

# Guten Morgen, meine Damen und Herren



SUMMER SCHOOL

## Greenhouse Hydroponics *Automation & Management*

*September 23 – 29, 2019*

*Hochschule Geisenheim University*

*Lecture Hall 3 in the Müller-Thurgau-Haus*

*Von-Lade-Str. 1, Geisenheim*



**Papaioannou Chrysoula**

SPECIAL THANKS TO  
Dr. EVELYNE DIMKOU



# Papaioannou Chrysoula



- Mechanical Engineer
- PhD in Greenhouses (Covering Materials)
  
- Prof. University of Thessaly,  
\_\_\_\_\_ Dpt. of Agrotechnology

**My topic  
is aeropony**





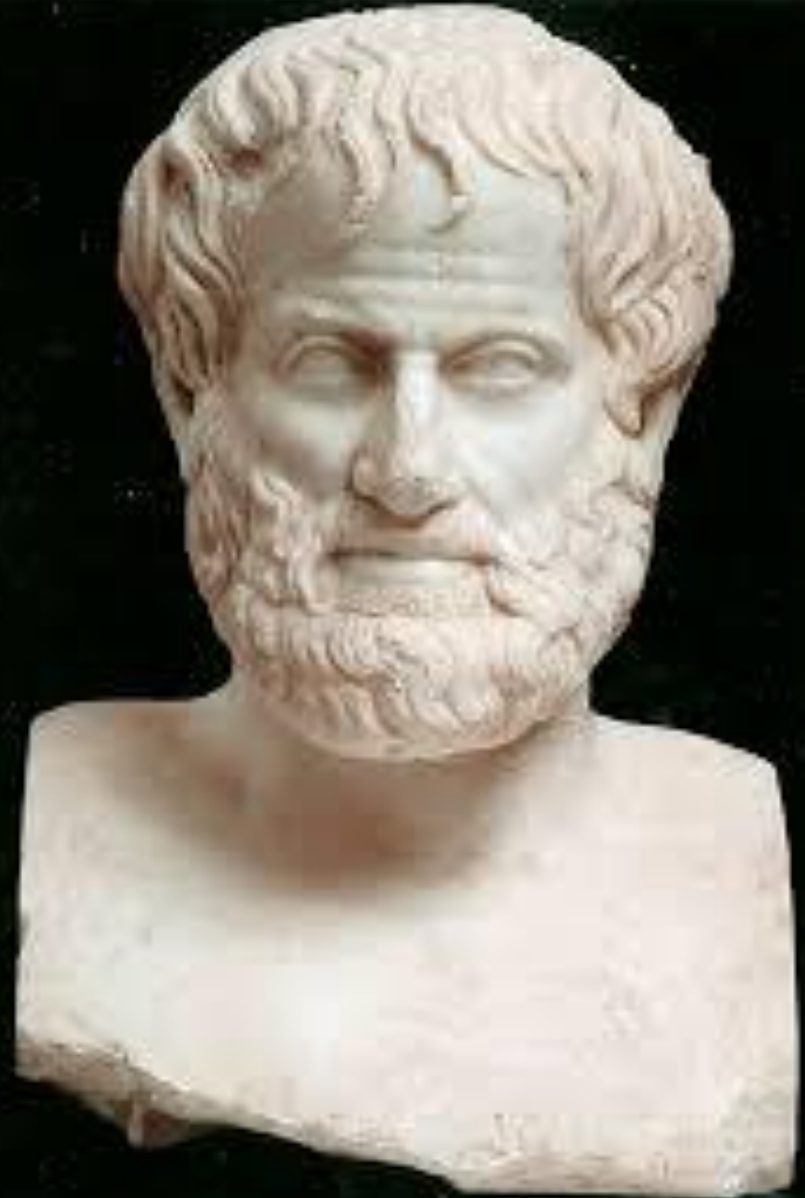
# Great moments in Agricultural Science

**300 BC**

**Aristotle,**

**Greek Philosopher,  
Teacher  
of Alexander the Great  
From North Greece  
(Stageira, Makedonia)**

**“Soil feeds the plants”**



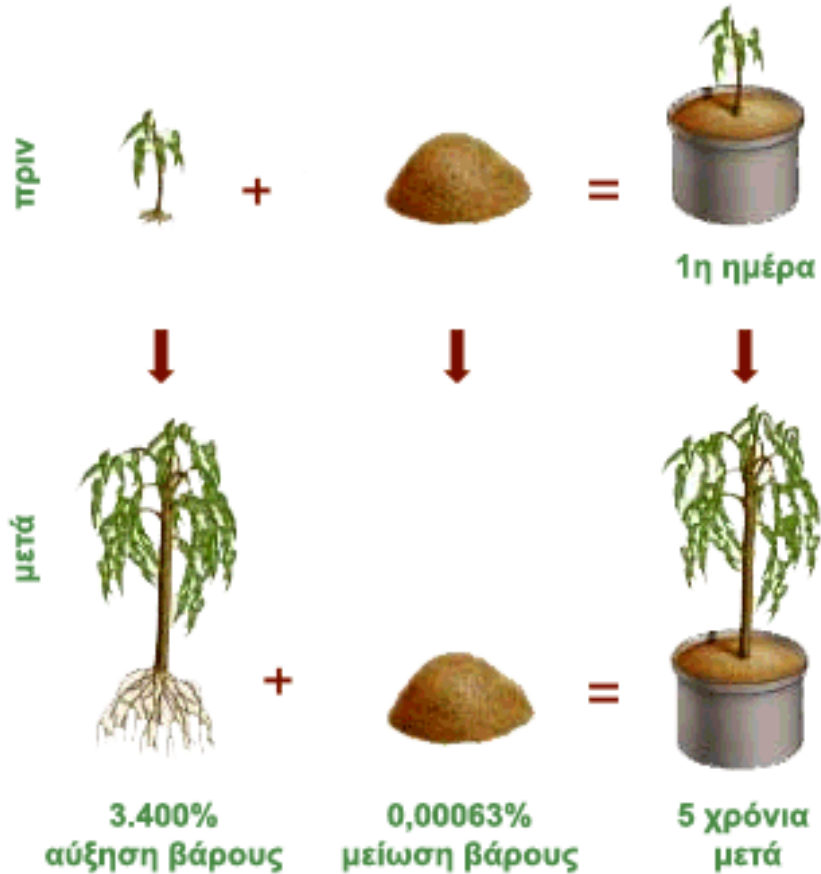
16<sup>th</sup> century

**Jean Van Helmont,**

University of Leuven



# Jean Van Helmont's experiment:

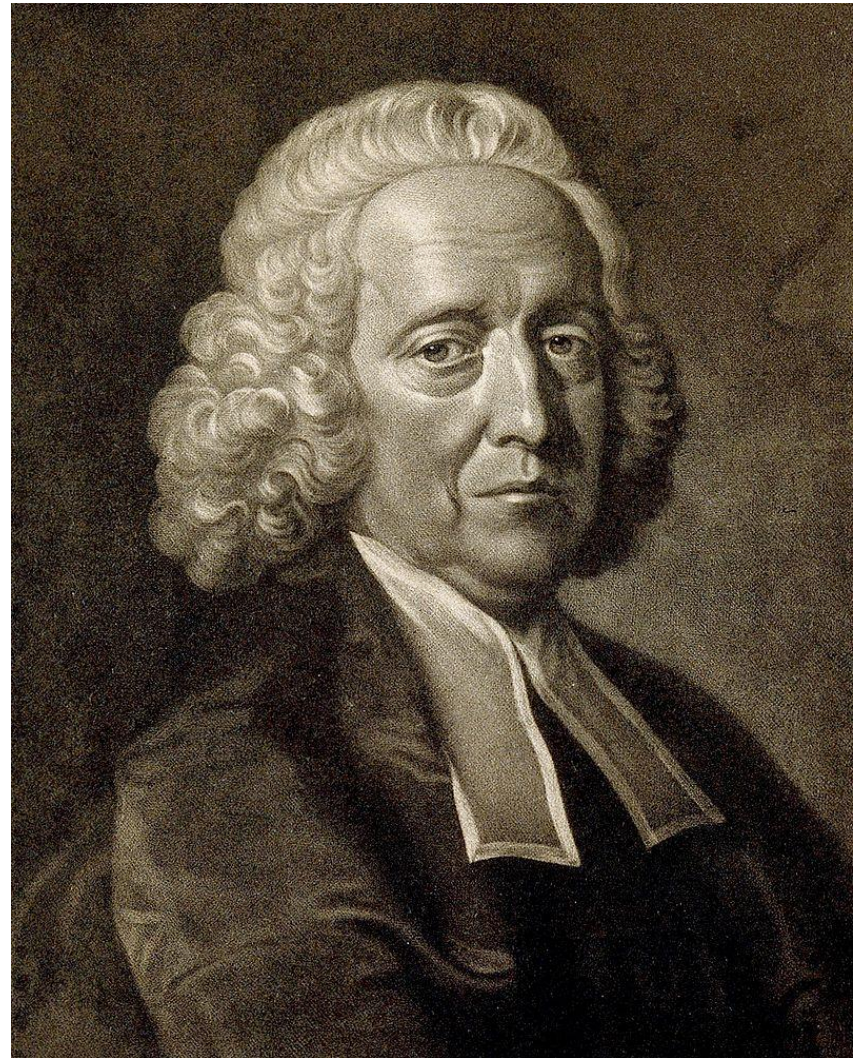


17<sup>th</sup> century

**Stephen Hales,**

Cambridge University

**‘Plants use air CO<sub>2</sub>  
for  
photosynthesis’**







18<sup>th</sup> century almost  
**Joseph Priestley** (1733GB-1804USA),

**Discovered O<sub>2</sub>**



**Glass jar**

1. When no **O<sub>2</sub>** the candle wend off
2. Unless there is a plant inside to preserve the fire
3. Or to help the mouse to survive



Jan Ingenhousz (1730-1799)

‘Only the green parts of the  
plants  
can absorb  
ingredients of the  
atmosphere  
and  
this is happening only with  
the presence of light’



## Jean Senebier (1742 – 1809)

**Swiss pastor and naturalist.**

“O<sub>2</sub> that plants produce  
is derived from the CO<sub>2</sub>  
that they absorb”

(this was proved later /mid 20<sup>th</sup>/  
when the atoms of elements were  
discovered )



Julius Sachs's equation:

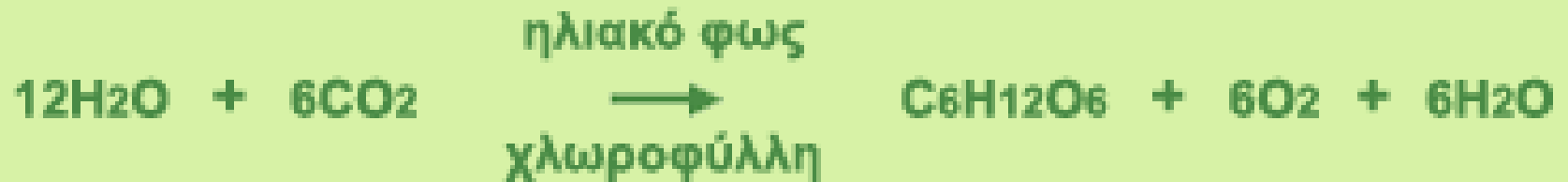


*German botanist from Breslau,  
1832 – 1897*

Julius Sachs's equation:



Was moderated :



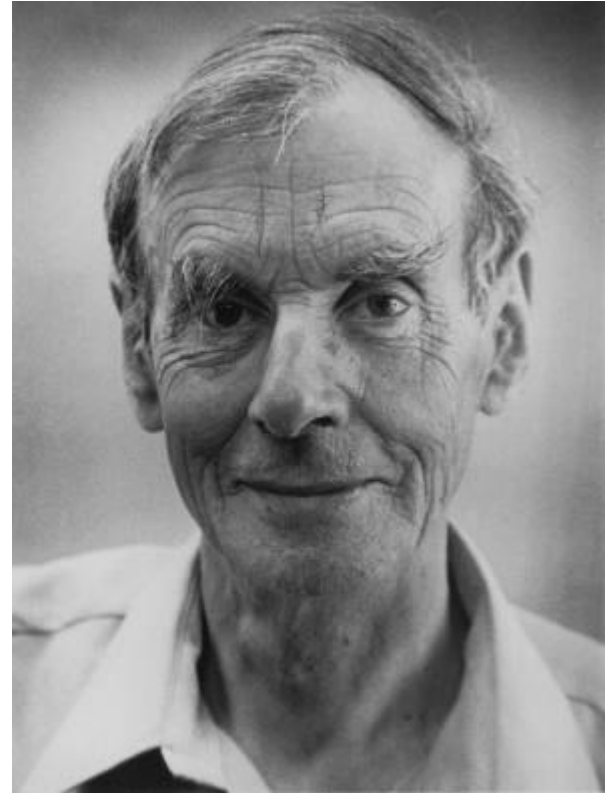
When it was discovered that:  
the O<sub>2</sub> that is produced comes from the water  
and not from the CO<sub>2</sub>  
that it was believed

## 19<sup>th</sup> century Robin Hill (1937)

Execute an experiment

Proved that during  
Photosynthesis  
 $O_2$  is produced if there is light

Even though there is no  $CO_2$  available



**British plant biochemist (1899-1991)**

# Melvin Calvin

(1911-1997)

Proved dark Photosynthesis  
(Calvin circle)

‘The main products are a  
high energy  
carbohydrate, which  
directly or indirectly  
ensures energy in all  
living organisms and  
oxygen’



American biochemist,  
University of California

# Question #1

**How many chemical  
elements are needed for  
plant growth??**

○ **Until 1869** : N, P, K, Ca, Mg, S, Fe = **7** elements

○ **1880** : +C, H, O = **10**

○ **1890** : +Mn = **11**

○ **Until 1940** : +Cu, Zn, Mo, B, Cl, = **16**

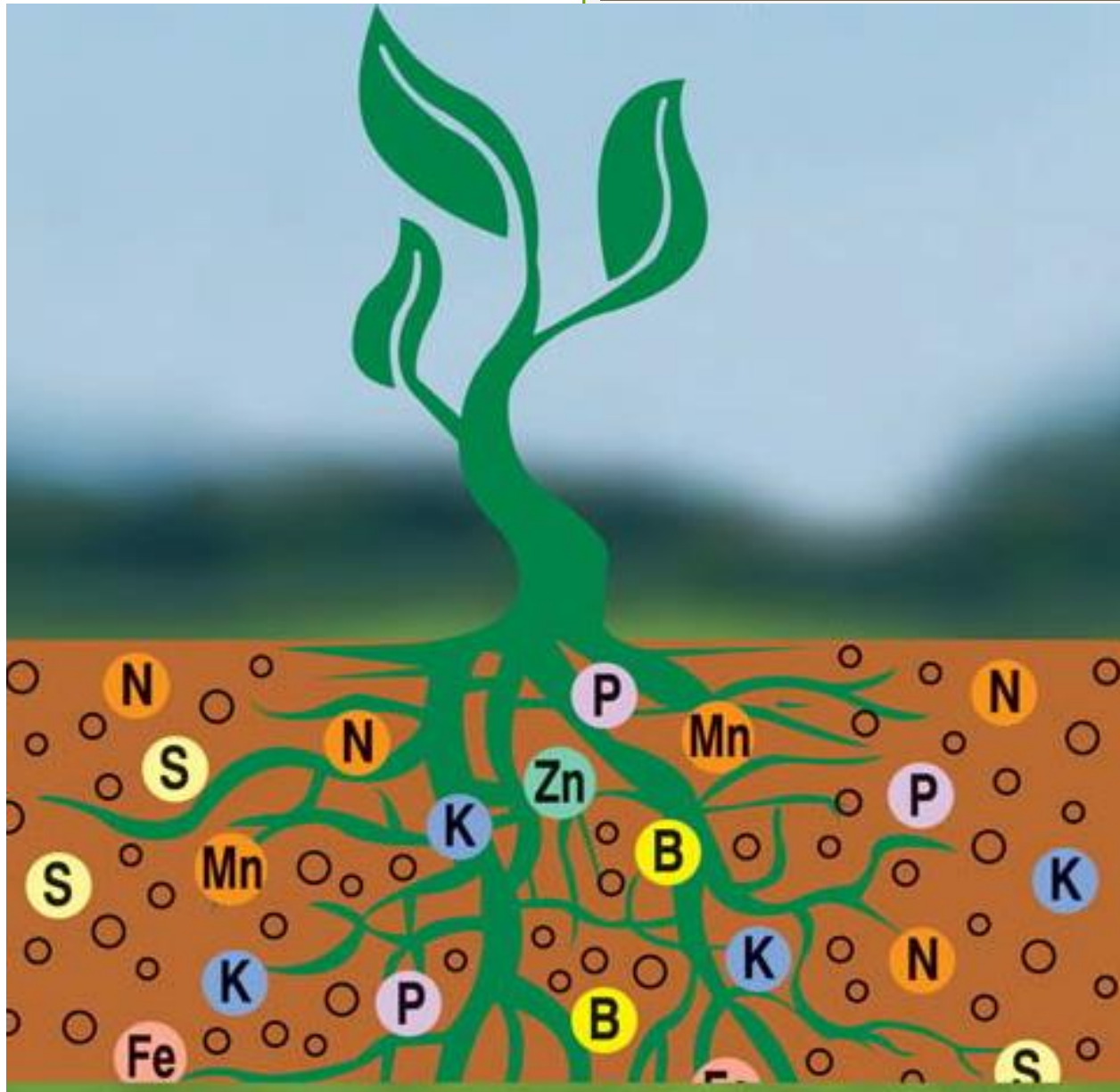
○ **Later/Recently**: + Na, Co, Si, V, Ni = **21**

# Question #2



# How the plants are taking them???

- Basic law of liquids movement:  
Pressure difference creating by a pump



## Question #3

- How the roots can find oxygen for growth
- Which is the normal practice???



$O_2$

**Aerate the root zone**



Velestino, 2002

hy  
dr  
op  
oni  
cs

Prof Bartzanas,  
Univ. of Athens

Prof Dany El Obeid  
Univ. of Lebanon

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ae  
ro  
po  
nic  
s





hydroponics

aeroponics

Ponics = pono  
=ΠΌΝΟΣ=  
**I am in pain.....**





hydroponics

aeroponics

aponics

ΠΌΝΟΣ = I am in pain.....  
ΑΠΟΝΟΣ = I am not in pain.....



UNIVERSITY OF  
THESSALY



Construction of  
the aeroponic  
greenhouse





03/03/2017









# Infrastructure















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# Greenhouse cover





# Mechanical Equipment



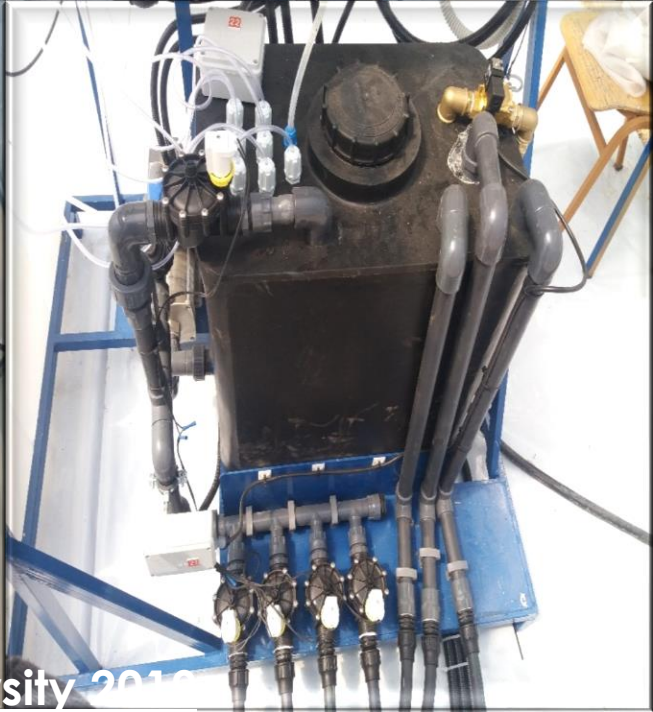


# Fence and gate





# Preparing tables for plants and Assembly of Nutrition System

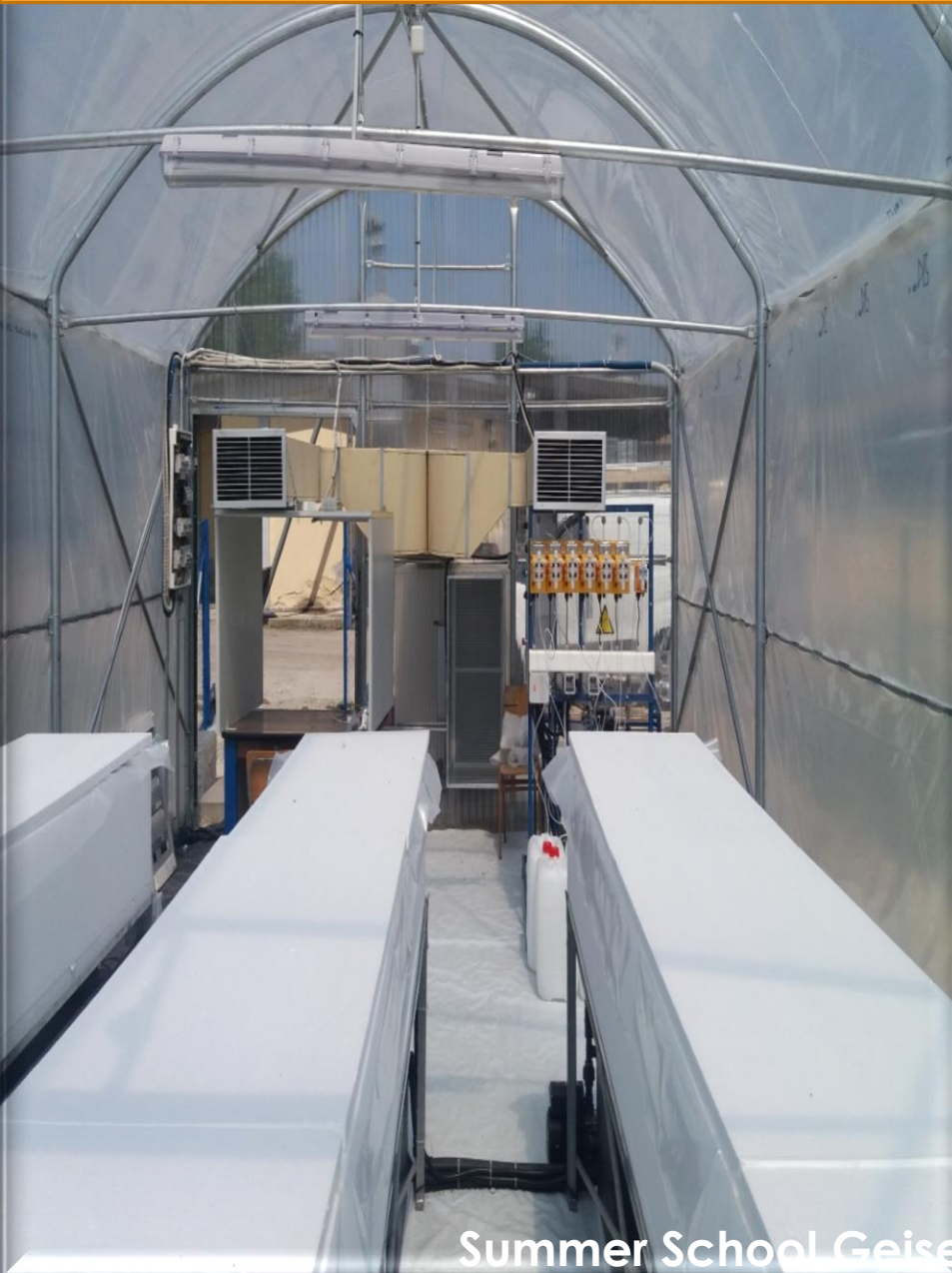




# boxes of the plants and pipes for irrigation/fertigation



almost ready



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done



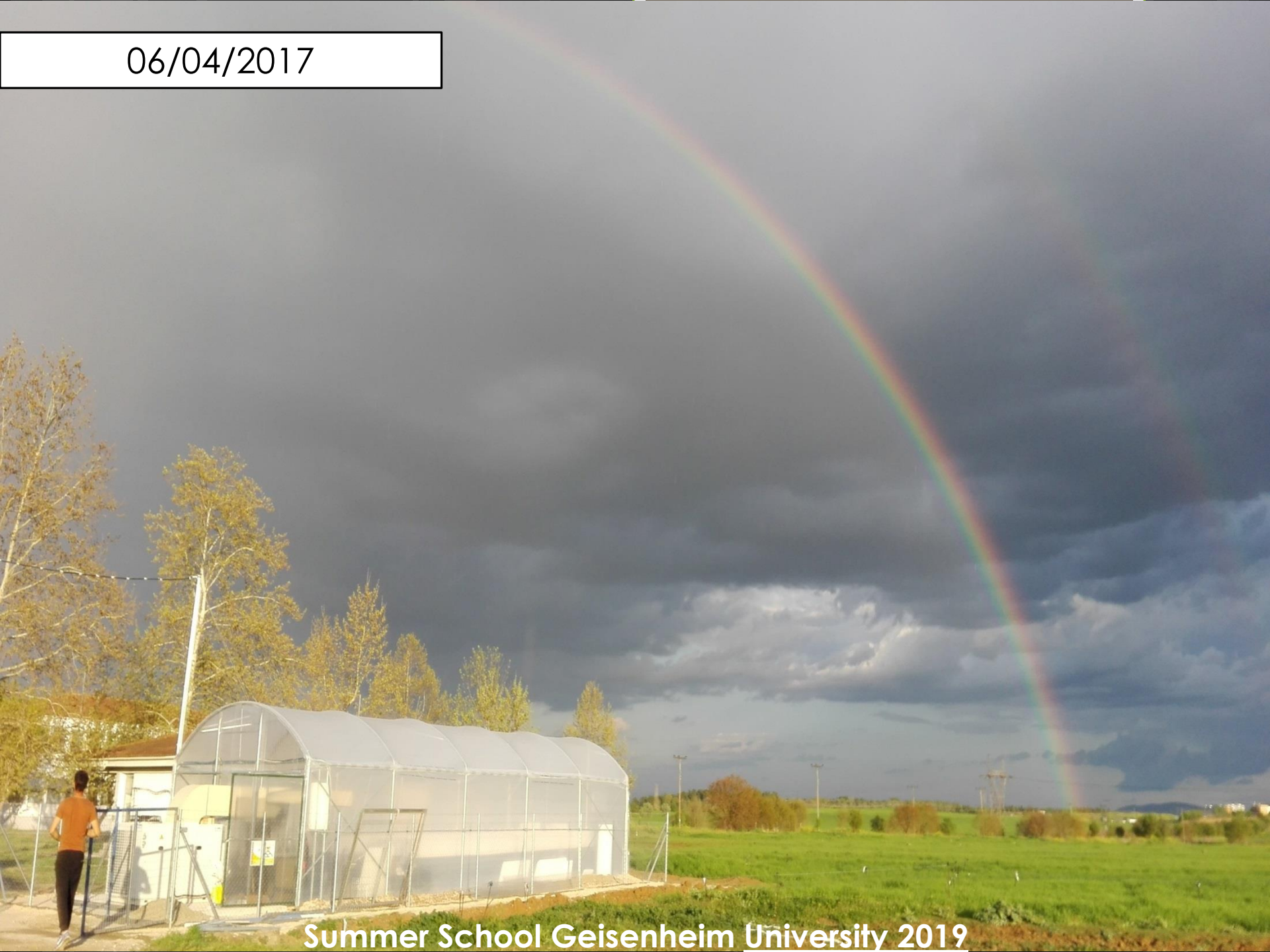
06/04/2017



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06/04/2017



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# Sponsors



**Tokatlidis Lazare,**  
Chemical Engineer = Funding Resource

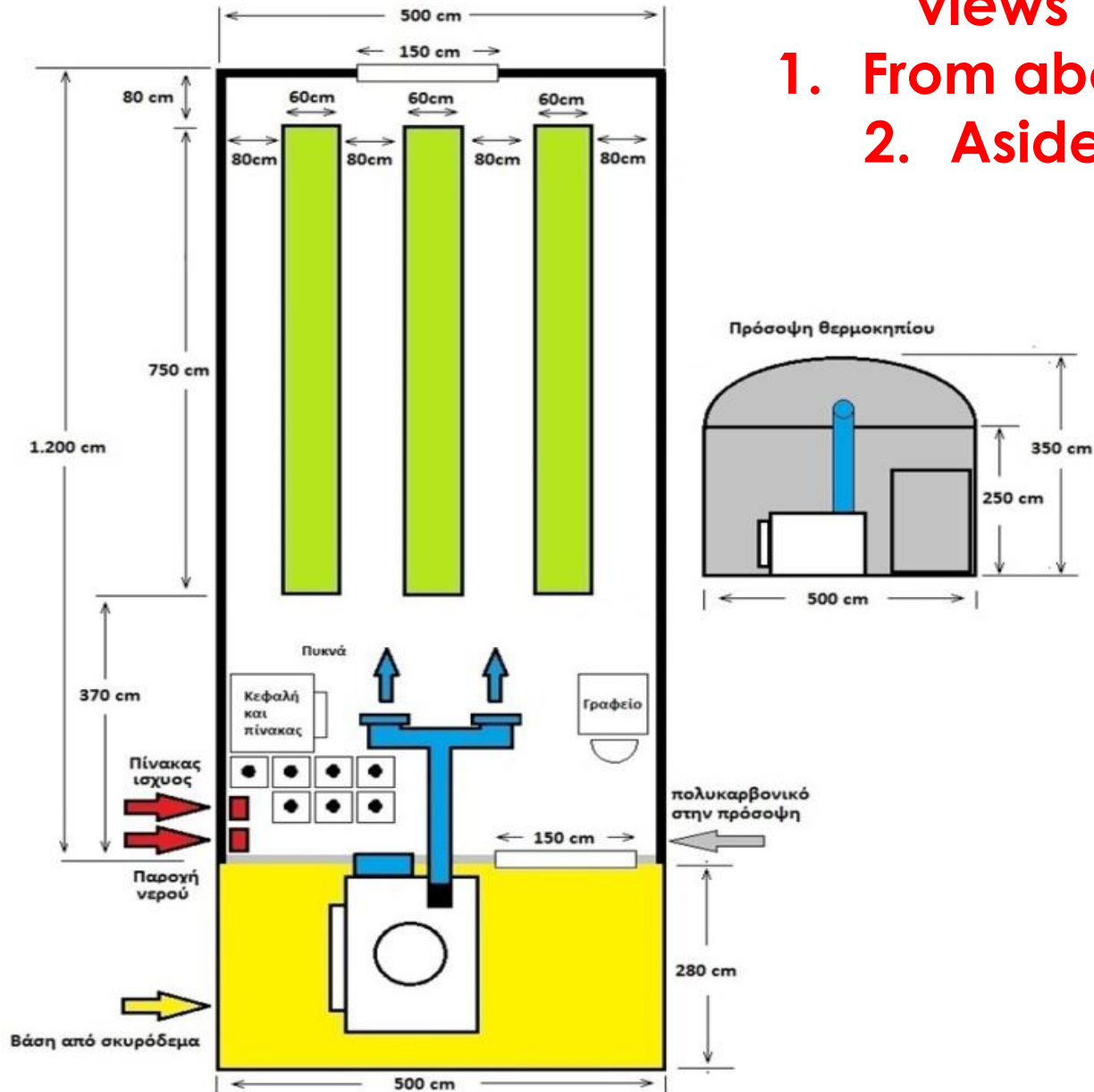


[www.fabelab.com](http://www.fabelab.com)  
g/Cooling System

**drawings**

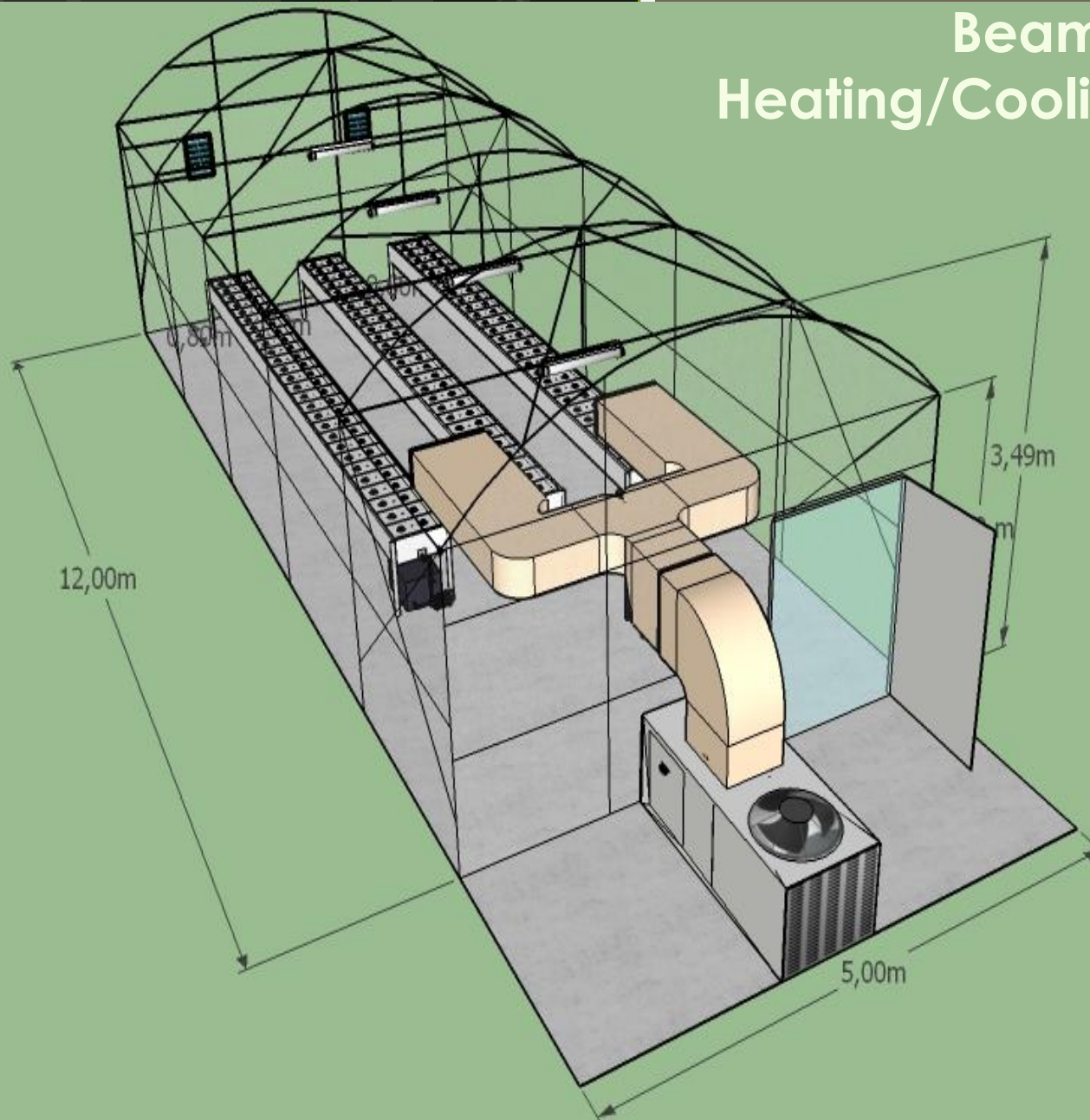
views

1. From above
2. Aside



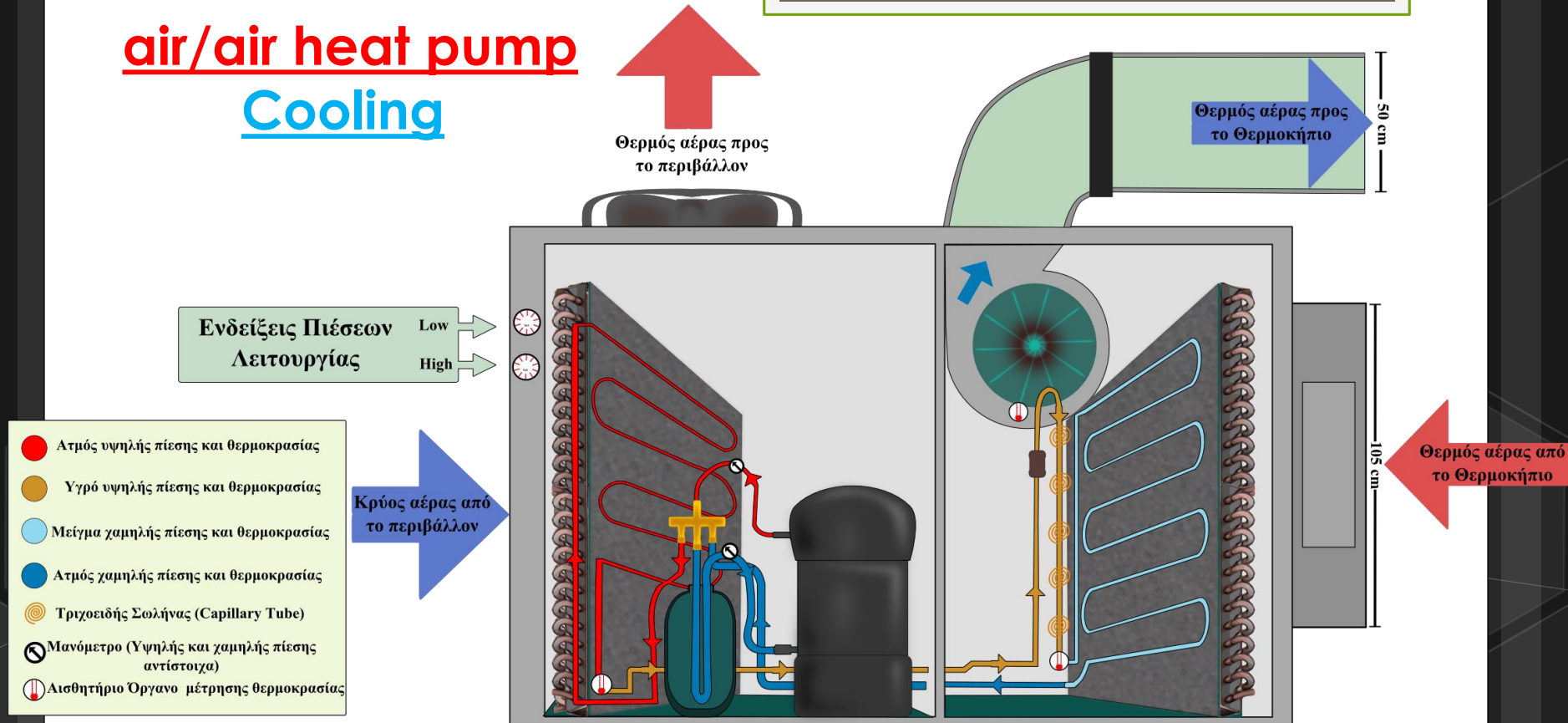


# Beams Heating/Cooling System



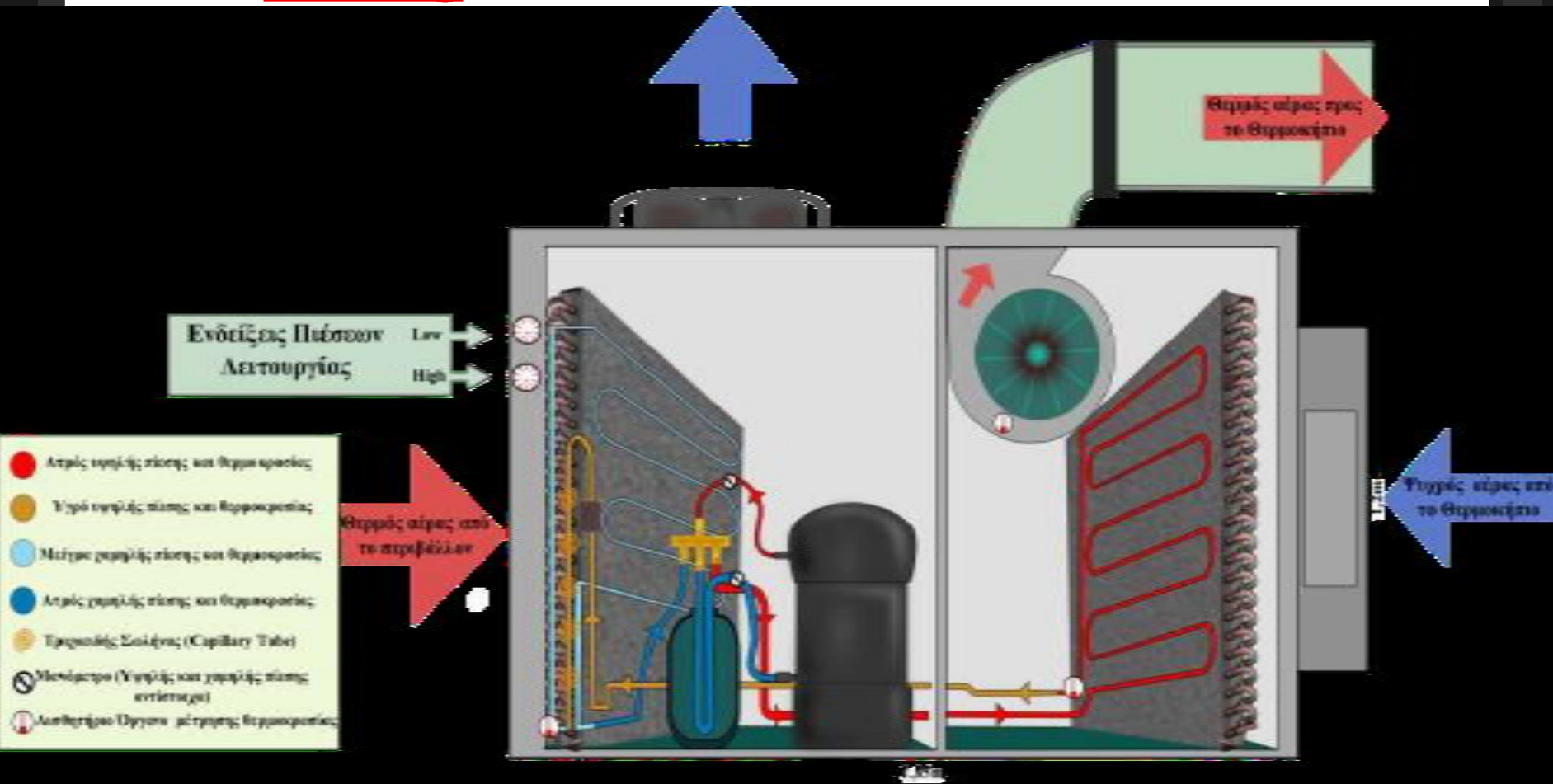


# air/air heat pump Cooling

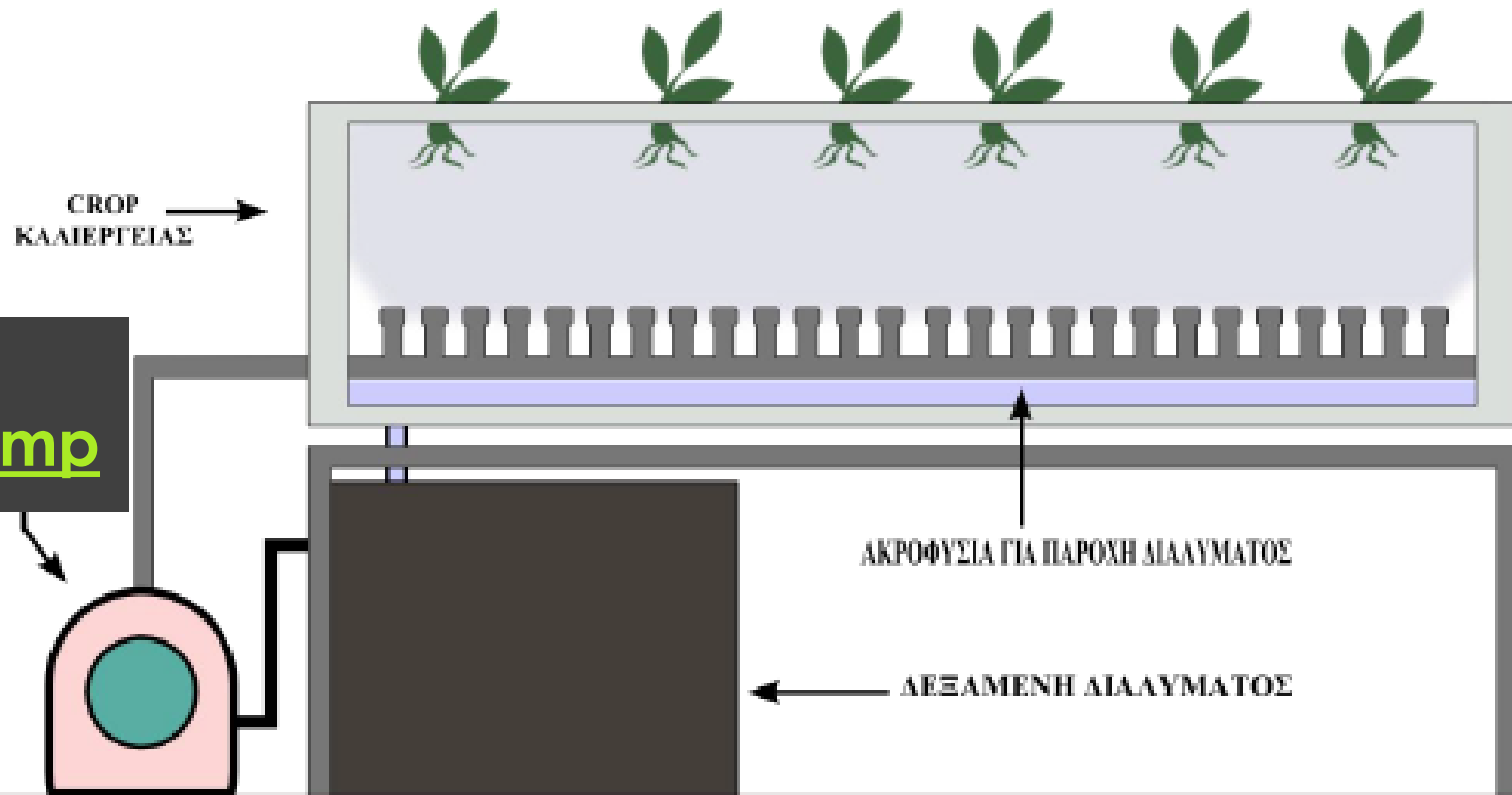


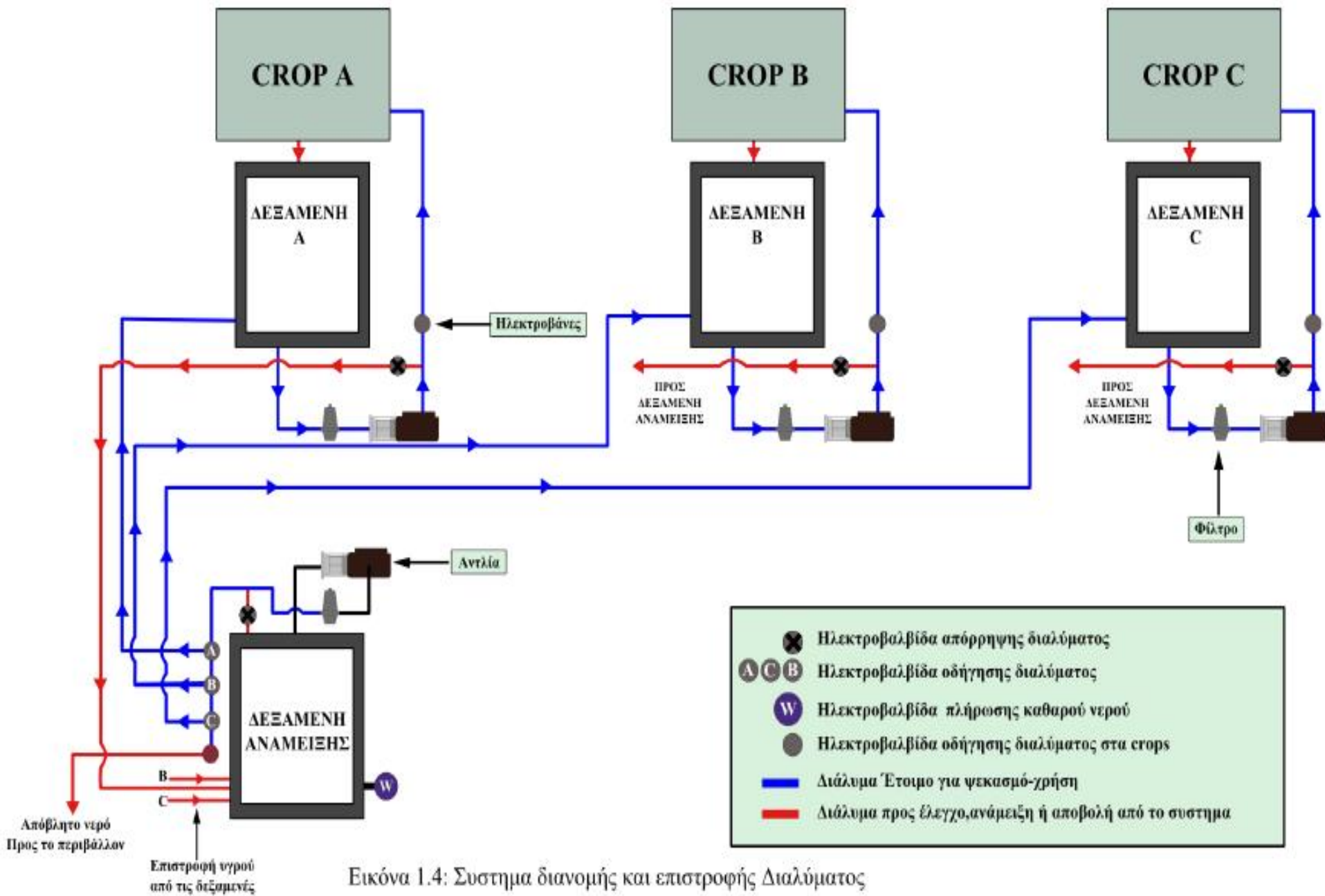
Διάγραμμα 2.1: Κύκλος Ψυκτικού κατά τη Διαδικασία της ψύξης

# air/air heat pump Heating

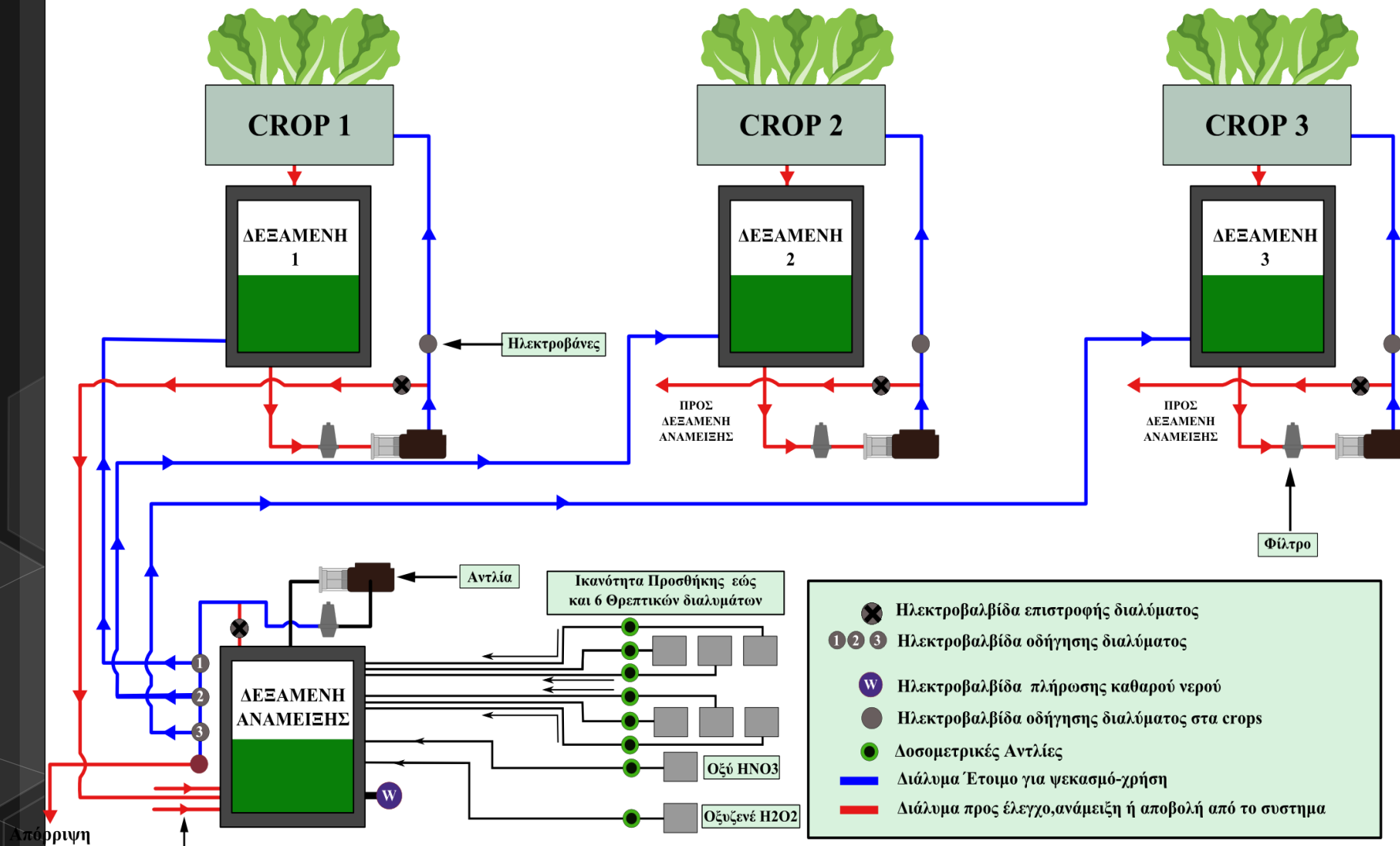


## Irrigation / Fertigation





Εικόνα 1.4: Σύστημα διανομής και επιστροφής Διαλύματος



Διάγραμμα 1.4: Σύστημα διανομής και επιστροφής Θρεπτικού Διαλύματος



# **Displays of Automation Control**



**EXIT**

380 Vac OK

**PLC OK**  
**Battery OK**

System is initialized

Allow make 1	Allow make 2	Allow make 3
Day only	Day only	Day only
make	make	make

NO Fix pH 1	NO Fix pH 2	NO Fix pH 3
Fix pH	Fix pH	Fix pH

IRRIG-1	STOP
IRRIG-2	STOP
IRRIG-3	STOP

synchro time  
PLC with PC

LOCAL time

11:54:59

PLC time

11:54:59

set Liters  
Irrigation

Είμαστε HOME

see CROP 1

see CROP 2

see CROP 3

see KLIMA

POWER behavior

set Parameters

DATA BASE

Read Data Base

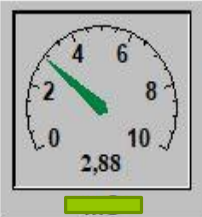
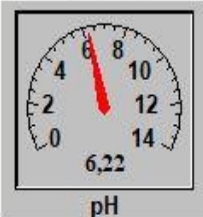
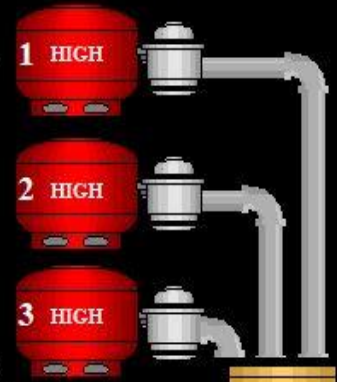
Actual parameters

SWITCH PRG-1 ON  
SWITCH PRG-2 ON  
SWITCH PRG-3 ON

see Events

Clear

Sensors STATUS  
  
**OK**



Reset all Fails

PRG over time

EMPTY	
FILL	
FIX pH	
TRANSFER	1 2 3

pH Fix over time

EMPTY	
SEND	1 2 3
FIX pH	
RECEIVE	1 2 3

ΥΠΕΡΧΕΙΛΙΣΗ

BOX TEMPERATURE

set min Box Temp

AIR TEMPERATURE

set max Box Temp

pH/EC FAIL 1 2 3

HIGH EC 1 2 3

HEAT PUMP FAIL

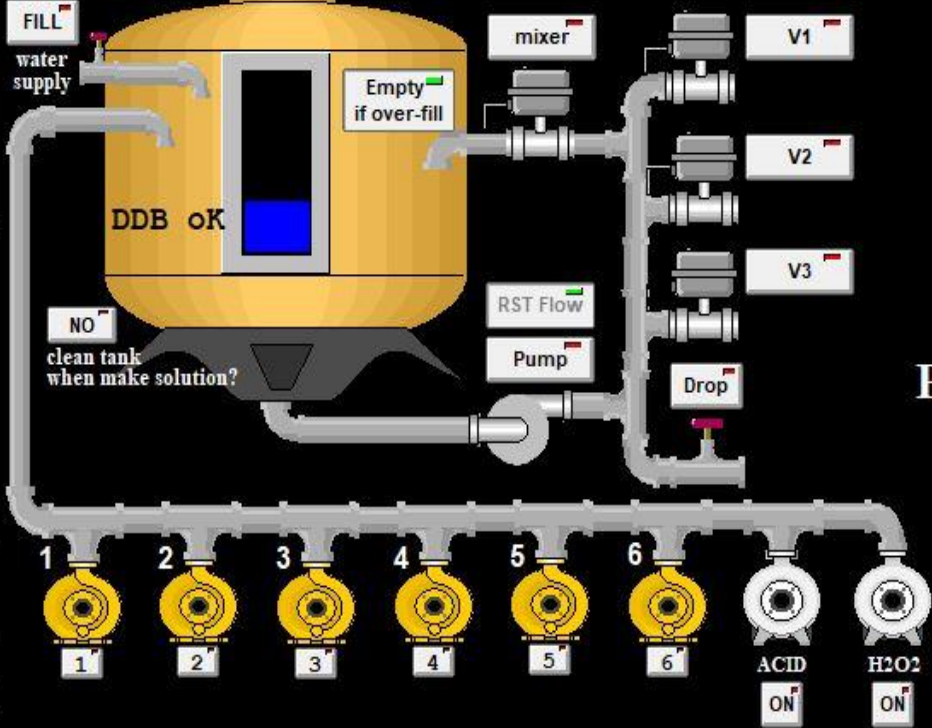
TANK LEVELS

NO FLOW 1 2 3

set min Air Temp

set max Air Temp

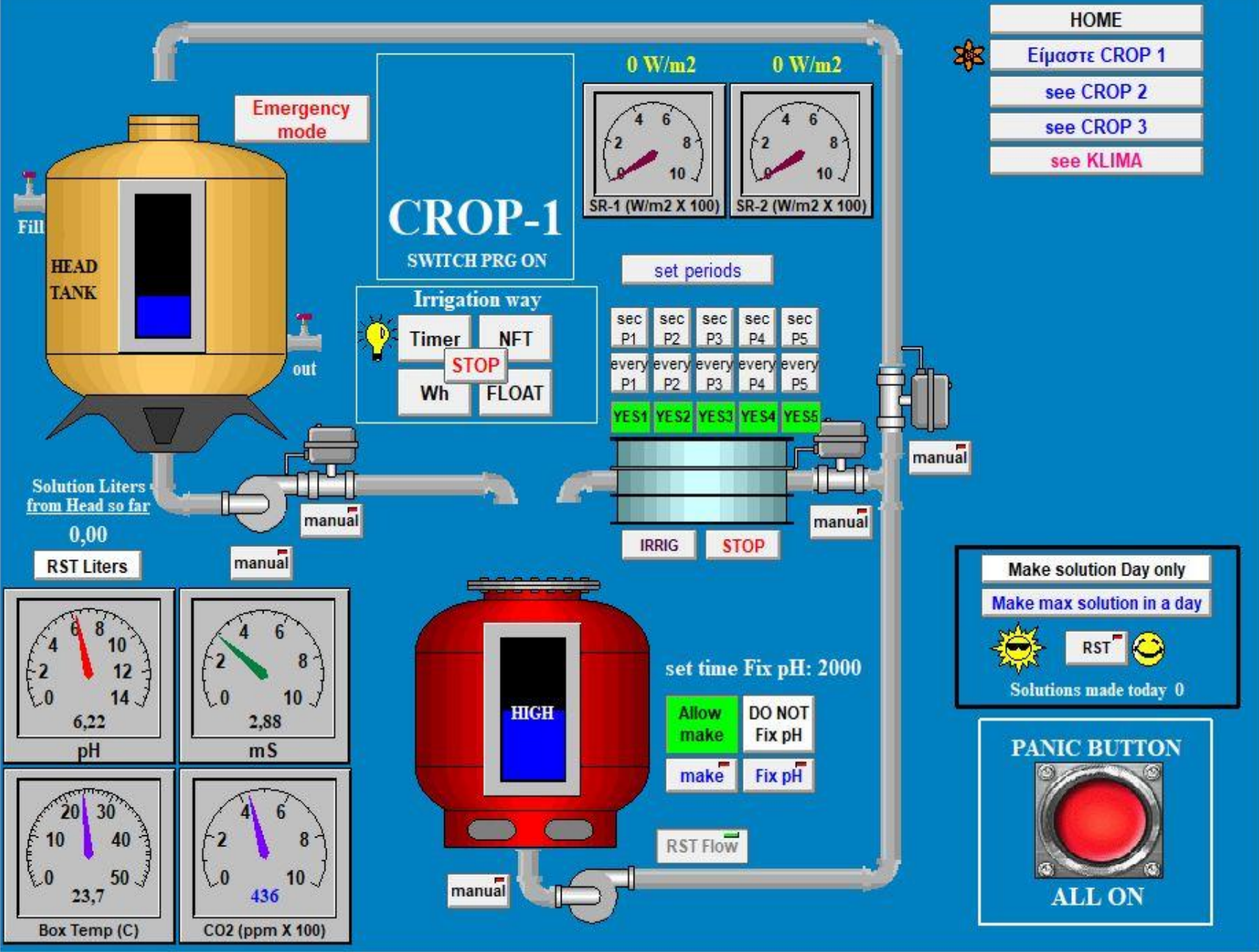
See Level alarms




**PANIC BUTTON**



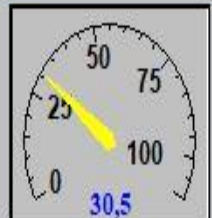
**ALL ON**








Offset Temp (C)  
32,0

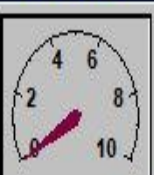


RH (%)  
30,5



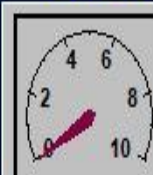
CO2 (ppm X 100)  
436

0 W/m2



SR-1 (W/m2 X 100)

0 W/m2



SR-2 (W/m2 X 100)

VPD (KPa) = 3,30  
Dewpoint (C) = 12,5  
Temp OUT = 39,0  
Hum OUT = 36,0  
SR-1 OUT = 0  
SR-2 OUT = 0

HOME

see CROP 1

see CROP 2

see CROP 3

Είμαστε KLIMA

**ΠΑΡΑΘΥΡΟ** ANGLE

0,0 Km/h 0,0

↑ ↓ set NO cal Release

Temp set max Km/h-1 set max Km/h-2

OFF m ON s

Close Night auto

ANGLE BETWEEN angle-1 angle-2

**DATA BASE**

Read Data Base

YES REC NOW

every minutes

REC in 1 minutes

**DAY HEAT PUMP**

from  to

**GRAPHS**

see Graphs

**Temperature Regulation**

YES DAY YES NIGHT

set is = 27,0 C

set T day Winter

set T night Winter

set T day Summer

set T night Summer

Compressor ΔT = 1,0

**POWER behavior**

Temp Diff

FANS FIRST Delay FANS OFF

**ΚΟΥΡΤΙΝΑ**

↔ ↔

with SR in day

set SR Δ SR delay

with time in day

from to

Open at Night

**CO2** 

from to

auto OFF

set CO2 ppm

set Δ (ppm)

CO2 valve

OFF minutes

ON sec

**FOG** 

from to

For 134 sec

auto OFF

IF Temp >

IF HUM <

FOG valve


OFF minutes

ON sec

**HEAT PUMP**

AUTO

SUMMER




**Humidity Regulation**

YES DAY YES NIGHT

set % Day Every (Min)

set % Night For (Min)

**AUTO TIMER FANS**

Manual FANS

from to

from to

from to

RST Heat Pump

Auto RST RST times 0

HEAT PUMP 22/08

FAIL times 000 Last time 1203

**ΣΥΜΠΥΚΝΩΜΑΤΑ**

00000,000 Liters

RST mL/pulse

**PANIC BUTTON**



ALL ON

Ready to start !!!!!







# **Growth and Development**



5 July 2017



14 July 2017



19 July 2017



21 July 2017

**Canopy level**



5 July 2017



14 July 2017



19 July 2017



21 July 2017

**Roots development**



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# Measurements

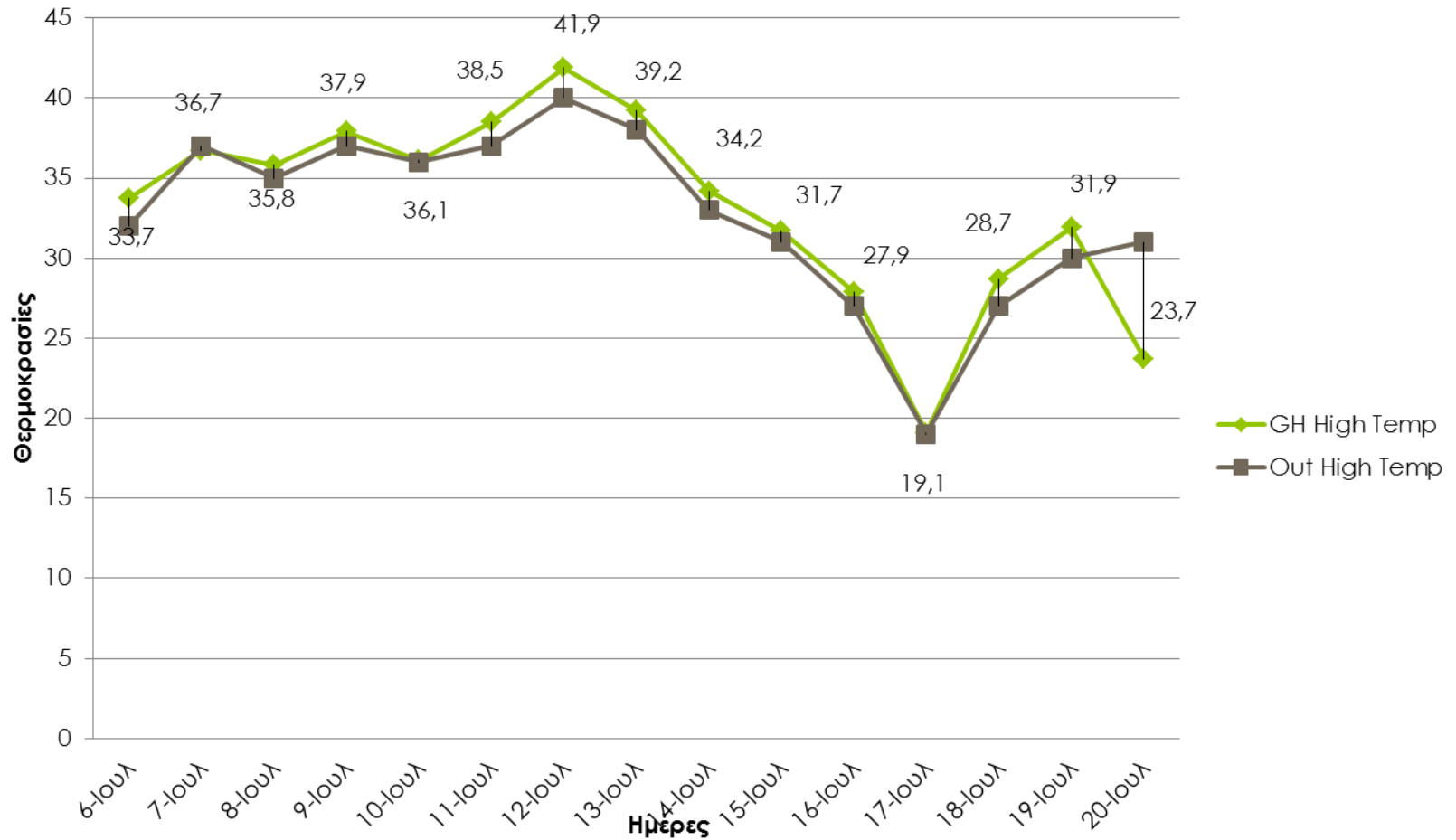


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## Θερμοκρασίες Ιουλίου









3/10/2018



4/10/2018





9/10/2018



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10/10/2018



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NOEMBΡΙΟΣ 2017 – ΜΑΙΟΣ 2018



1<sup>st</sup> harvest after 113 days





**Thank you!**  
**I wish you the best**  
**in Agriculture!!!**