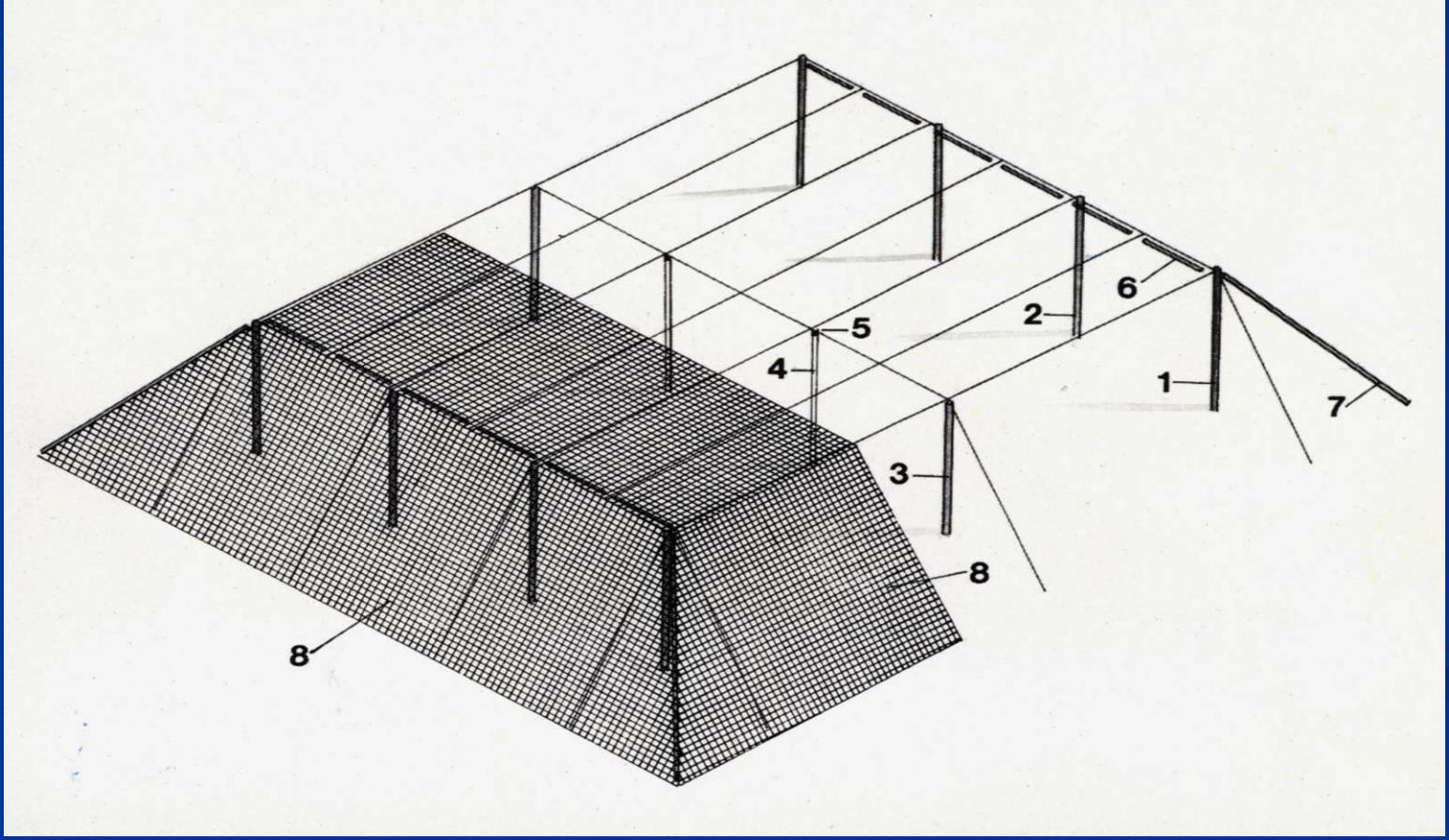
Bemisia tabaci


בית רשת
עמית

Net Houses

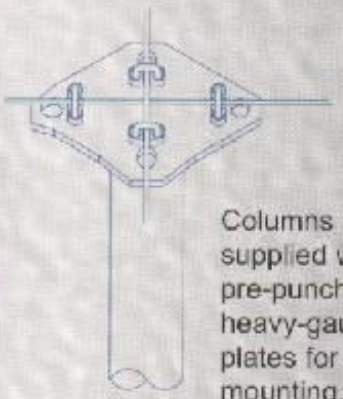

92 6 14

Flat Roof Net House

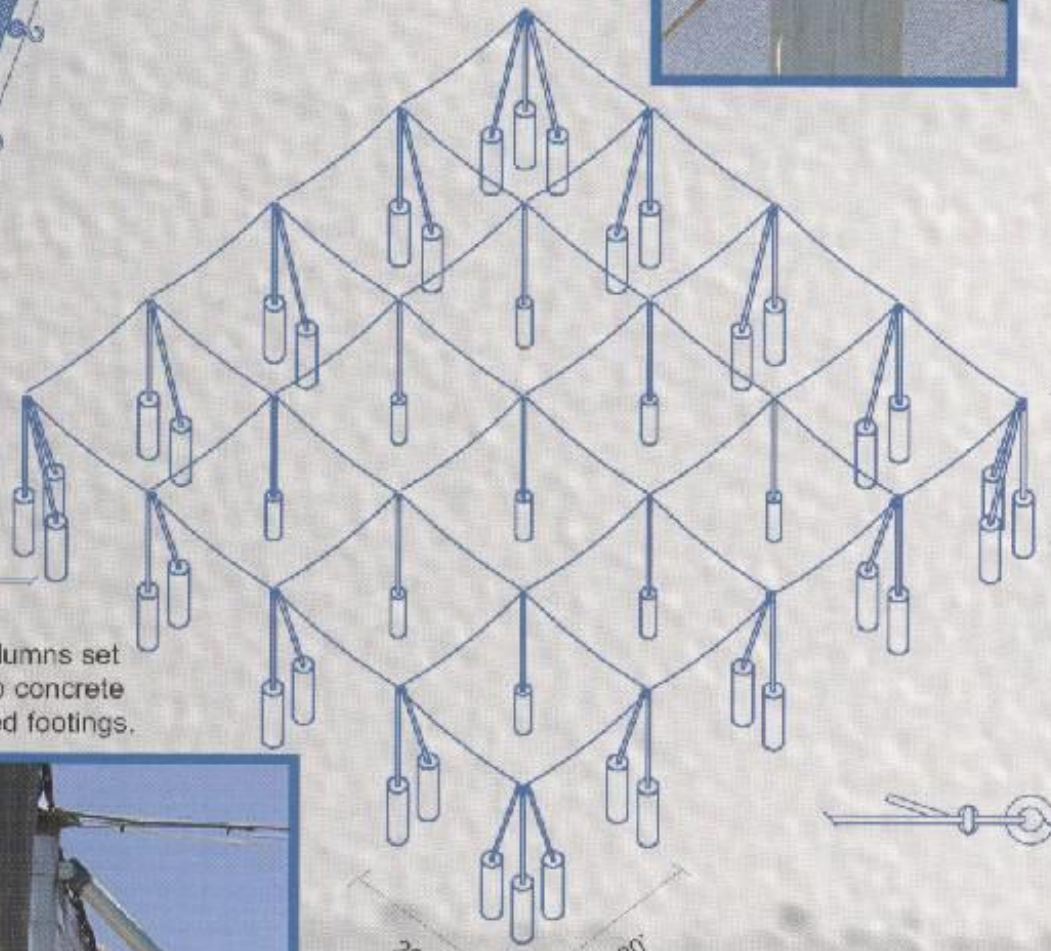


CABLE FRAME FIXED ROOF

Grommeted shade fabric is secured to cable with metal hooks, cable ties or fabric clips.

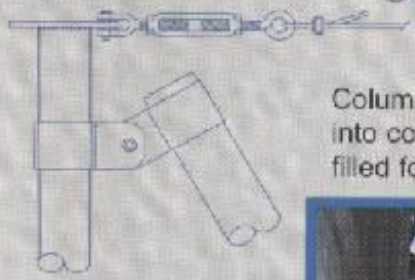


Columns are supplied with pre-punched heavy-gauged plates for cable mounting.

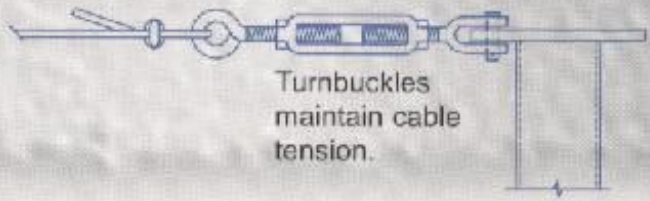


8' - 10' - 12' - 14' - 16'

Knee braces create structural wind bracing.



Columns set into concrete filled footings.



Turnbuckles maintain cable tension.

Design Structure factors(1):

- Climate
- Location
- Mapping the Area
- Plot Size (+50-100%)
- Directions
- Span
- Crop type
- Eaves height
- Roof slopes
- Frame Span
- Labors

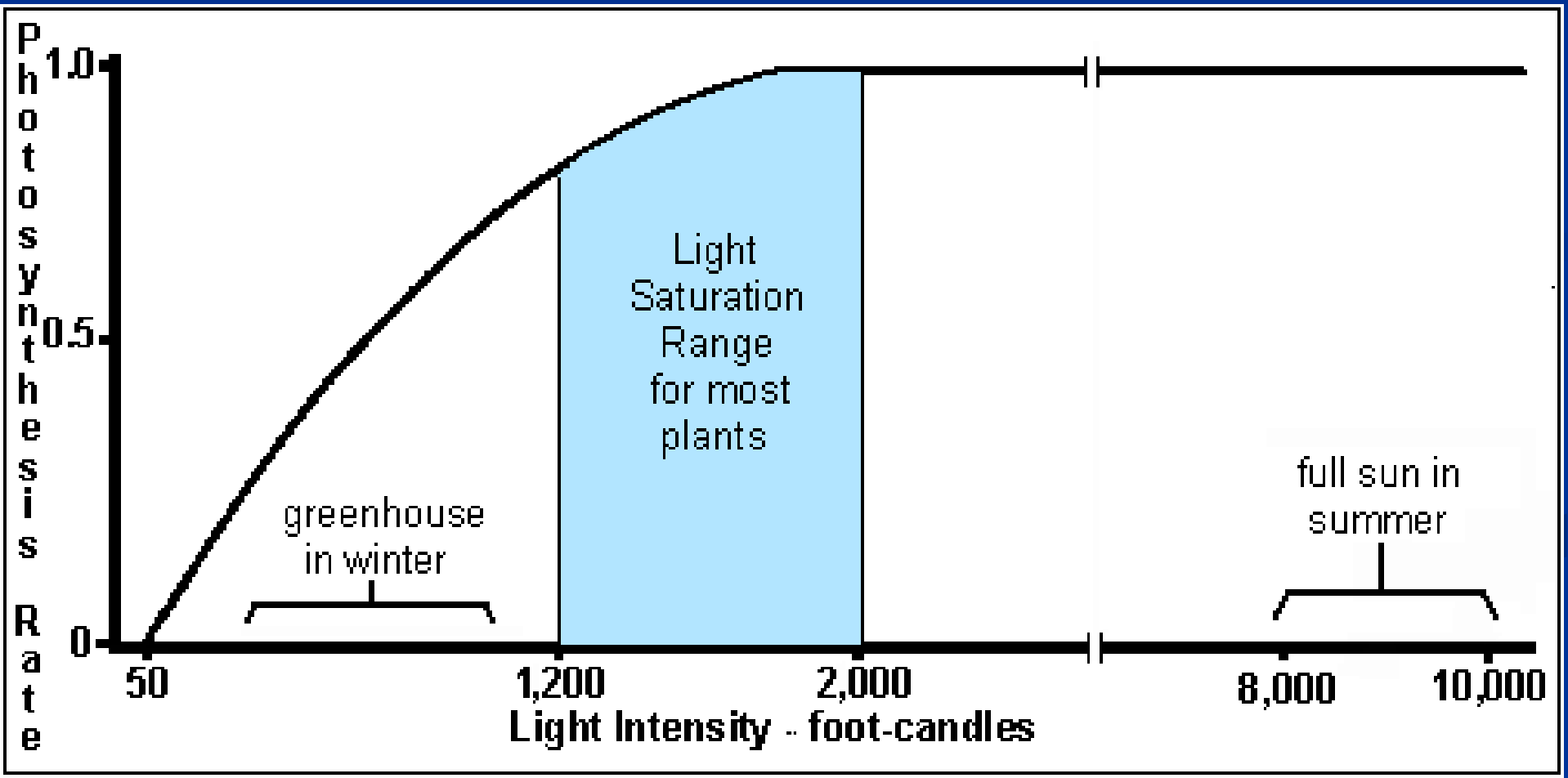
Climate determined by:

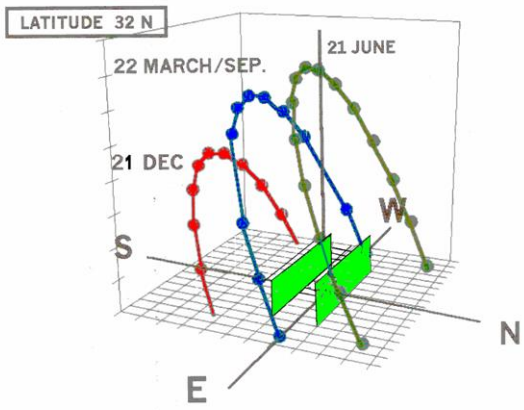
- Latitude (solar radiation)
- Altitude
- Weather maritime or continental
- Local topography

Design Structure factors(1):

- Climate
- Location - The greenhouse should be located where it gets maximum sunlight

EFFECT OF LIGHT INTENSITY AND CO2 ON PHOTOSYNTHESIS

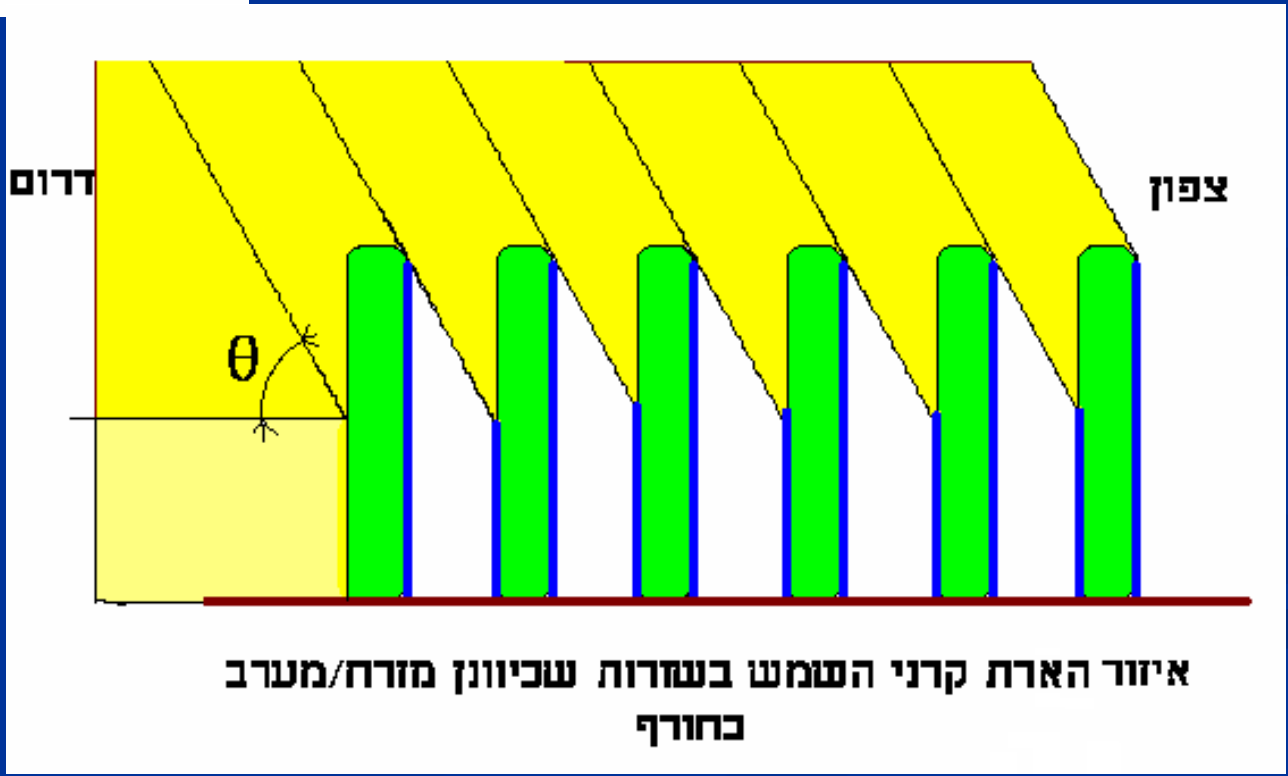


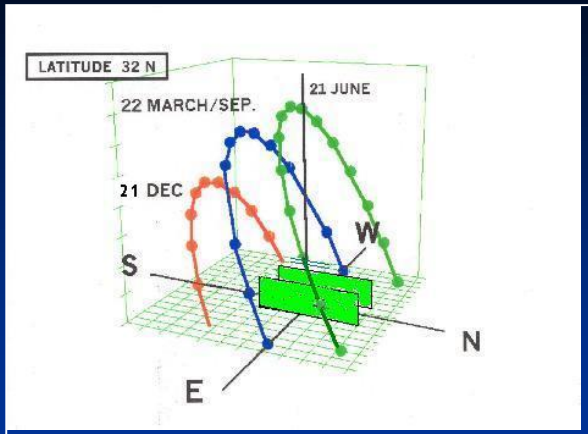


Sun radiation in trellising crops

Rows E-W

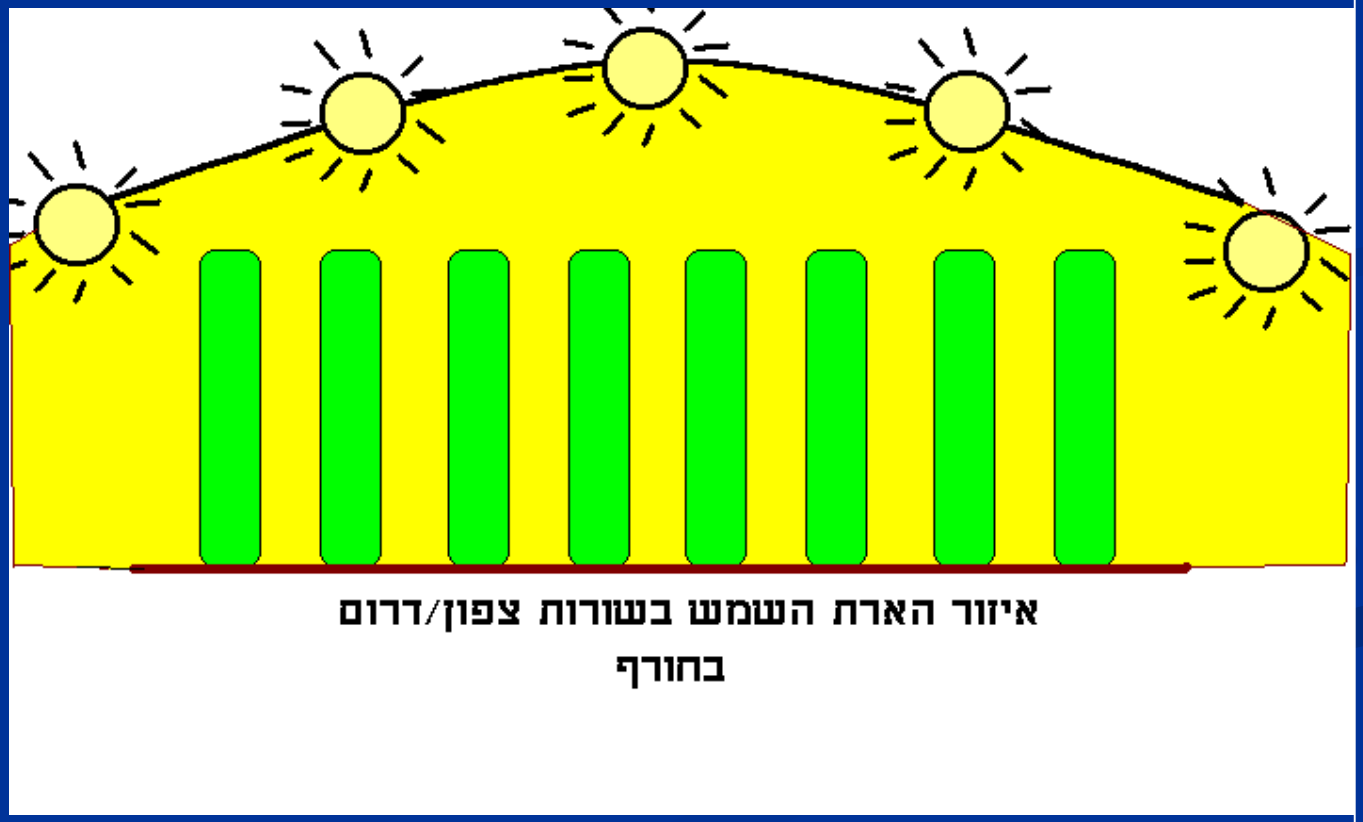
Θ=34.5





Sun radiation in trellising crops

Row N-S



איזור הארת השמש בשורות צפון/דרום
בחורף

Considerations

- Orientation E-W improves the transmissivity vs N-S (for our latitude) although radiation distribution is less uniform.
- Slope of 20-25º to maximize transmissivity.
- In low roof slope greenhouses (10-12º) orientation is not critical from radiation point of view (i.e. 'parral')

DIRECTIONS

- GH – With Natural Ventilation from the Roof – N/S and the opening on the opposite side of the prevailing wind.
- GH – With Natural Ventilation from the Sides – N/S and the maximum width 30-40m.
- GH – With Forced Ventilation – N/S and the Fans Located Down the Wind

SHADING







Pepper at Yair Experiment Station Arava Valley, Israel 22.2.01

GH 10 – Constant shade net

GH 4 – Temporary Net

GH 1- Maximum light

Bananas under Net houses Development & impact on the industry

- Year 2000 – 2,500 hectares, average total production = 120,000 mt, average water consumption per hectare = 23,000-27,000 m^3

0 BANANAS UNDER COVER

- Year 2012 – 2,400 hectares, average total production = 150,000 mt, average water consumption per hectare= 16,000 m^3 (irrigation return based on 6 mm instead of 10 mm)

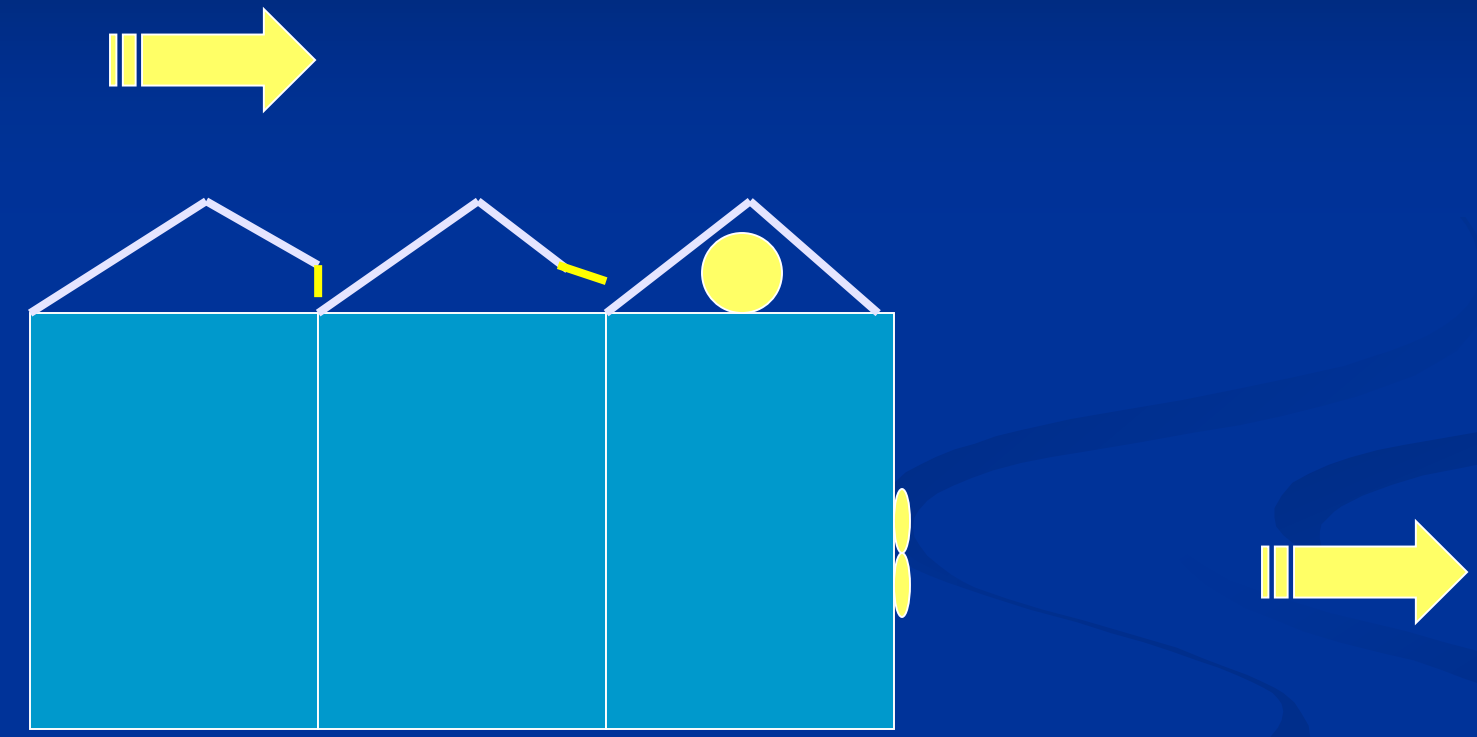
1,700 hectares of BANANAS under NET HOUSES (70%)

Data from Y. Levy, Shaham MOA

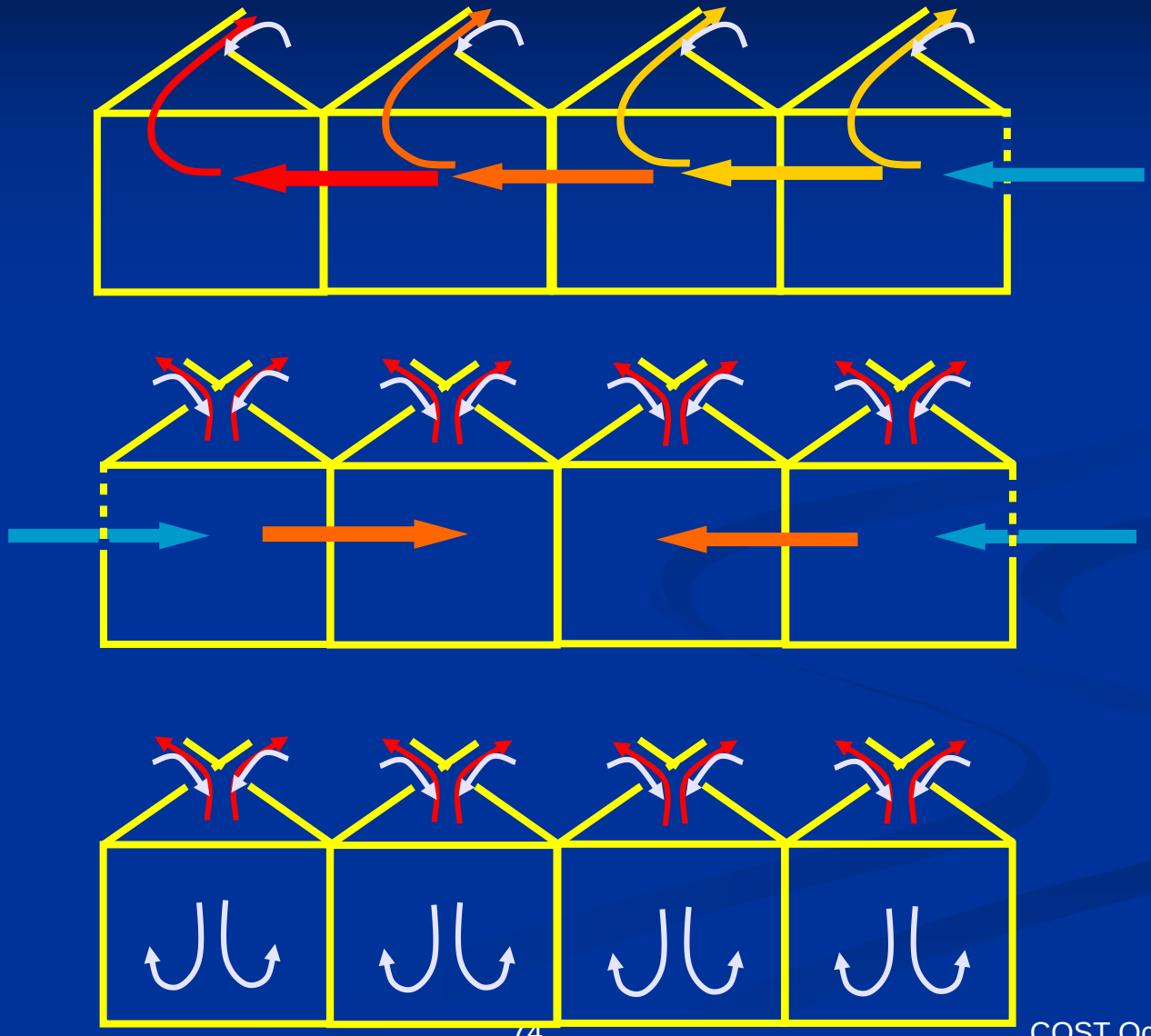
VENTILATION

Ventilation

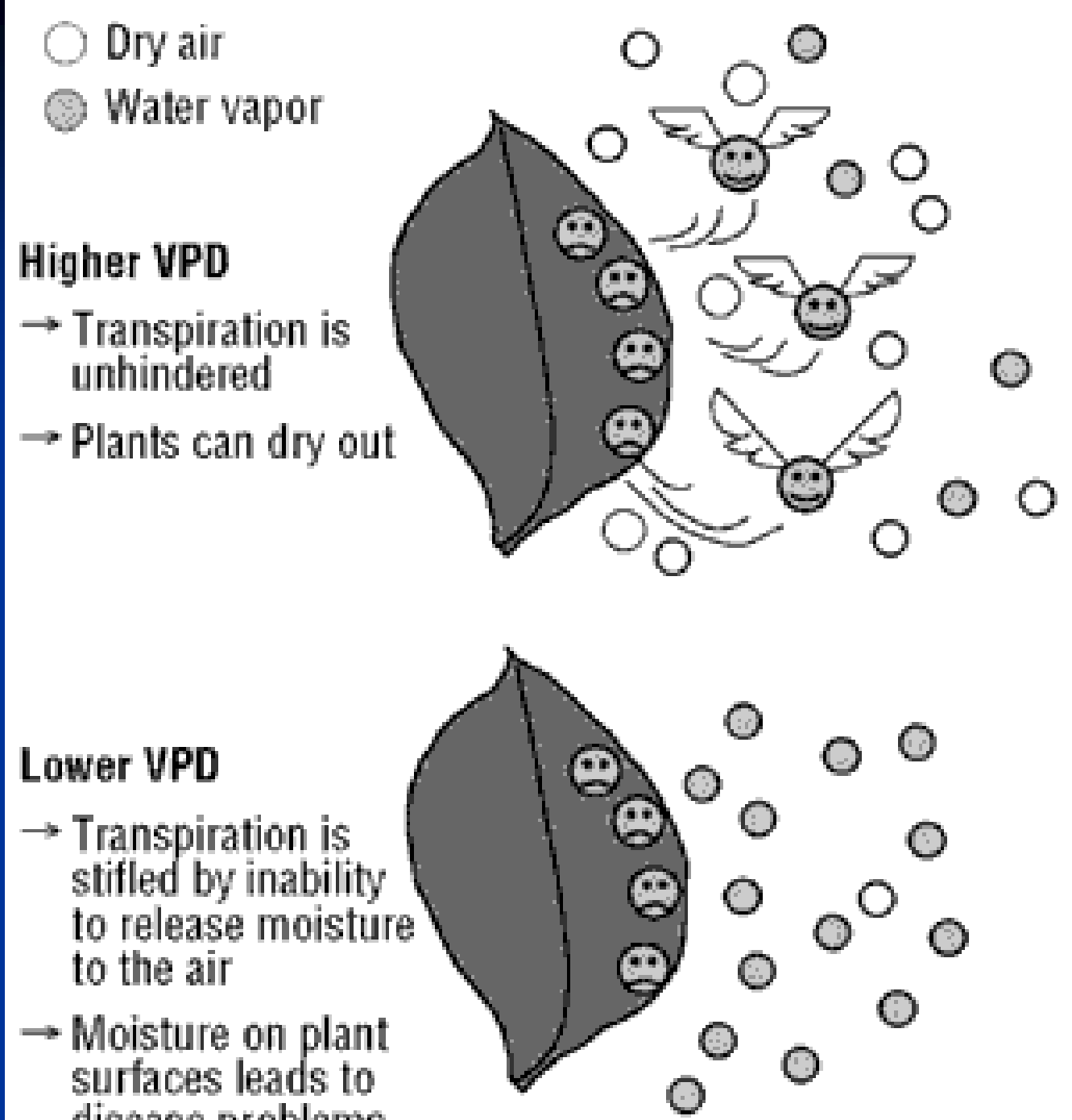
WIND DIRECTION



NATURAL VENTILATION



Air Circulation


Dry air
Water vapor
Higher VPD
→ Transpiration is unhindered
→ Plants can dry out
Lower VPD
→ Transpiration is stifled by inability to release moisture to the air
→ Moisture on plant surfaces leads to disease problems

Cooling systems

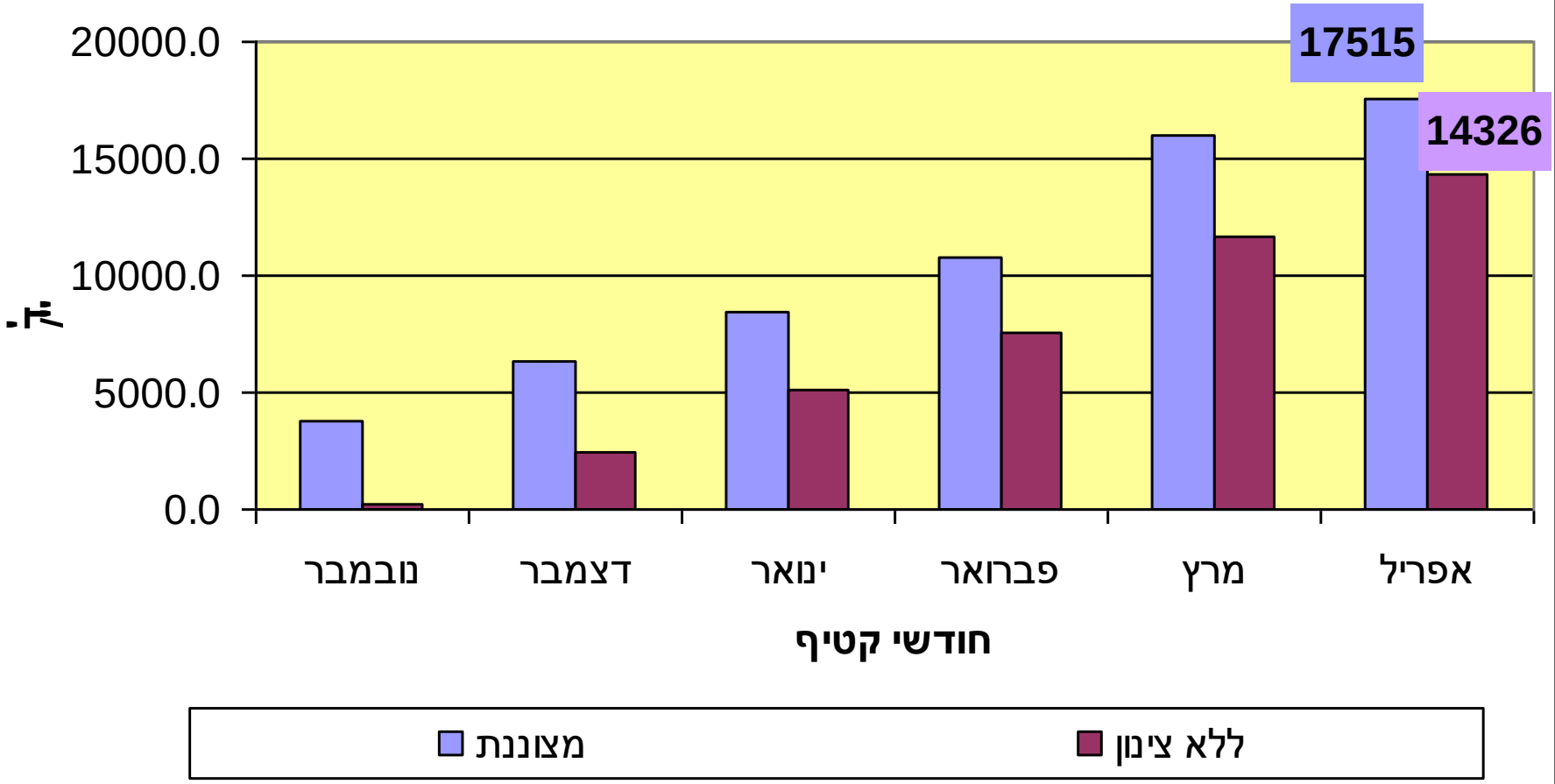
COOLING SYSTEMS

1. PAD AND FAN
2. SPRINKELRS
3. FOGGING
4. DESERT COOLING

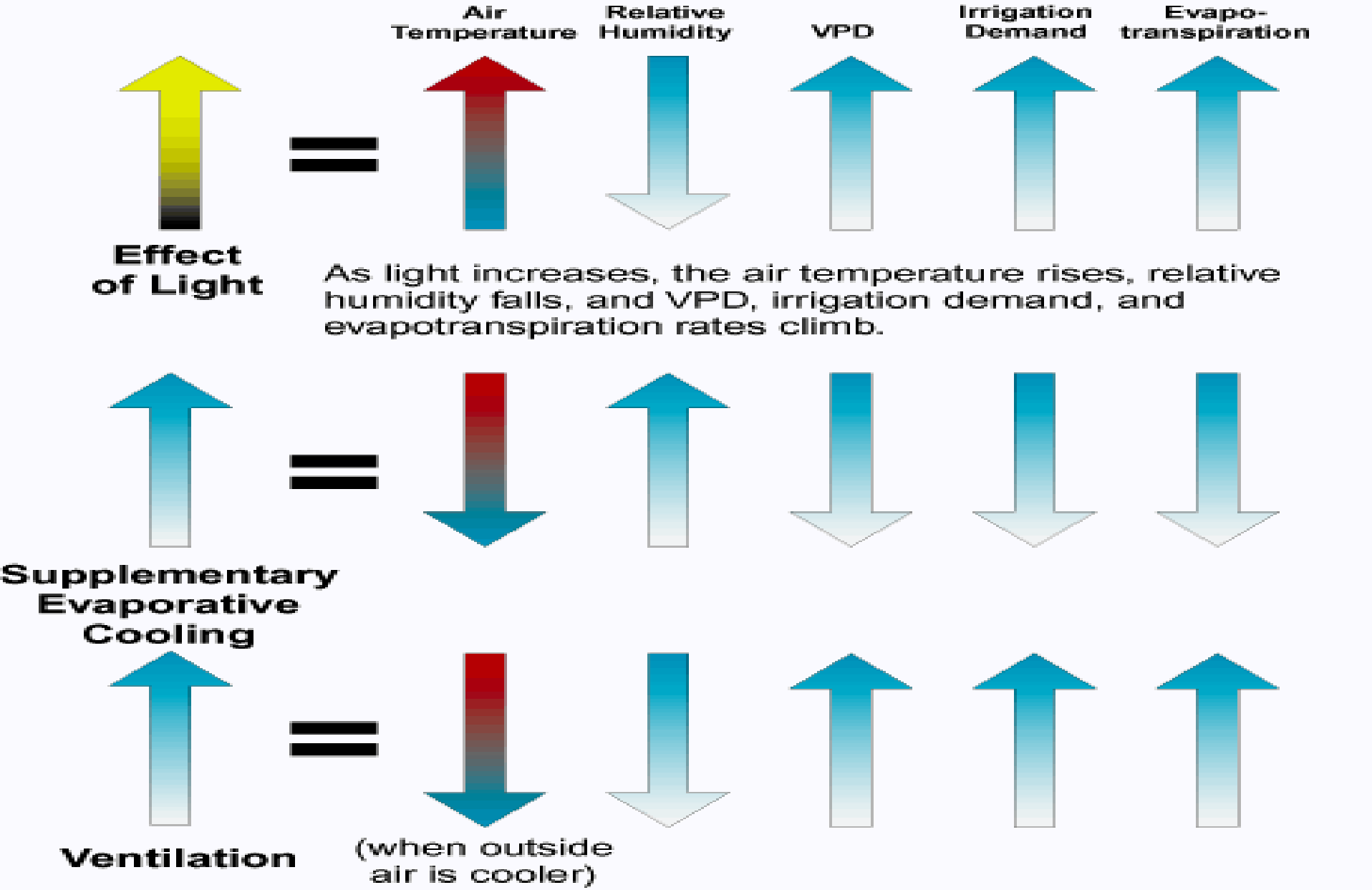
FOGGING

Evaporating cooling

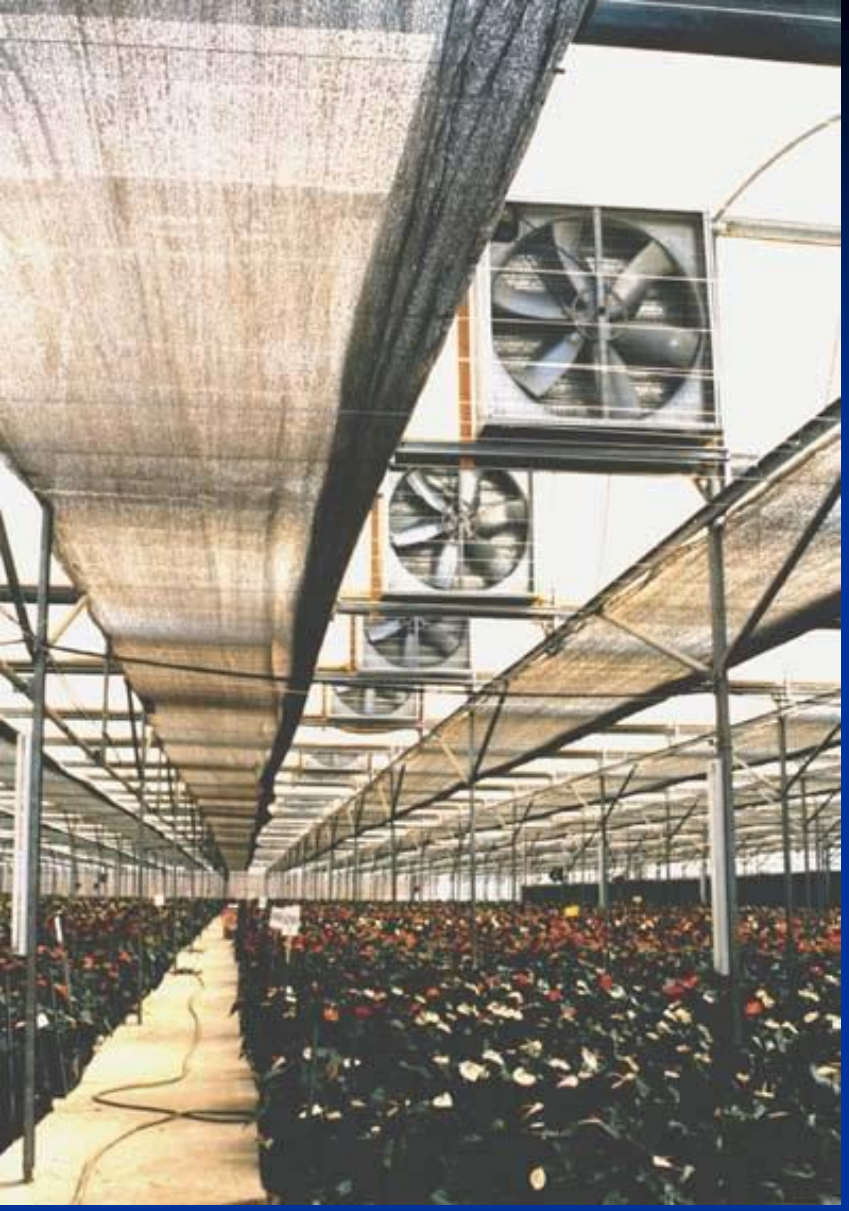
יבול מצטבר - פרויקט צינון
מורדכי ברזני 2003/2004



Greenhouse Cooling Relationships



Thermal Screen



FERTIGATION SYSTEM

Water treatment system

Water Reservoir Tanks

Water reservoir

Heating Systems

CARBON DIOXIDE (Lorenzo,2002)

- Inside the greenhouse there is a decrease of the CO2 ambient concentration, due to the Assimilation by the canopy
- During the majority of the daytime period, CO2 concentration inside the greenhouse is lower than the external concentration
- Insufficient air renewable:
  - Low ventilation area
  - Low wind velocity, etc.

A standard value for applying co2 to greenhouse is 5-4.5gr/sqm/h to maintain 700-1000ppm

(Hand, 1982)

Gutters growing system (for berries, lettuce, green onion, herbs……)

Growing tubes

COVERING MATERIALS

Important Characteristics of Greenhouse Covering Materials :

1. Light Transmittance
    1. Maximum transmission of Visible Light (P.A.R.)
    2. Filtration in the range of Ultraviolet radiation
    3. Filtration in the range of Infra-red radiation
    4. Ability to change Direct Light to Diffused light
2. Life Span = Mechanical and Chemical Stability over the course of time.
3. Strength
4. Light Weight.

Criteria for Covering Materials:

5. **Scratch resistance**
6. **Prevention of Condensation (anti drip).**
7. **Prevention of dust particles from settling.**
8. **Low cost.**
9. **Friendly to the environment and with the capability of recycling.**

1st Generation: Weathering The Plastic

UV Stabilizers

2nd Generation: Closing The Gap

IR

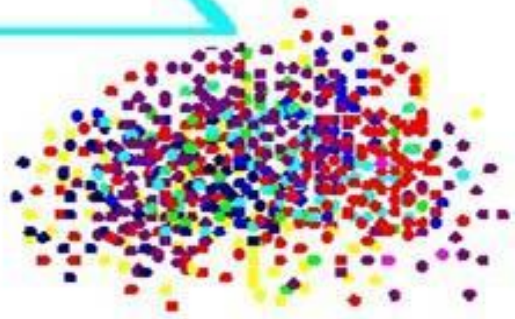
AF

3rd Generation: Film as an Agrothechnical Tool

Optical Filters

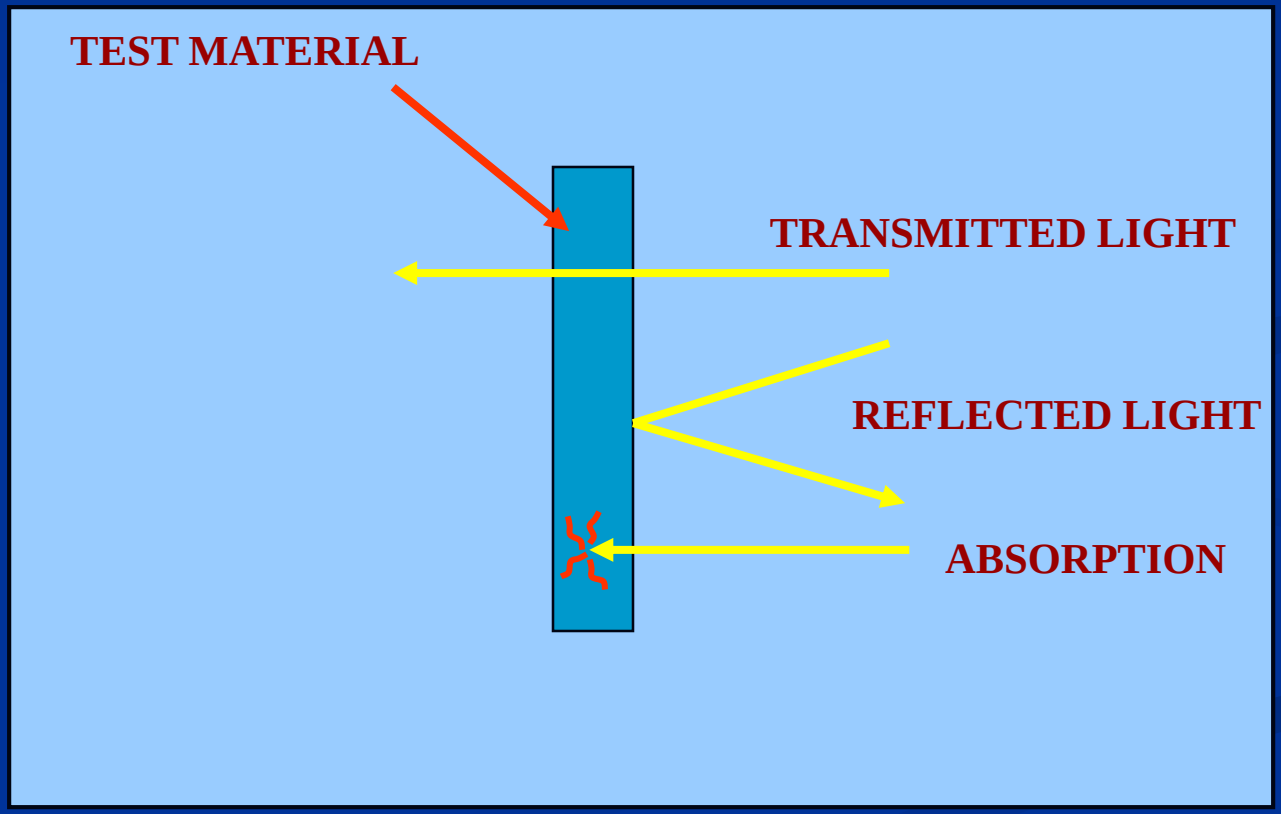
Controlled Atmosphere

Slow Release

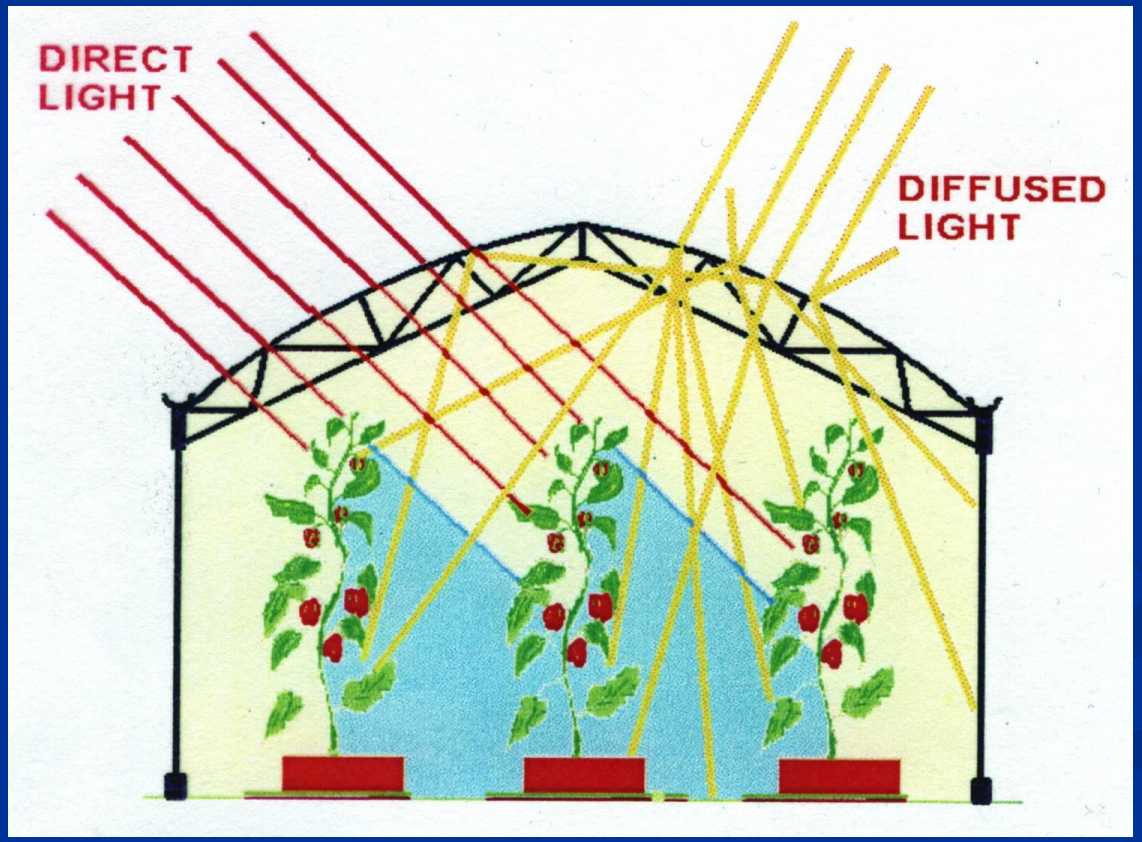


Maximum transmission of Visible Light (P.A.R.)

ABSORPTION + REFLECTION + TRANSMITTED =100%



DIFFUSE LIGHT



Diffuse Light

Vertical light distribution

- Most light intercepted by upper leaves
- Lower leaves contribute less to photosynthesis

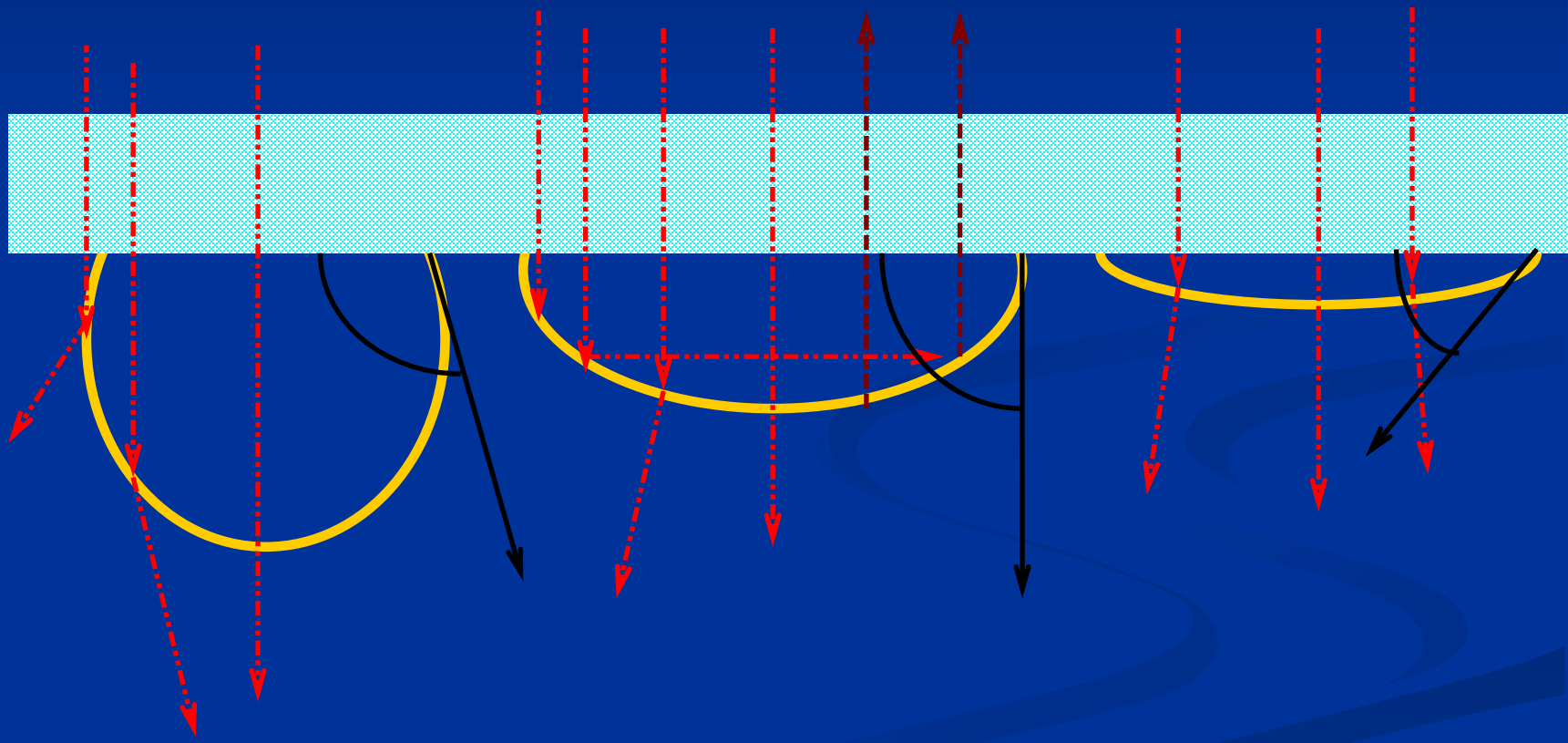
Horizontal light distribution

- No shadow by greenhouse construction
- Uniform growth

Anti Drip

Prevention of Condensation (Anti Drip).

Prevent Droplets



EFFECT OF ANTI DRIP

Without anti drip

With anti drip

ANTI DUST

Plastic and Plant protection

E

מזרח ונהרות

Inside

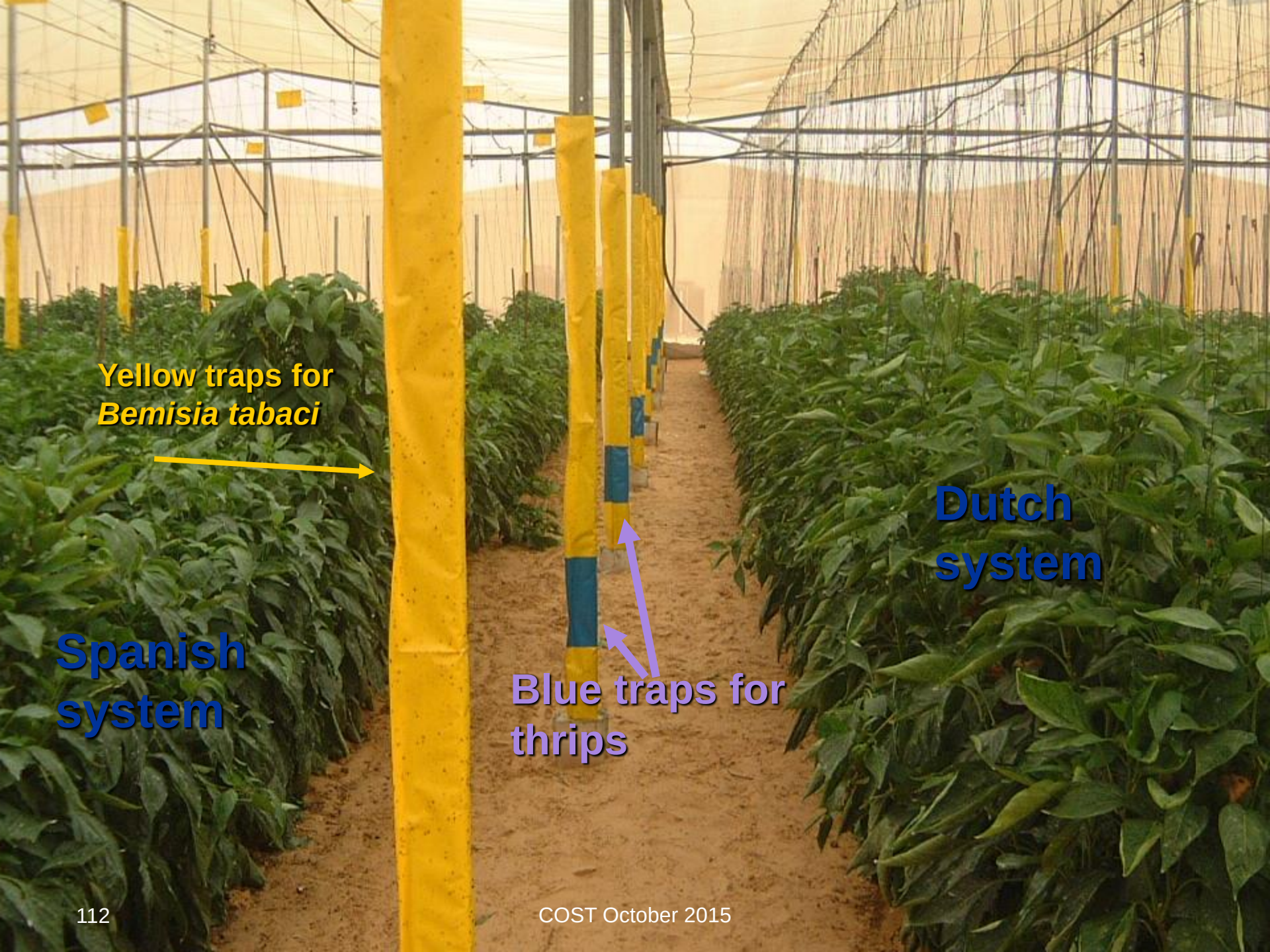
בתו

W

מערבי הרות

COST October 2015

The effect of UV blocking on insects behavior in GH


Yellow traps for
Bemisia tabaci
Dutch system
Spanish system
Blue traps for thrips


THANKS