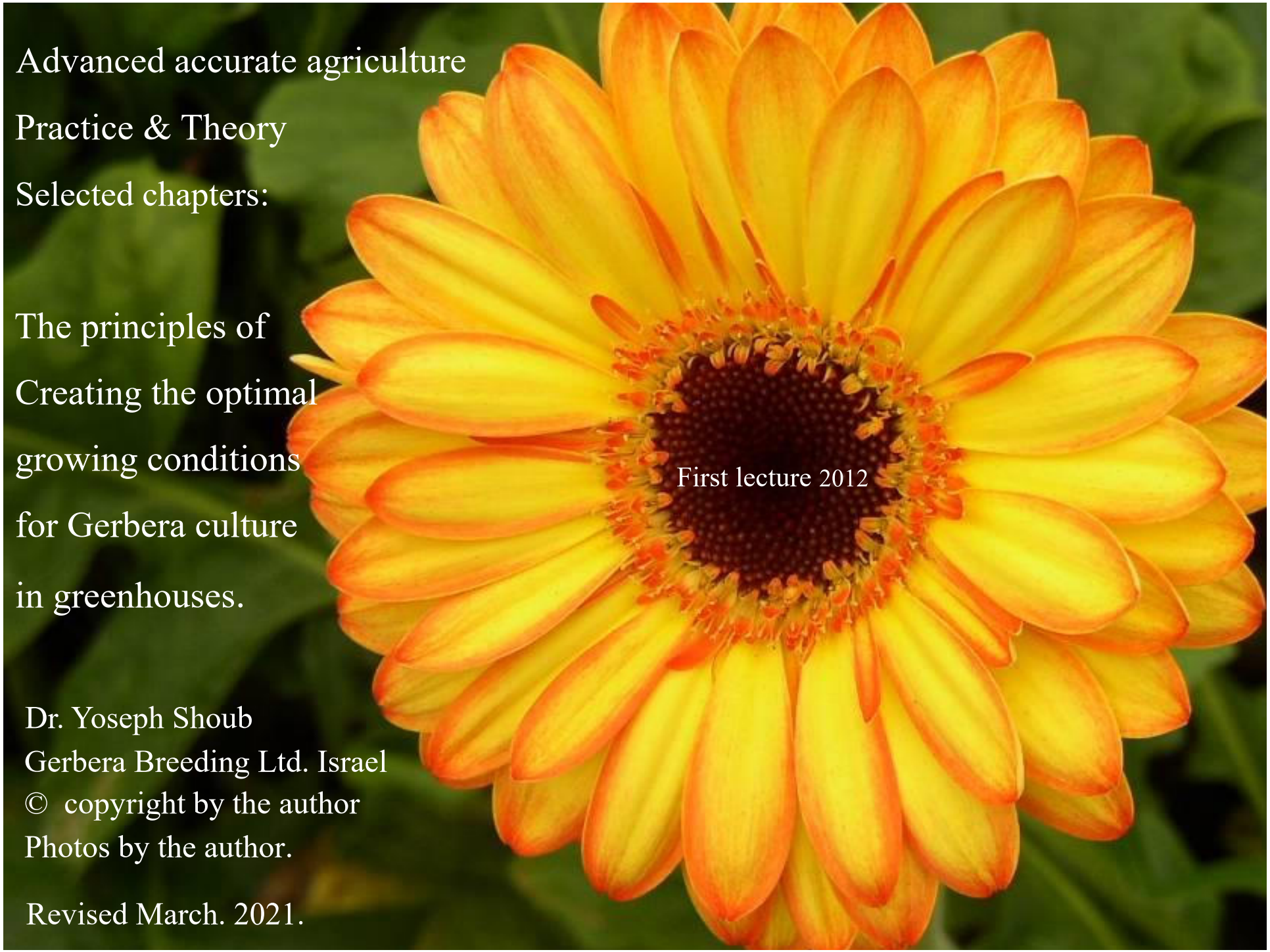

Advanced accurate agriculture

Practice & Theory

Selected chapters:

The principles of
Creating the optimal
growing conditions
for Gerbera culture
in greenhouses.

First lecture 2012

Dr. Yoseph Shoub
Gerbera Breeding Ltd. Israel

Revised March. 2021.

Preface -

The accumulated experience of the new agricultural programmed techniques, and the easy way of transferring the knowledge via the internet, make it possible to managed the floriculture business with new ideas and better understanding how to improve and increase the production.

Investing in agricultural-research, developing modern irrigation methods, selecting crops and new varieties that fit our climates, lead us to achieved already great economical results.

This presentation, is an example for our services, aimed to Share our knowledge and experience with the customers of "Selecta Cut Flowers", by presenting the principles of new practical methods for getting the production potential of our gerbera varieties.*

By the way, we'll learn more about the gerbera plant, referring to its physiological activities, and about our responsibility, as growers, to create and control the "Optimal Growing Conditions" that will pay back our investments.

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* Our varieties are marketed world-wide solely by Selecta Cut Flowers S.A.U

E-mail: info@selectacutflowers.com

our mail is gerbera1@zahav.net.il our site is www.gerberaisrael.com

Being occupied with the principles of Growing Conditions for gerbera in greenhouses, we'll have to pay attention first on the gerbera' roots system. The roots worth it, as the roots are the solely suppliers of the water, the oxygen and the other minerals that enable the plants to achieve their production potential.

In countries with hot- summer season, as in Israel, *my country,* and in many of the countries where our varieties are grown now, it isn't easy to achieve, throughout the year-round, the: 'Optimal growing conditions' for the above soil plants'- organs, ***Unless 'Optimal water volume' is supplied on time to the root's media, when it really needed there.***

An essential note -

The gerbera is a 'Self-inductive plant', It means that its' flowers initiation is not affected by the day-length or by the temperatures.

It's ability to develop and produce flowers are related to its' own growth-rate.

On the other hand, the rhythm and the rate of the plant growth *(of any plant)* ***depends on the ability of its roots to supply, on time, water containing oxygen and minerals.***

An intensive modern plant would probably declare that:
In order to get the production potential and the quality-potential, all it needed is the:

'OPTIMAL GROWING CONDITIONS'

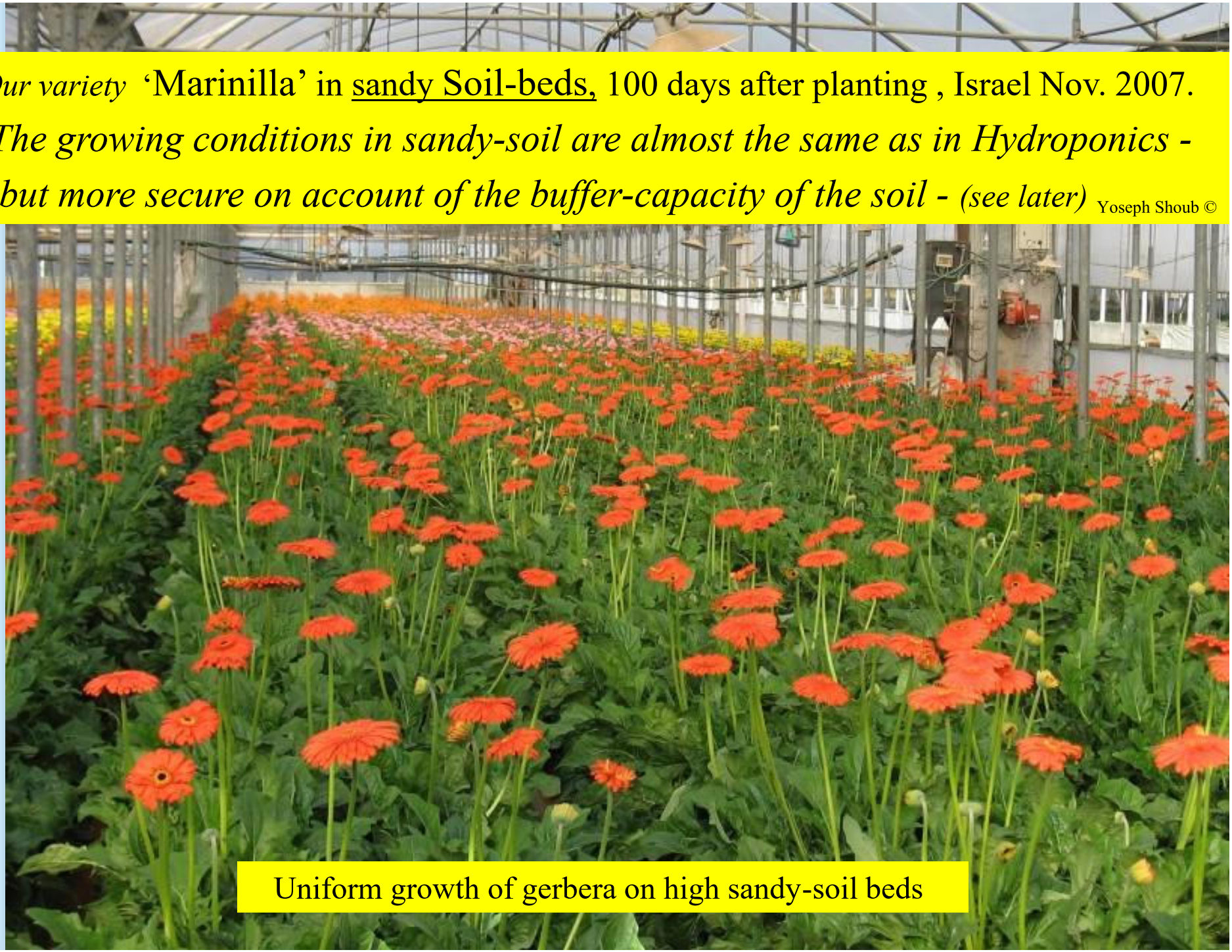
(or at least as close to it)

So; What are the optimal growing conditions for the gerbera, under the greenhouse-conditions, in the soil, or in any other growing-media.
And how to create it?

We'll try to clarify it.

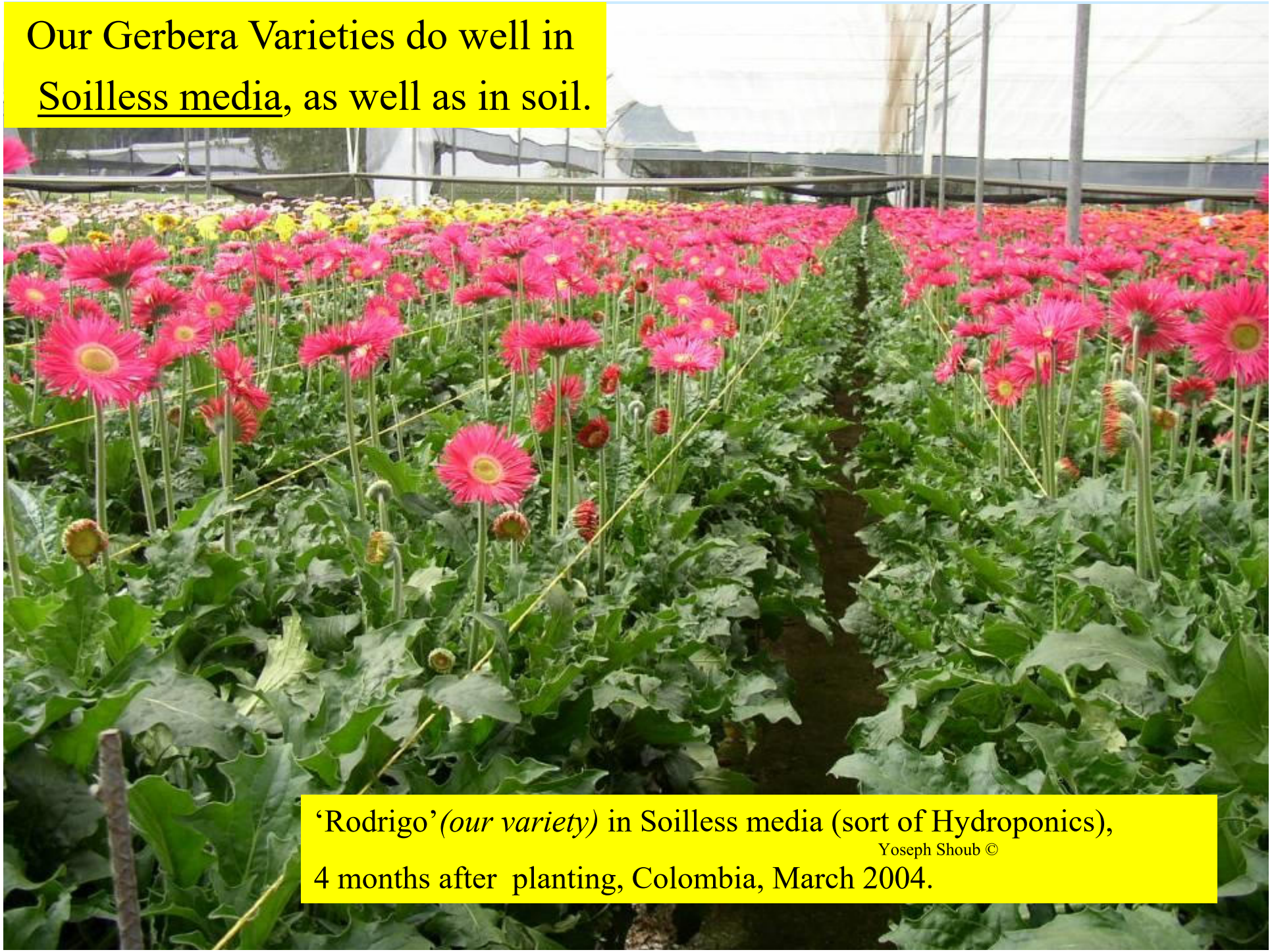
Our variety 'Marinilla' in sandy Soil-beds, 100 days after planting , Israel Nov. 2007.

The growing conditions in sandy-soil are almost the same as in Hydroponics - but more secure on account of the buffer-capacity of the soil - (see later) Yoseph Shoub ©



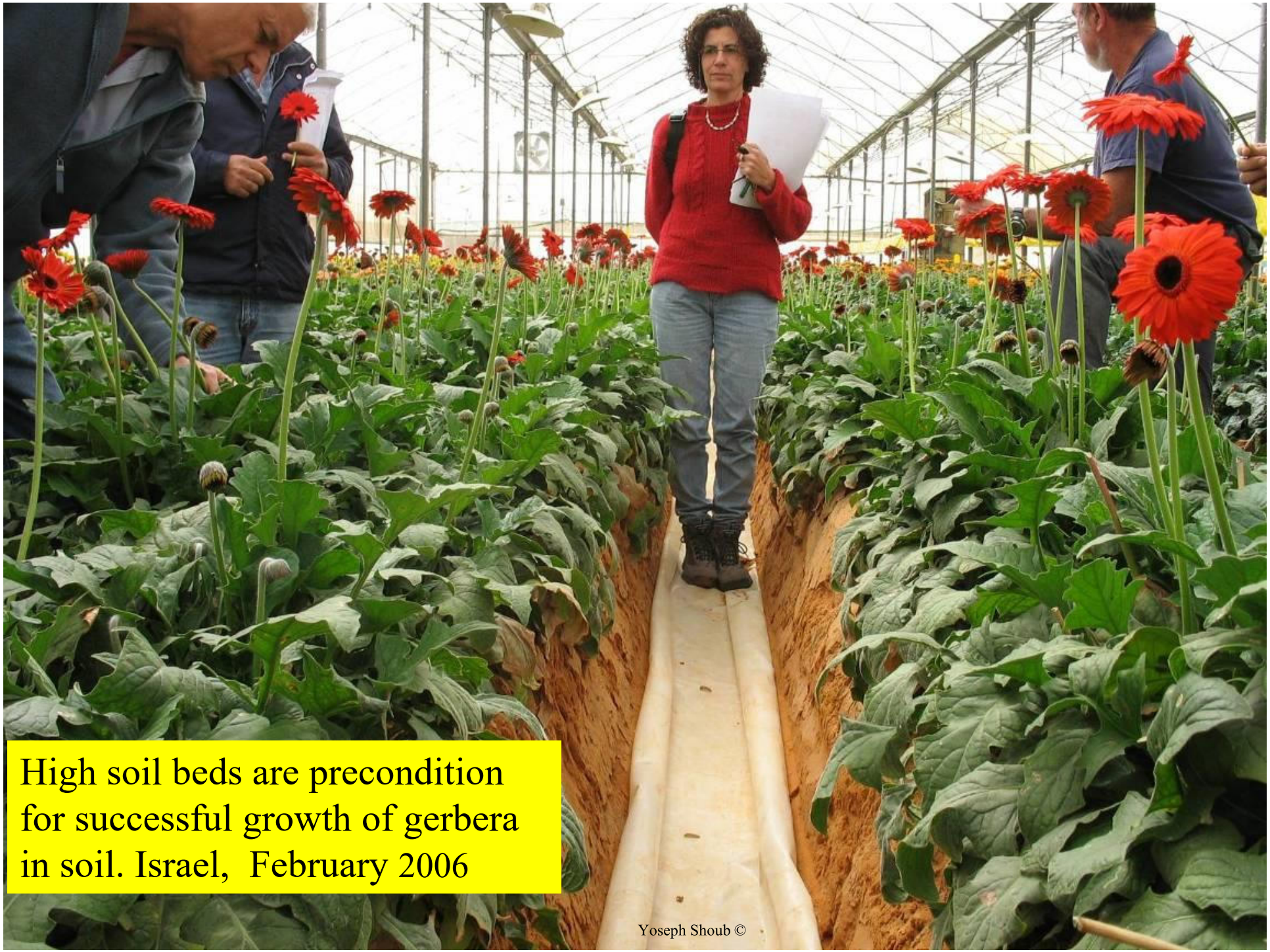
Uniform growth of gerbera on high sandy-soil beds

Our Gerbera Varieties do well in Soilless media, as well as in soil.



'Rodrigo' *(our variety)* in Soilless media (sort of Hydroponics),
Yoseph Shoub ©
4 months after planting, Colombia, March 2004.

Our gerbera plants in raised ***organic*** soil-beds (25 - 30 cm high), Colombia, 2008


High soil beds are precondition
for successful growth of gerbera
in soil. Israel, February 2006
Yoseph Shoub ©

Raised soil-beds for gerbera, the imported ***sandy soil*** covers the original clay soil.

Soil-beds with our gerbera varieties, Dehradun, Uttarakhand India 2009

Draining soil-beds, 25 - 35Liter per plant, compare to 4 - 6 liter in the bags or in the containers method.

The gerbera roots system -

The roots are most important organs of the plant, as they absorb. transport and supply continuously, over 24 hours, the water, the oxygen and the soil minerals in it.

The gerbera roots system include: Adventitious roots, Secondary roots, and Root hairs.

Gerbera root system in soil, Ecuador.
The secondary gerbera roots are active at a soil depth of 0 to 30cm.*

---

* *Lower than this depth the presence of the atmospheric air is gradually decreasing!*

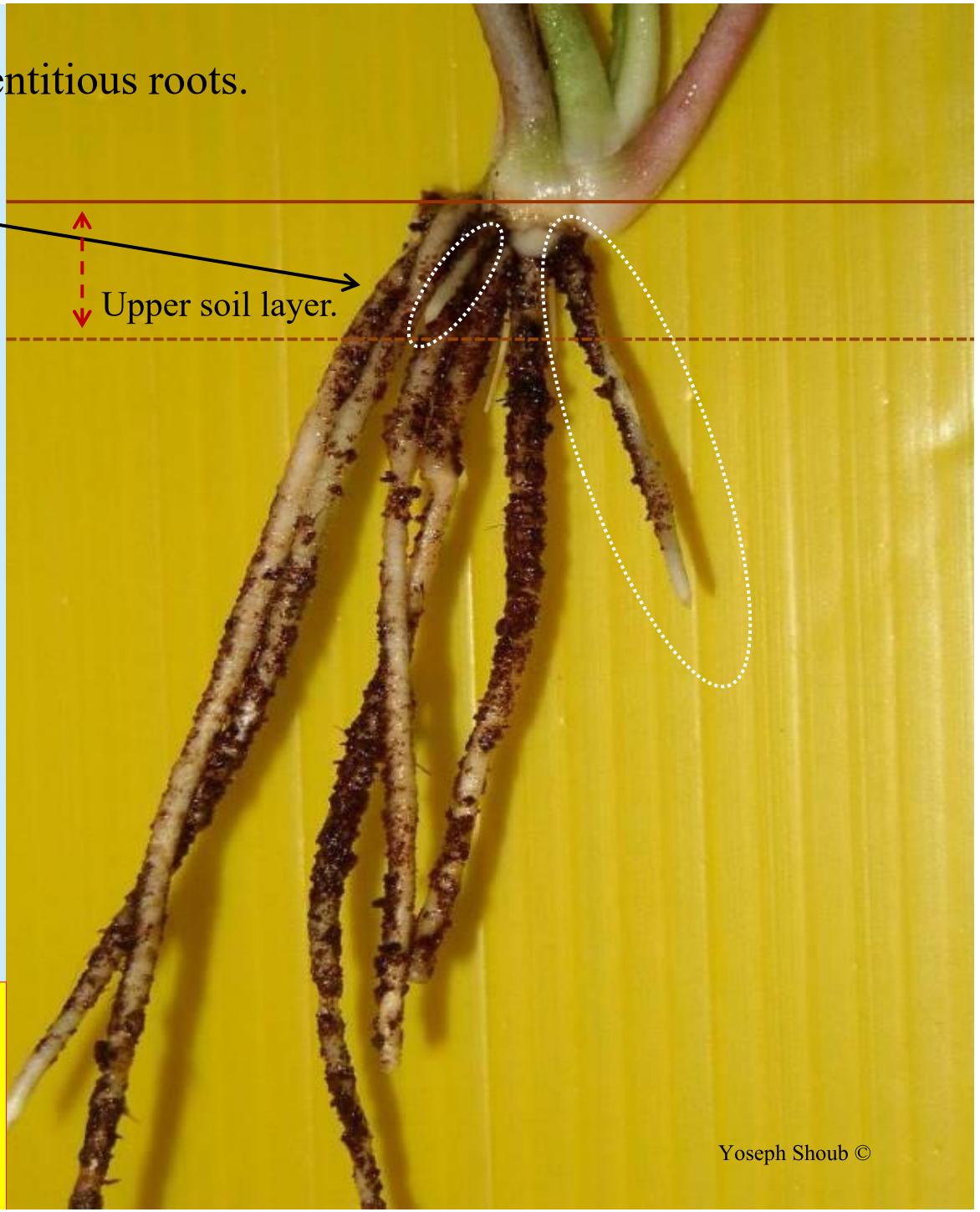
Young gerbera stem and its adventitious roots.

The adventitious roots of the gerbera develop from the stem basis, located in the upper soil layer. They do not split, the secondary roots develop on them.

The upper layer of the growing media is exposed to the external conditions.
It is unsafe for young new roots to pass it, referring the:

High Evaporation rates.
Changes of Air / water relations.
Fertilizers' Salts accumulation.
Changes of the Temperatures, etc.

Therefore keeping the optimal growing conditions - in all the roots volume is always advisable.



Look of root-systems of a gerbera seedlings grown in Coco-peat fibers, in 4L container.

Secondary roots 60 days after planting in coco peat. Root hair are there, but aren't seen.

Adventitious and secondary roots 100 days after planting.

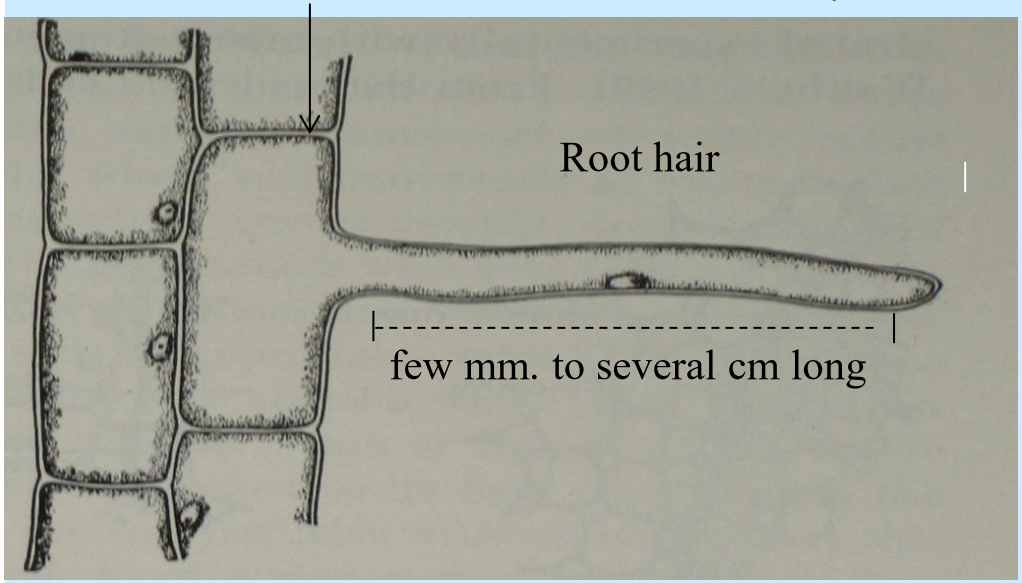
The Root hairs -

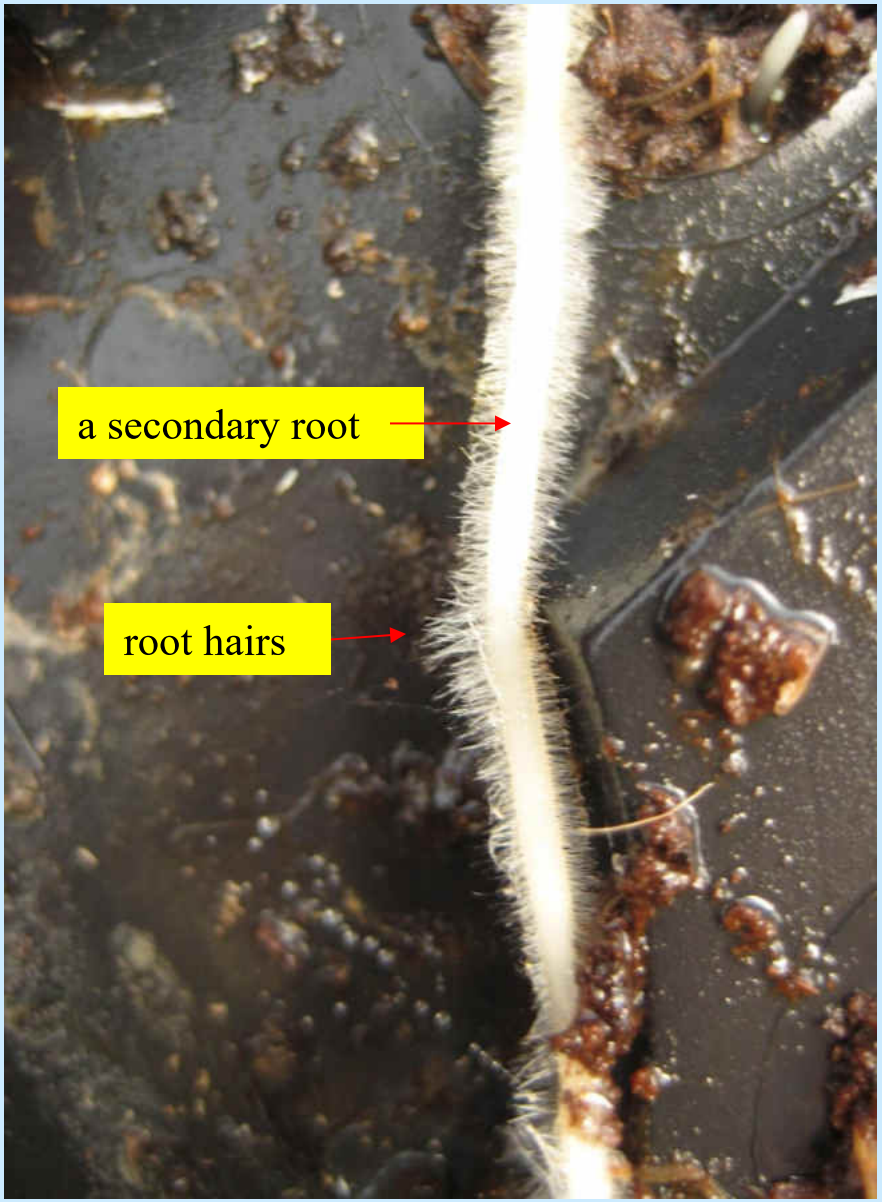
The root hairs are epidermis cells of the secondary roots.

Their function is to absorb (Sucking) and supplying water, oxygen and minerals to the above -soil organs of the plant.

Well; vital cells, but then as to their size and the thinness of their cell-walls, they are very sensitive to the growing conditions.

A Scheme of external cells of a secondary root.





Root hairs of an Apple seedling.

The secondary-roots and the roots' hairs do the efforts of 'Sucking' the 'Soil-Solution'.

Secondary roots inside the container.

Young gerbera seedlings, in coco-peat (4 seedlings in each 4 L. container),
60 days after planting. Gerbera Breeding Ltd. Israel, March 2012.

'Fertigation' = Irrigation + Fertilizers via dripping.

Under the Israeli summer conditions, the daily amount of water used for Fertigating gerbera in **'Sandy soil beds'**, is about 750 CC per plant.* The same plants grown in '**Soilless media'** *(mostly Coco Peat)* are irrigated with 800 - 1000cc per plant.*

However;' it is not for us to recommend the exact amount of water needed to maintain the 'Optimal growing conditions**', unless we measure it**, as it depends on variable factors

Physical factors: *Temperature, humidity, winds, light intensity, water quality, and the water holding capacity of the media.* **Most of these factors are not controlled**.

Practical-Controlled factors - *The root's media type, the irrigation system, the drippers volume, the container shape and volume, the irrigation rhythm*, the fertilizers concentration, *and the salts accumulation in the roots -zone = '**Salinity'.***

---

* Smaller amount of these minimal daily summer quantities, might creates ***salinity*** problems.

** The ***dangerous Salinity phenomena*** is discussed in other chapter.

Oxygen availability in the Soil-Solution is a critical factor for the plants' activities!

The Oxygen is a vital Element exist in the air and in the water & in all the living organisms, in the plants and in all the Organic Compounds produced by the pants. It Provide energy for the Respiration and the Oxidation processes.

> The Oxygen involved in all the plant's activities, and it is our responsibility, as growers, to maintain in the Soil-solution the highest oxygen level.

> The air around, holding 21% Oxygen, it present as well in the soil-structure porosity. In fact only 10 - 20 ppm of the O_2 free molecules are able to, and tend to dissolve into the soil solution, as other soil minerals do in bigger quantities.

> The roots absorb the soil-solution and transport it to all the above soil plants' tissues.

And this is the only way the atmospheric oxygen can infiltrate into the plant tissues**!**

Thus; we may say:

'The plant's interest is only in the soil-solution and not in the soil-structure'

Therefore; the Soil-Structure is the growers concern, and it will remain our concern forever!

For performing the daily activities, the plants utilize: Water, Oxygen, CO_2, Soil-minerals, and the Sun-Light for the following processes:

Respiration - Occurs throughout 24 hours, supplying the energy needed for the Physiological activities = The oxidation processes utilize oxygen.

Transpiration - Occurs throughout the day hours for lowering the leaves' temperatures, and avoiding radiation damage by using water = The soil solution movement, transport the oxygen and the minerals from the soil to the leaves.

Assimilation - Occurs throughout the day hours = Photosynthesis processes in the leaves produce the sugars needed for the plant development.

Translocation - Occurs 24 hours = The sugars and other nutrients are translocated from the leaves to all the growing sites, including the roots. and for that the roots absorb the soil solution also at night.

Growth & Development - Occur 24h the year-round, assembling many processes of = many growth and flowering cycles.

Intermediate Practical Logic Conclusions -

Under Optimal Greenhouse Conditions, the plants are able to perform continuously their actual growth-actions. For doing that - *besides getting the three free growth factors* - Light, Temperatures and CO_2 - The plants have to invest energy for absorbing actively, the 'Soil-Solution' from the roots media, and transport it all over the active s' organs.

Thus logically; It looks as it is possible to get the desire production in shorter time, with small amount of water - by accurate systems that will follow and supply on real time, these small quantities, actually transpired by the plants, while it required and it occurred.

'Optimal Growing Conditions' lighten the plants, to absorb efficiently the 'Soil-Solution'.

Well; for that we need to improve the Irrigation-control-systems, in away that it will react on real time to the physical and the chemical changes values in the roots media while the roots are functioning intensively.

Lorca -

One of our old varieties.

Yoseph Shoub ©

In our Gerbera Breeding farm, we are using already such control system. Saving water, saving fertilizers, saving heating costs and getting better production of Continuously flowering cycles

Significant Air Temperatures that affect the gerbera culture -

Temperature range of 8 - 38C is acceptable for gerbera culture.

Day temperatures of 17 - 28C are optimal for high quality growth & blooming.

Night temperatures of 10 - 18C are optimal for growth and for high quality stems and flowers.

Practical remarks:

Night temperatures above 23 - 25C decrease flowers & stems qualities.

Night temperatures of 5 -10C for very long period, delay the growth, and can create malformed flowers. *

Temperatures of 0 - 4C for long period, stop the growth, can cause mortality rate.

---

* *Before long;* we *hope to release our new 'Cold Resistant Gerbera Types'.*

Optimal relative humidity for gerbera

The considered optimal relative humidity for gerbera during day time is 60% to 85%.

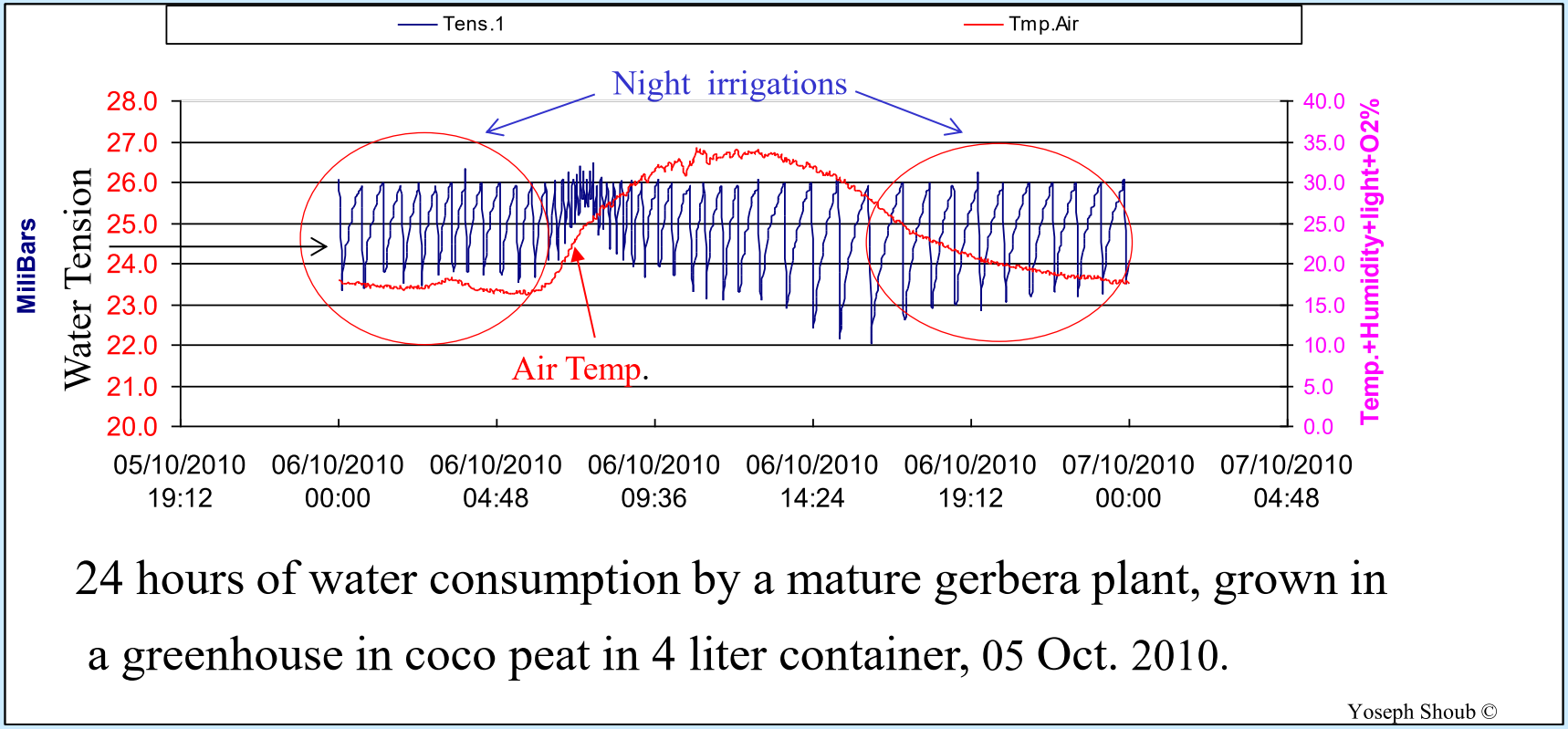
Within the optimal range, the plant transpire, absorb water, minerals and CO_2 without any difficulties. Therefore, in controlled greenhouses, gerbera plants develop properly and produce lots of quality flowers.

However, in practice the average relative humidity during summer days in our greenhouses is around 40% to 60%, (with some extreme days even with 10 - 25%);

but water supply on time, avoids any decrease in production and quality.

Notice - Very low humidity, go with dry hot winds, can cause damage like Salinity phase.

Active water consumption throughout the nigh and the day is a real fact.



24 hours of water consumption by a mature gerbera plant, grown in a greenhouse in coco peat in 4 liter container, 05 Oct. 2010.

The 23 night irrigations and the 32 day irrigations, approved basic physiological fact.

The 'AA' Tensiometer device detect the Water Tension changes occur in the roots media, along 24 hours and react on real time to the water consumptions, **by micro irrigation-pulses**, compensating the amount of the used water.

A device For Irrigation control -

The ‘AA’ “Electronic Tensiometer” *

(one of various used Tensiometer types)

The ‘AA’ Tensiometer type, measures accurately the micro-changes occur in the ‘Water tension’ in the roots volume *(in soil or in soilless media)* along the plants’ daily activities.

Under optimal growing conditions, when the roots absorb the soil-solution, the ’AA’ tensiometer detect it and compensate the plant’s needs , on real time’ by small volume irrigation pulses

It synchronizes the fertigation pulses, to the rhythms of the plant’s activities.

Practically; absorbing the soil solution Increase the water tension, and Irrigation pulses Decrease the water tension.

* ‘AA’ – AutoAgronom Ltd. Israel.

Regular changes of the Water -Tension, Water-availability, and the Oxygen-availability, in soil or in soilless media, used for cultivate plants.

Practically; 'Water Tension Values' are Physical figures in the roots'-media' that show the changeable-water -availability situations in the roots' zone during 24 hours of the plants activities.

> When the roots' volume is **Saturated** *(full of water without air),* in soil or in soilless media, the water tension values are low *(a temporary-state without oxygen presence).*

> While it drain and the plants absorb the water, the water capacity in the media is reduced, and the water tension increases *(now oxygen is presence)*

> And vice versa - When the water capacity increases *(by irrigation),* the water tension is reduced.

So, when the fertigation only starts, the water availability is gradually increases. Now; if the fertigation continuous without control it reaching the saturation point' *(again:- full of water without air).*

As long as the water/air ratio remains optimal, the water availability for the plants remains optimal too. **And that's the Tensiometer responsibility.**

Data of: Extreme hot dry weather in our Gerbera greenhouse 23.05 2019.

(see next slides)

Yoseph Shoub ©

(8.5 hours)

09:30 ⟷ 18:00

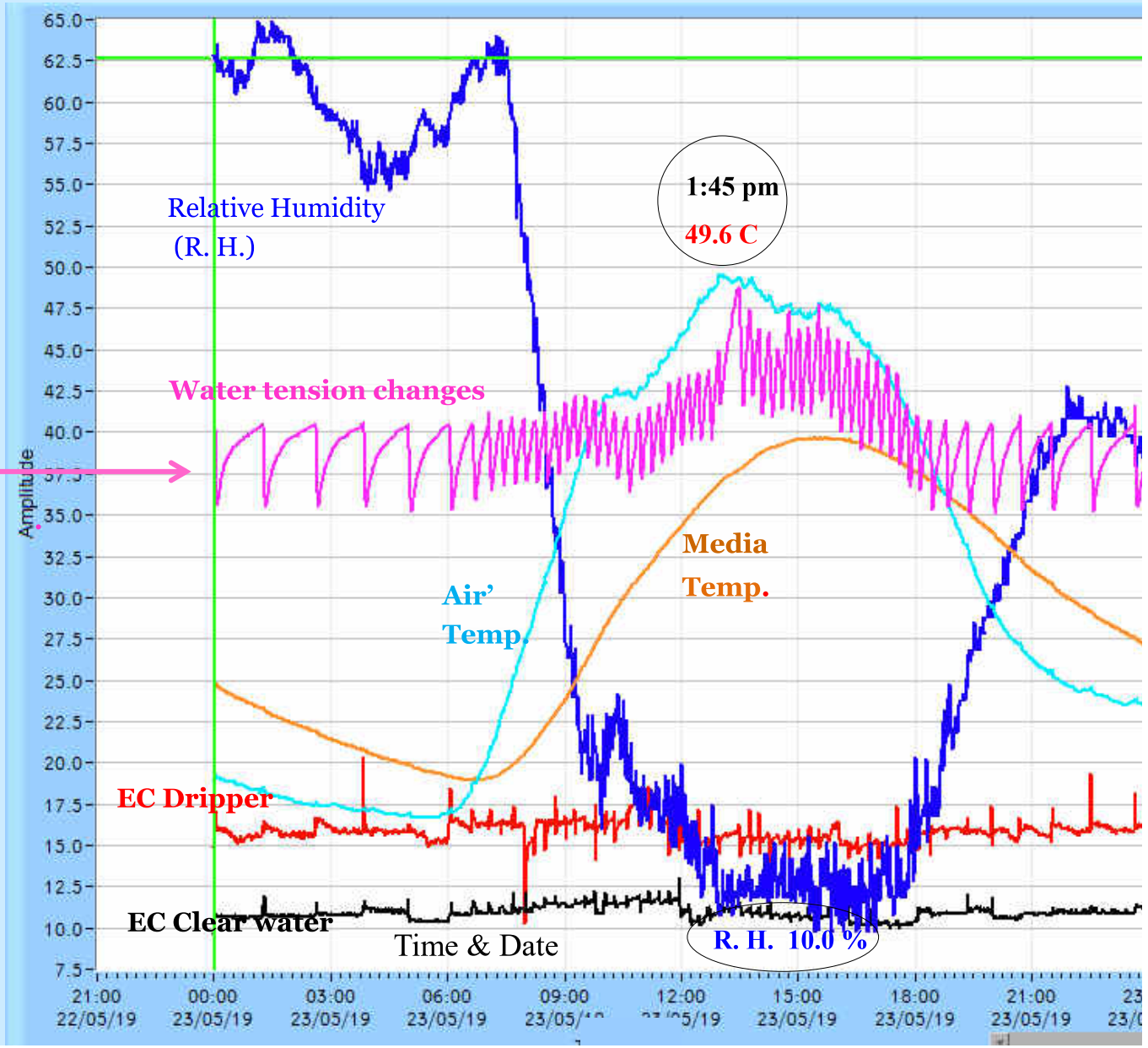
40C 49.6C 40C

In our greenhouse:

The water volumes used by the plants is provided back on real time to the roots' zone. It controlled by the 'AA' Tensiometer, Via the irrigation pulses, supplying the water directly to the measured volume in the container.

Therefore;

The plants performed as usual as if the weather was not extreme at all. (*next slides*)




Time: 1:45 PM
Temp: 49.6 C
Gerbera selection trials 2019.
Yoseph Shoub ©
Yoseph Shoub ©
The photo was taken on May 23rd 2019 at 1:45 pm.

“Colombian Flare”

Yoseph Shoub ©

The photo was taken,
at 1:45 pm
the heat highest hours.

Creating Hydroponic conditions in soilless media -

The known ‘Hydroponic-Method’ deals with agricultural crops that can grow with Only their roots exposed to the nutritional solutions in water volumes.

In fact; **it is possible to get the benefits of the ‘Hydroponic conditions’ in inexpensive systems**, in which it is possible to create - in solid different types of **Soilless-media,** the Optimal growing conditions for many agricultural crops. *(Flowers, Vegetables, Ornamentals, Forestry, Field crops).*

The gerbera is one of them, and it used already extensively with our varieties at our greenhouse for the last 30 years and also by experienced farms as in Colombia, for example, *(in different media, in plastic bags, or in containers).*

It these new methods, the emphasis is on controlling the roots’ system volume. it efficiently controlled by common sensors and irrigation-software computers.


Yoseph Shoub ©

limitations and Qualities of the **inexpensive Hydroponic conditions' systems.**

Limitations -

Setting conditions: Easy drained media, Low volume drippers, Controlled Fertigating system, and. Controlled natural ventilation and shading.

Qualities -

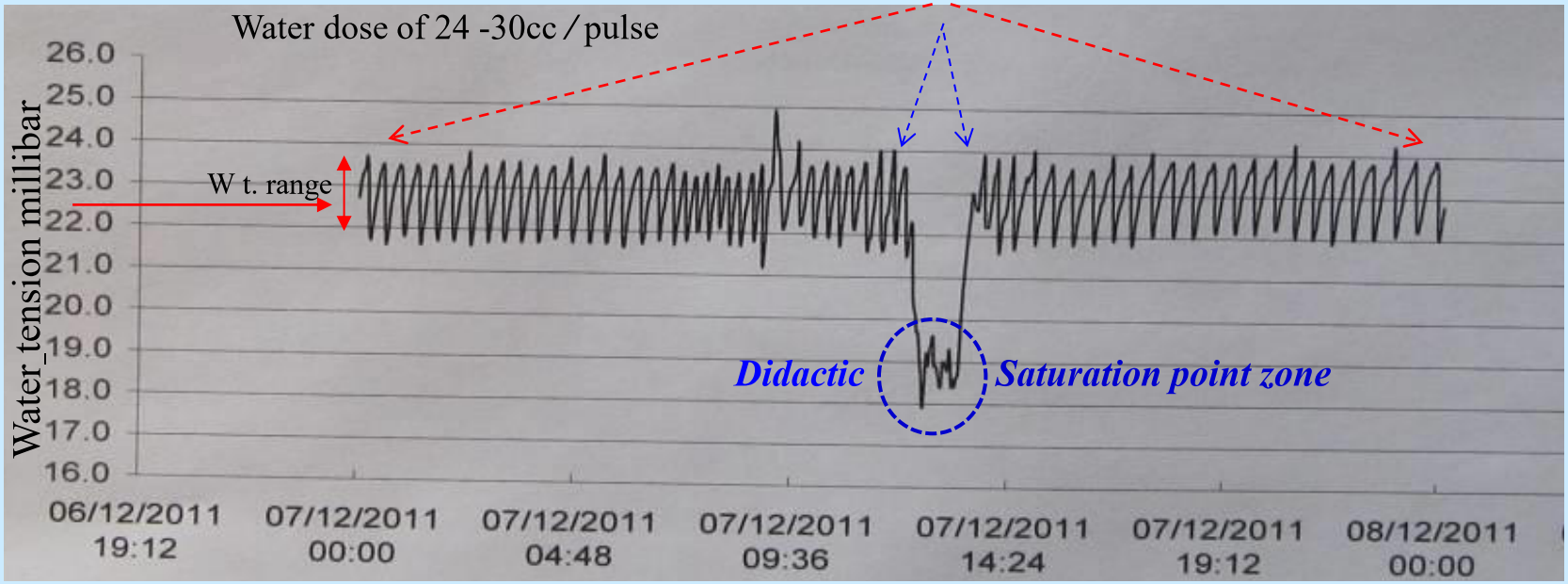
Oxygen and minerals are always presenting in the growing media and touches the root-hairs, while the Water-tension values are : "close to the 'Saturation-Point', **but they always are above it.** *(see next slide)***.**

'Saturation-Point', is a situation in which the water in the wetted media fill up all the capillary spaces in the media structure, and it pushout the air from the growing media for too long hours. Different media have different Saturation-Point values.

"Caution"

The Saturation Point is a critical dangerous situation for the secondary roots**.**

24 hours of Hydroponic-conditions - above the Saturation point.



A daily irrigation-pulses-graph, in our gerbera greenhouse.

For **Didactic reason**; we increased the dripping volume from 30cc fertigation pulse to 200cc, in one long irrigation - ***as above***. Our purpose was to discover the Water-tension values in case of developing Saturation conditions, in the Coco peat media used by us.

It derives the current results: On Saturation-point the water tension was around 19 -18millibar.

On that days; the regular programed irrigations start on 23.5 millibar, and the water- tension normally dropped down only by 2.0 millibar. Therefore; the detect Saturation point of our media is only 3 millibar below the regular water tension used for our gerbera plants.

Controlling the greenhouse atmospheric conditions -

Our gerbera breeding farm is managed as a small research station.

The greenhouse is controlled by the 'AA' Computer, It detect and react on real time, referring the Programed-Values that we developed along the years.

The Technical-Actions controlled by the computer includes:

> Open / Close the plastic curtains - *as to the natural Air-Temperatures*.

> Shading - *as to the light radiation.*

> Fertigation timing and quantities - *as to the experienced Optimal Water Tensions*. And the desired EC and pH of the Fertigated solution. *(see attached photos)*

The 'AA' method continuously controls the 'Optimal-ratios' of water/air relations, and keep the minerals low concentrations - in favor of the roots and the roots' media.

Thus; controlling the growing conditions, encourage and stimulate the Secondary Roots and the Roots-hair growth. It allows continuous maximal oxygen availability, allowing continuously the absorbing of the soil solution from the media.

Advisable Parameters to measure in the greenhouse -

Here is the List of the Parameters values that controlled the Growing-Conditions, in our greenhouse for the last 18 years. Our experience based on the accurate data collected *(day by day 24h 2005 - 2021).*

The 10 measured values: 1. Water-Tension* 2. Air Temperatures* 3. Soil Temperatures* 4. pH of Feeding Solution* 5. EC of Clear water* 6. EC of Feeding Solution* 7. EC of the Drainage, 8.Air Humidity, 9. Light Radiation, and the 10. Oxygen Availability. The detected information is delivered to our computer by common sensors.

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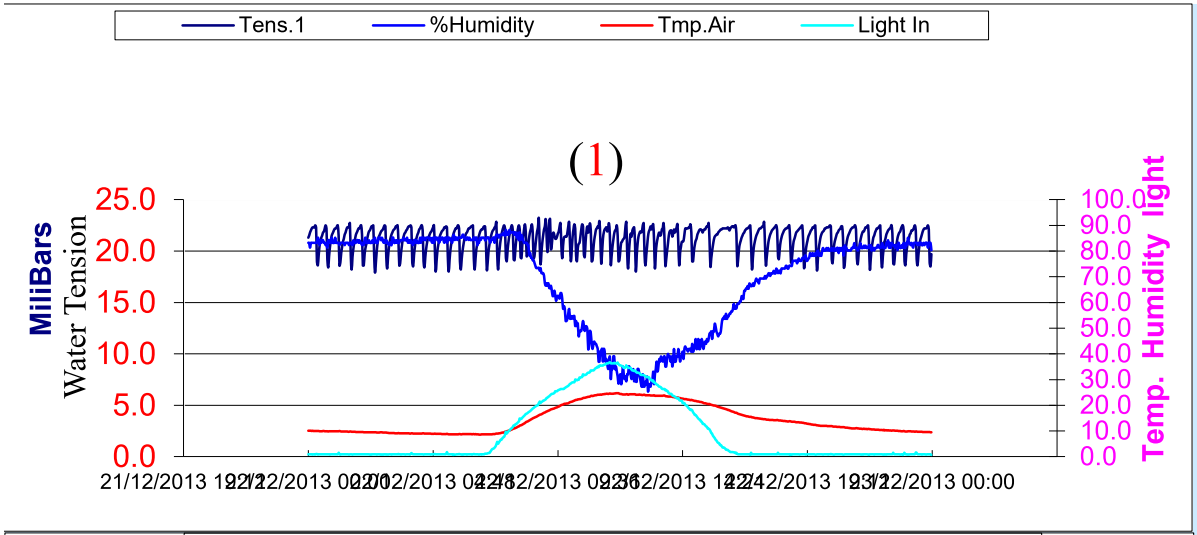
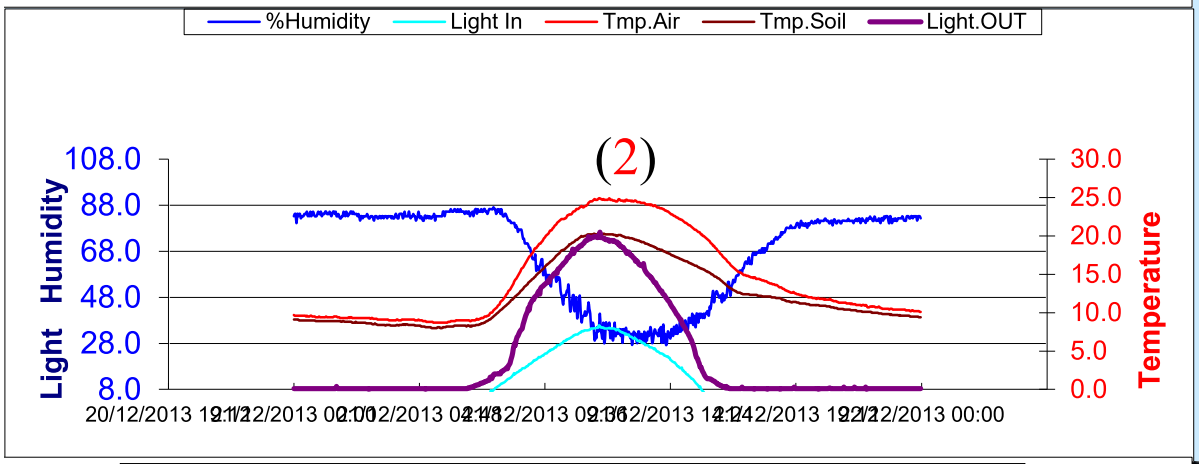
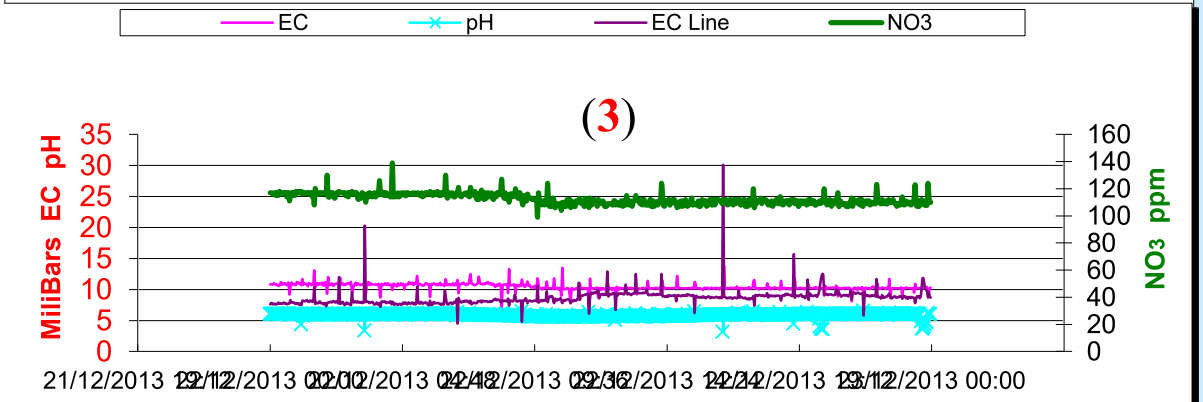
* *6 Values checked daily by us, we see them both in the greenhouse and on our PC.*

These parameters exist almost in every greenhouse, in the soil or in soilless media.







Controlling the greenhouse environment, in real time.

Daily graphs Data of the growing conditions in the Gerbera greenhouse

Ganey Am, Israel 22.12.2013

(1, 2)

6 Phys*ic*al values :

Water tension

Relative humidity

Temperatures: Air - Coco peat

Light in - light out

(3)

4 Chemical values:

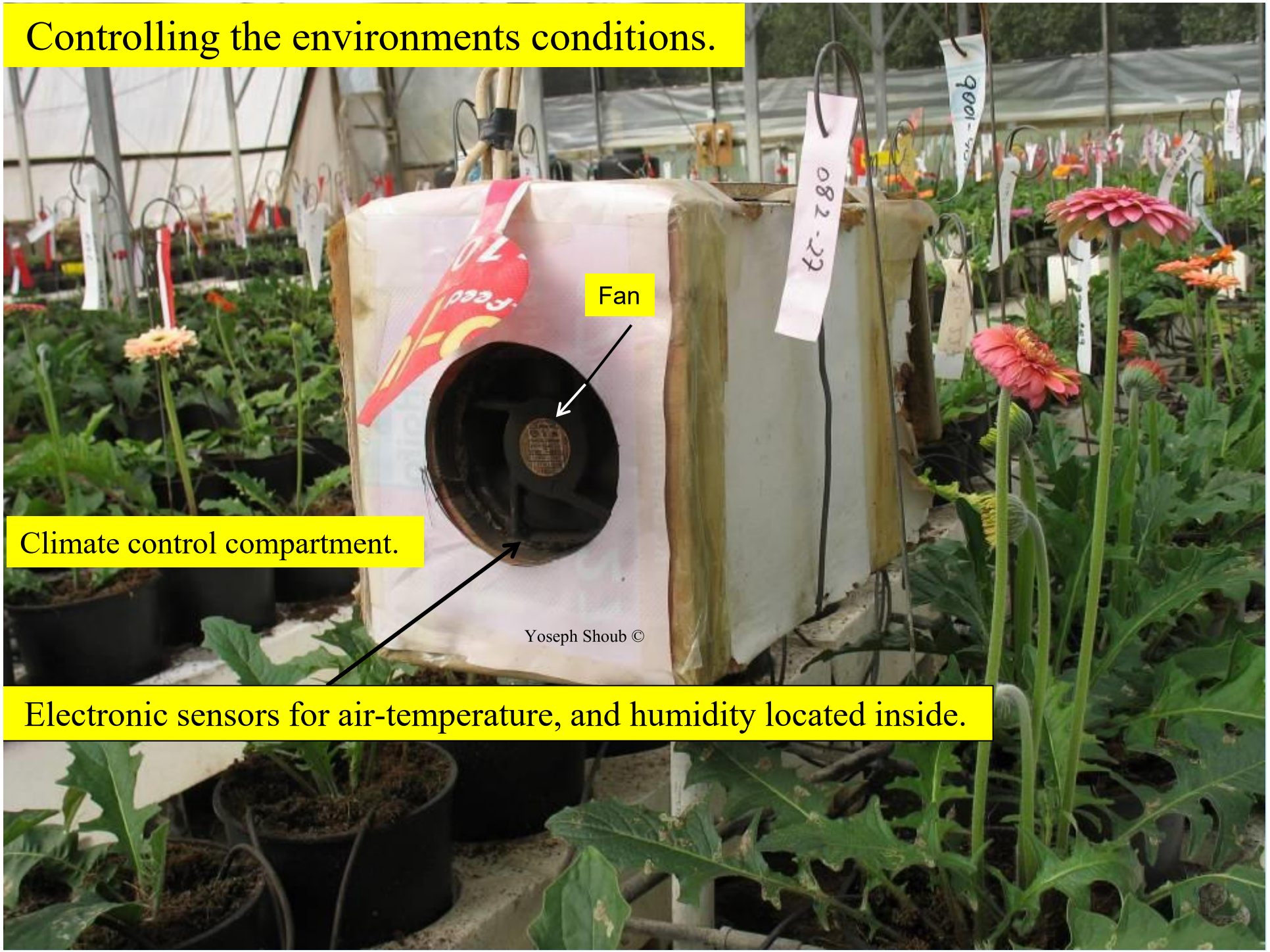
NO3 - drainage

EC - drainage

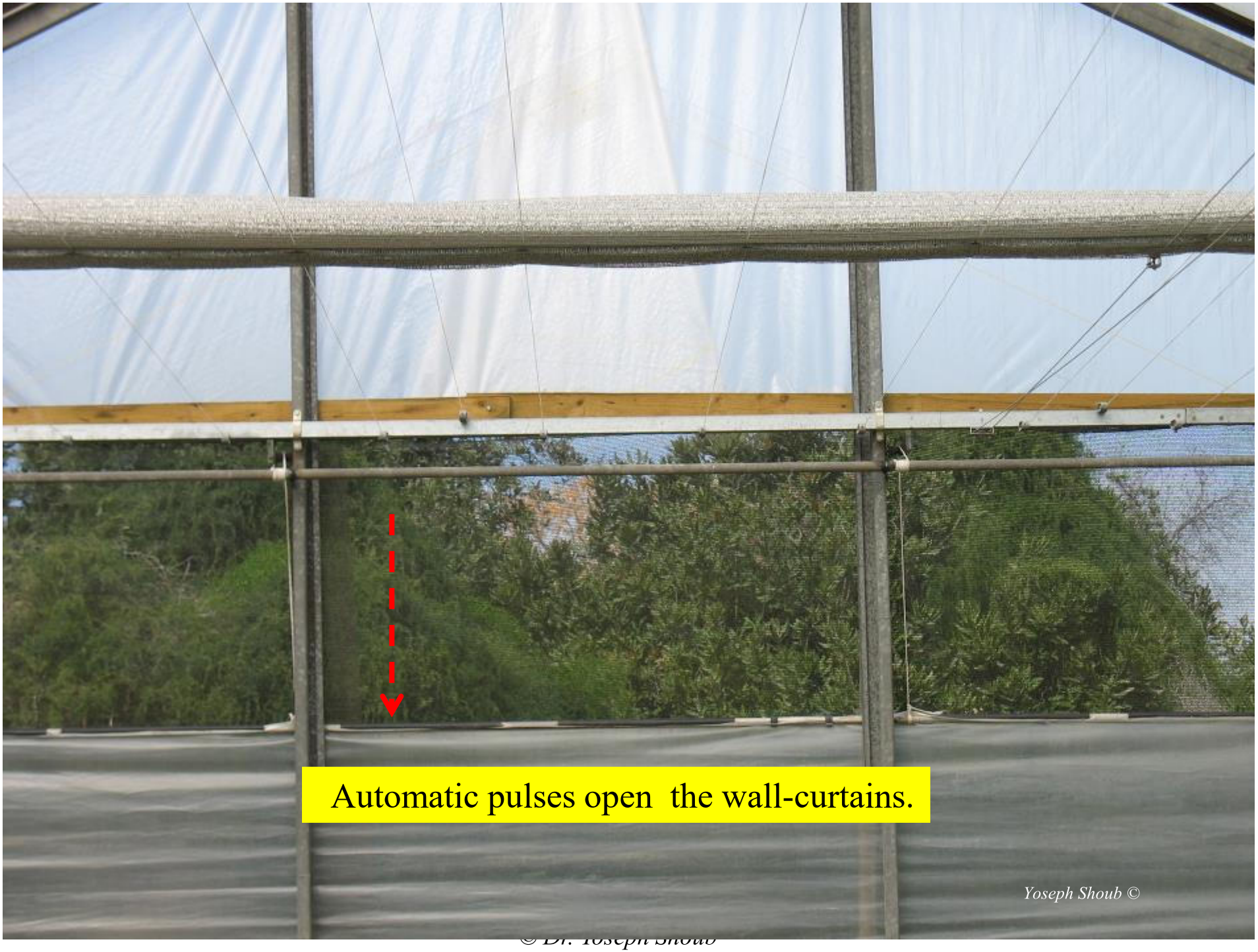
EC - feeding solution

pH - feeding solution

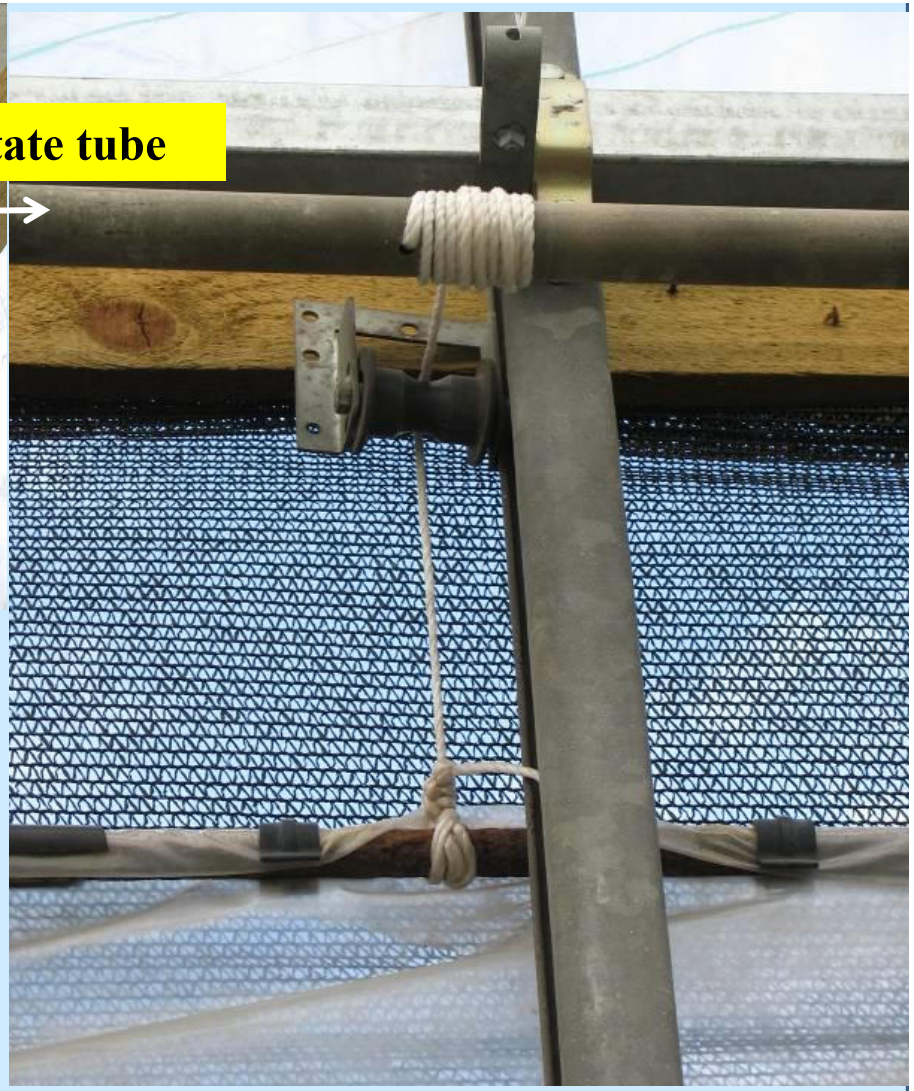
Controlling the environments conditions.



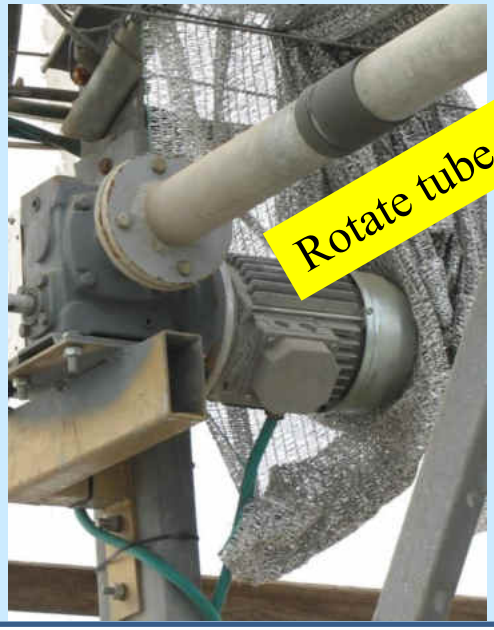

Greenhouse Temperatures control - *as to the natural Air-Temperatures.*
Opening downward pulses - above 26C.
Upward closing on 17C.
Open
Close
Yoseph Shoub ©



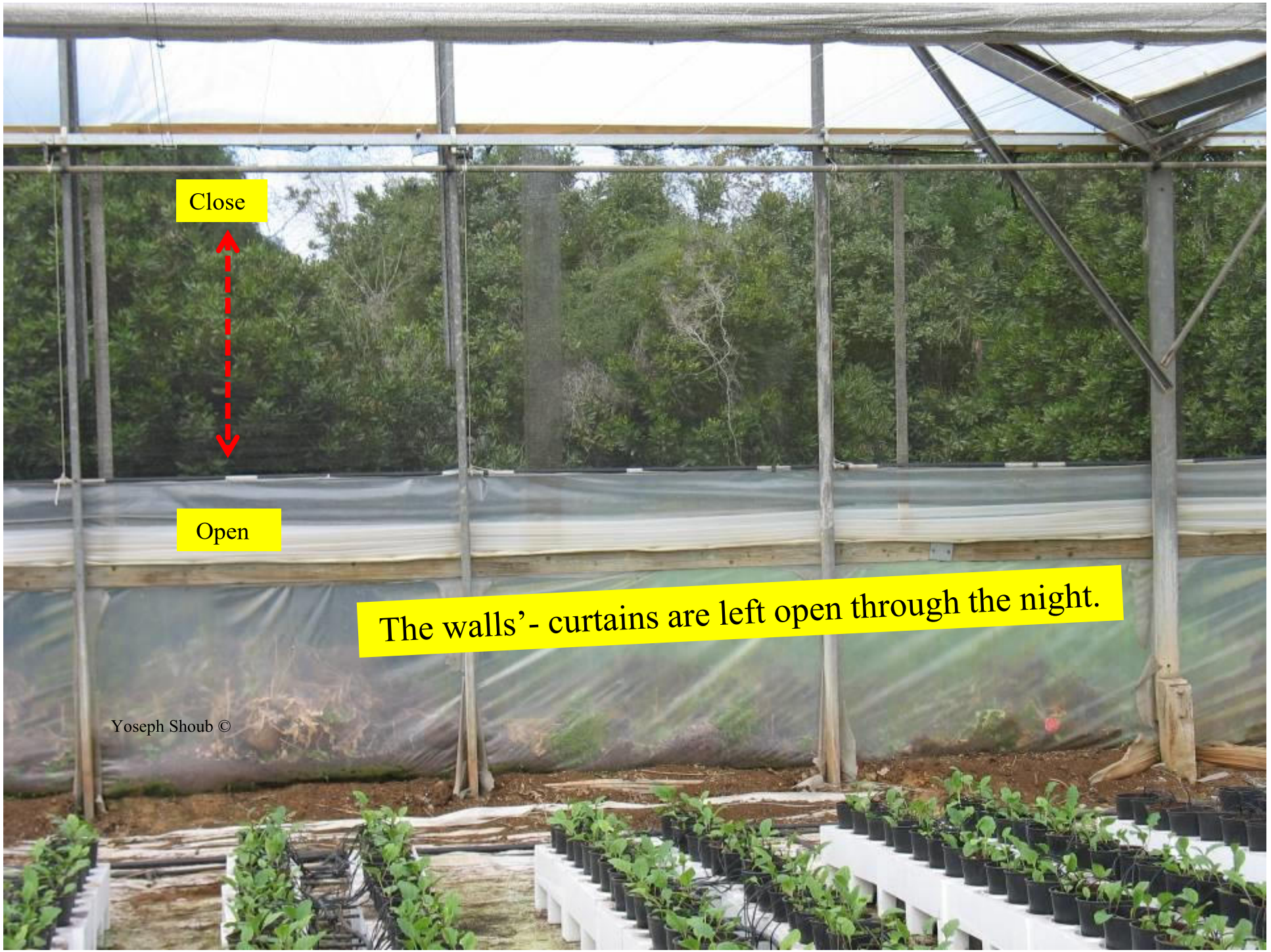
Rotate tube

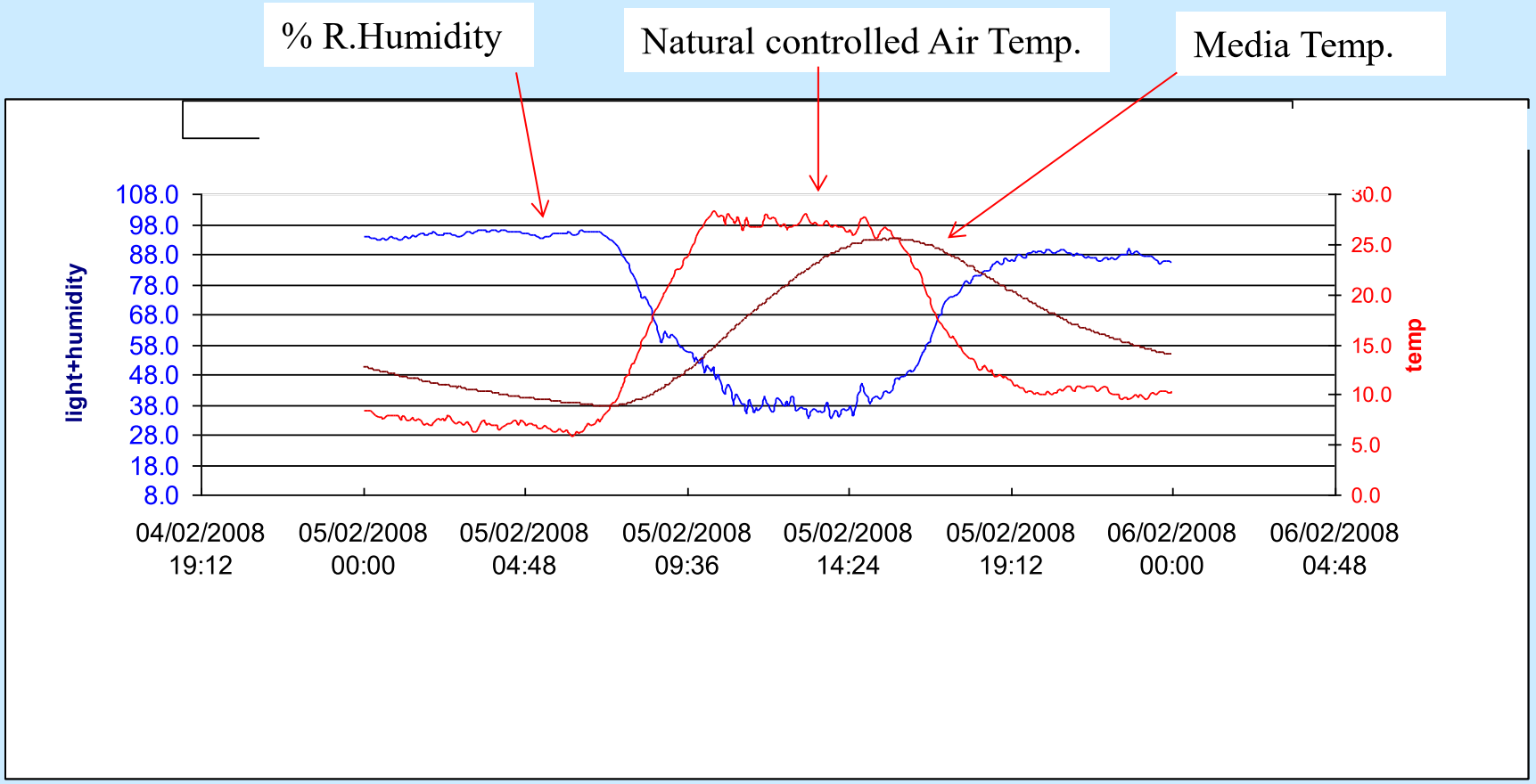


Automatic open / close engine
operating the plastic wall curtains.

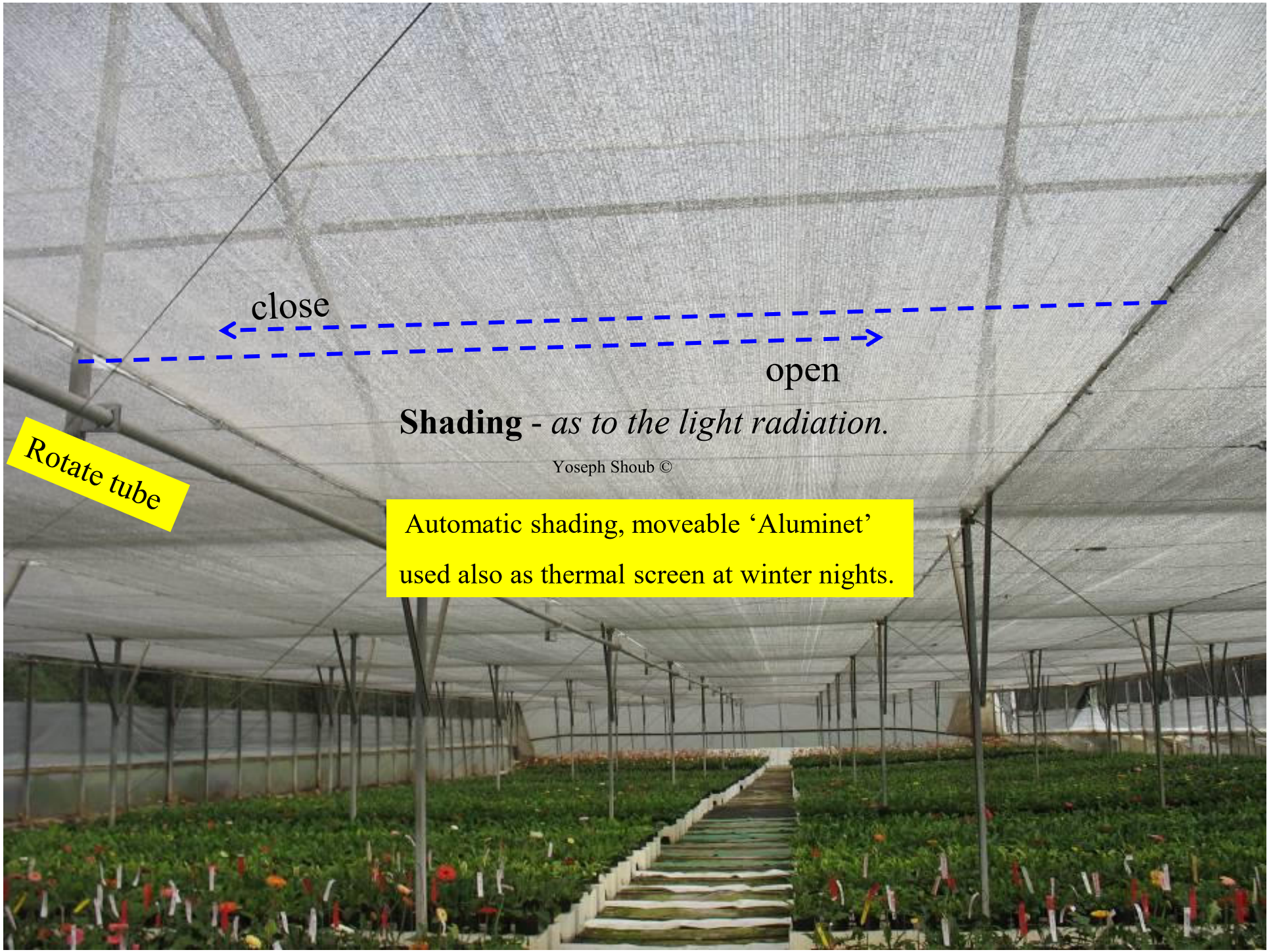


Close / open engin for shading.
Controlled by Light meter, or by Timer.

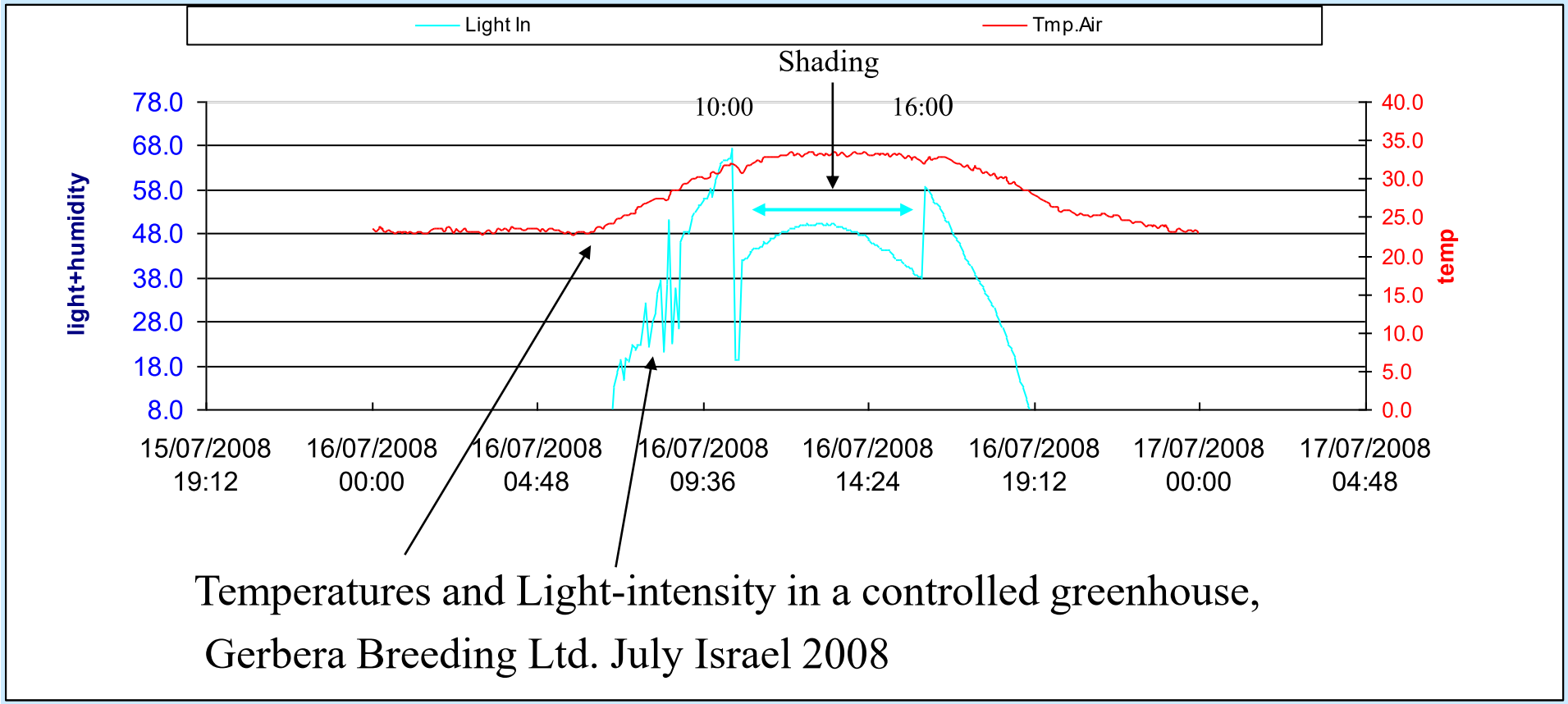

Close
Open
The walls'- curtains are left open through the night.
Yoseph Shoub ©



Relative humidity, air temperatures, ***and the temperatures of coco-peat media*** in 4 L. containers, in a controlled greenhouse. Gerbera Breeding Ltd. Israel February 2008.


close
open
Shading - as to the light radiation.
Yoseph Shoub ©
Rotate tube
Automatic shading, moveable 'Aluminet'
used also as thermal screen at winter nights.

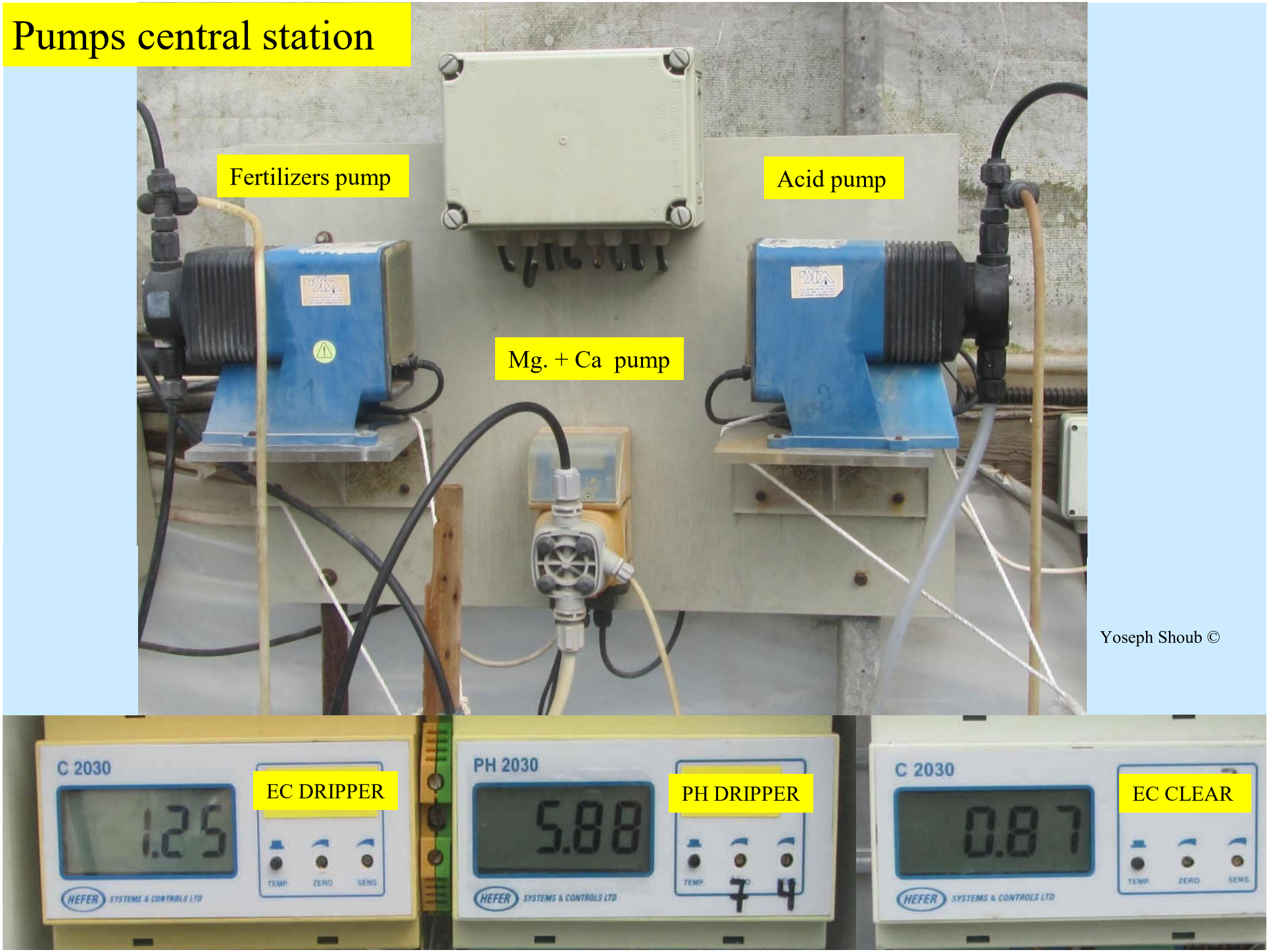

close
open
Yoseph Shoub ©



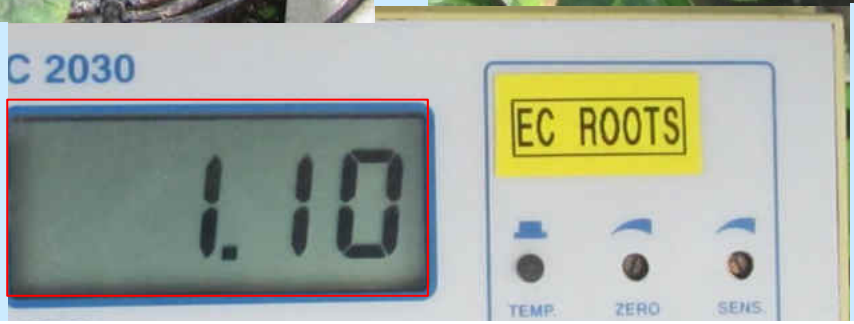
Temperatures and Light-intensity in a controlled greenhouse,
Gerbera Breeding Ltd. July Israel 2008


Automatic 3 Tanks system.
Ca + Mg
Acid
Fertilizers
Yoseph Shoub ©

Pumps central station



Collecting drainage
for the EC electrode



Pumping the
Soil Solution.

‘AA’ controlled gerbera-seedlings, 59 days after transplanting. ‘Gerbera Breeding Ltd’ Israel June 2014.

Feeding Formula used by Israeli growers for gerbera in Sandy-soils. *

Common used feeding formula: 800 - 1000 gr. fertilizers / 1000 Liter.

Conductivity	Acidity	Macro elements (ppm)						Micro elements (ppm)				
EC**	pH	N	P	K	Ca	Mg	S	Fe	Mn	Zn	Cu	Bo
0.8 - 1.3	5.5 - 6.2	170	30	220	100	40	60	2.0	0.28	0.26	0.06	0.5

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* One of many Feedings formulas used in soil culture.

** Added EC units above the EC of the local water.

Feeding Formula used in Gerbera Breeding Lt. In Coco-peat media.

Saving formula: 300 - 500 gr. fertilizers / 1000 L = ~ 45% saving.*

Conductivity	Acidity	Macro elements (ppm)						Micro elements (ppm)				
EC**	pH	N	P	K	Ca	Mg	S	Fe	Mn	Zn	Cu	B
0.4 - 0.6	5.5 - 6.2	100	30	110	100	40	60	1.8	0.22	0.24	0.10	0.3

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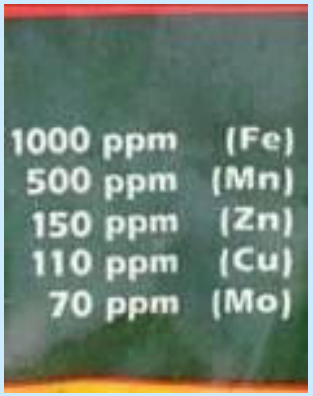
* Formula used for gerbera in Coco peat, in containers in our Gerbera Breeding farm.

** Added EC units above the EC of the local water.

Poly-Feed Fertilizer → 

+ 

+ Boron

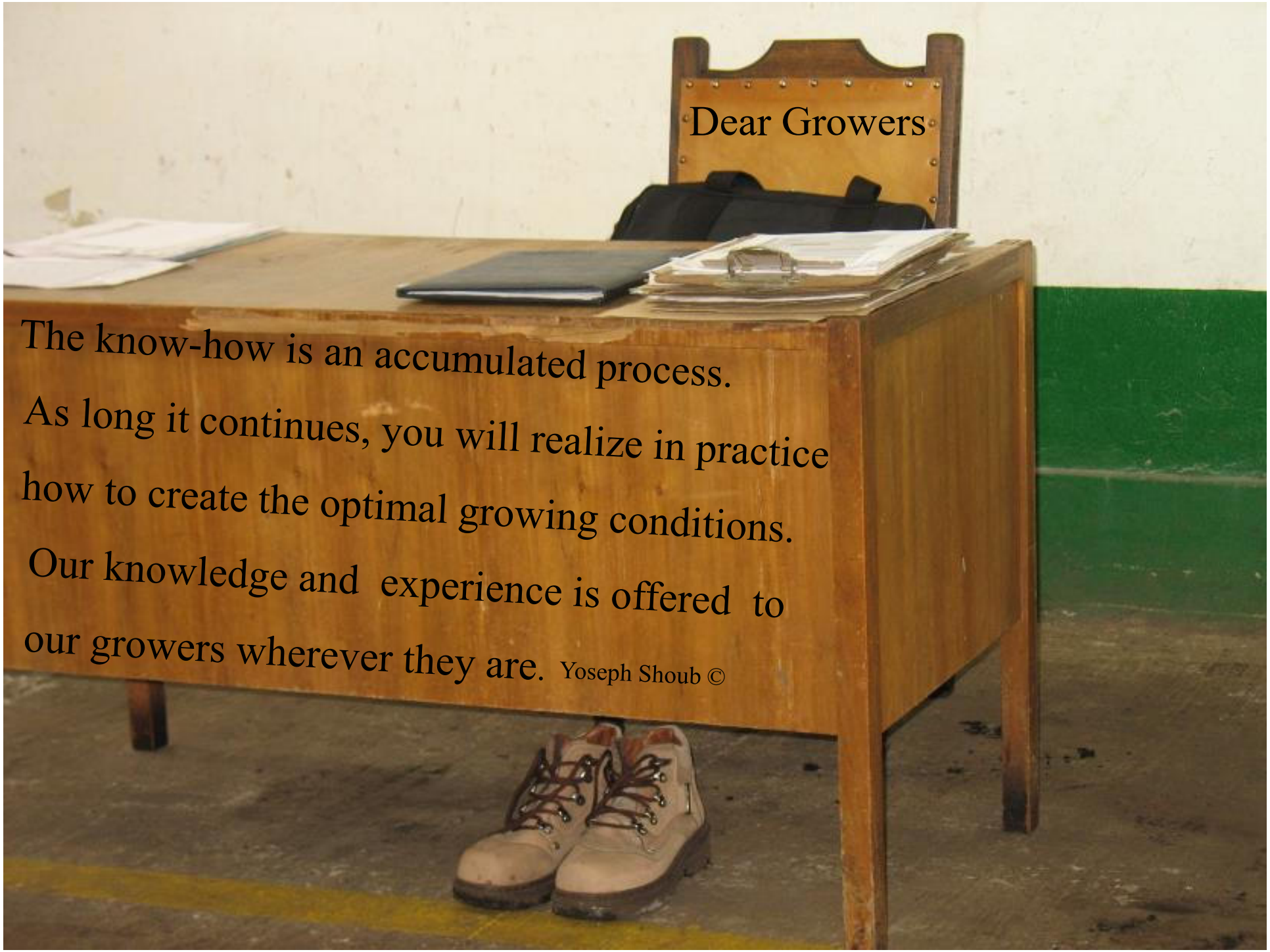
Conclusion -

The lecture started with a short look on drained gerbera beds, promising Optimal Growing Conditions for the roots growth. And we'll finish it with a look on a bunch of well developed adventitious roots, of 4 - 5 years old gerbera plant that grew in our greenhouse.

March 2021.

So: "Let us grow roots, the flowers are the by-products"

A Colombian agronomist said it already years ago.


Dear Growers
The know-how is an accumulated process.
As long it continues, you will realize in practice
how to create the optimal growing conditions.
Our knowledge and experience is offered to
our growers wherever they are. Yoseph Shoub ©


The end
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