Democritus University of Thrace

ZEPHYR

Innovative approaches to increase biodiversity in forest plant production

Prof. Kalliopi Radoglou

ZEPHYR

Environmental technologies

Democritus University of Thrace

ZEPHYR

Artificial regeneration

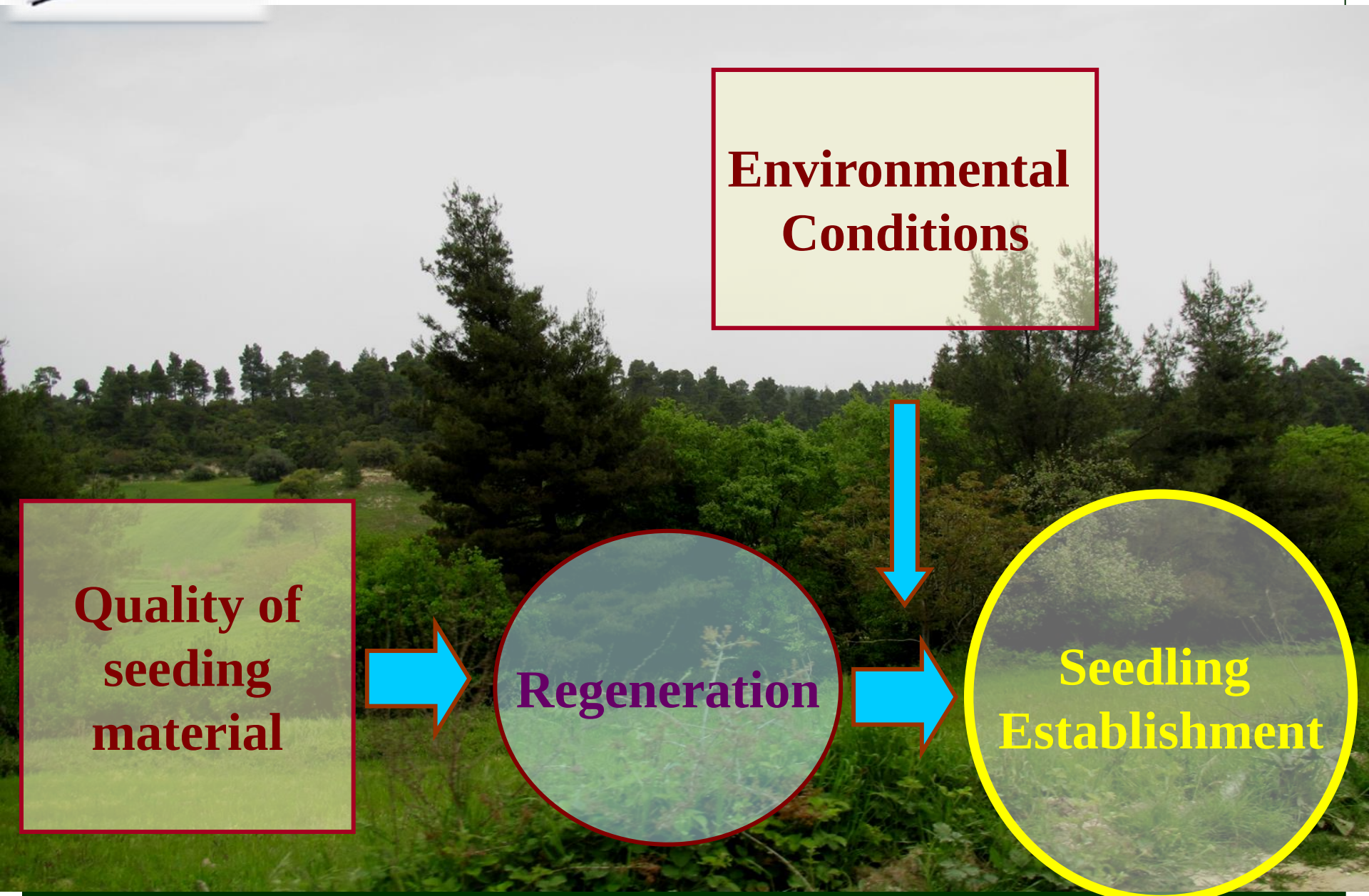
- **Enhances biodiversity of species** (seed-derived seedlings)
- **Among species** (regenerate increased number of forest species)
- **Within the ecosystems (**Species that occur at the regenerated sites, suitable, based on the climatic and edaphic conditions of the area).

Democritus University of Thrace

ZEPHYR

Challenges in forest plant production :

- Increased biodiversity from the increased number of diverse forest species for regeneration
- A more cost efficient way to produce seedlings to serve in regeneration purposes
- Increased demand for high quantity of produced seedlings
- Improved quality of the produced seedlings to enhance regeneration success
- The need to restore forest ecosystems, when possible.


Environmental Conditions
Quality of seeding material
Regeneration
Seedling Establishment

Democritus University of Thrace

ZEPHYR

Needs for increasing biodiversity at regenerated sites

- Collection-quality & quantity of seeds
- Seed treatment protocols
- Production of high quality seedlings for many species
- Different species (Seedling production protocols)
- Higher % survival at the regenerated sites

Democritus University of Thrace

ZEPHYR

Use innovative technology

- Cost efficient and environmental friendly production
- not affected by outdoors climate (controlled conditions)
- LED Labs
- New robot arm
- Integration of the technology into a functional prototype
- Provide cultivation protocols for the prototype

Treatments for Breaking Seed Domancy

Production Protocols

Seeds
Collection
Quality Control,
Storage

Planting (Types of seedlings)

Better Seedling Quality

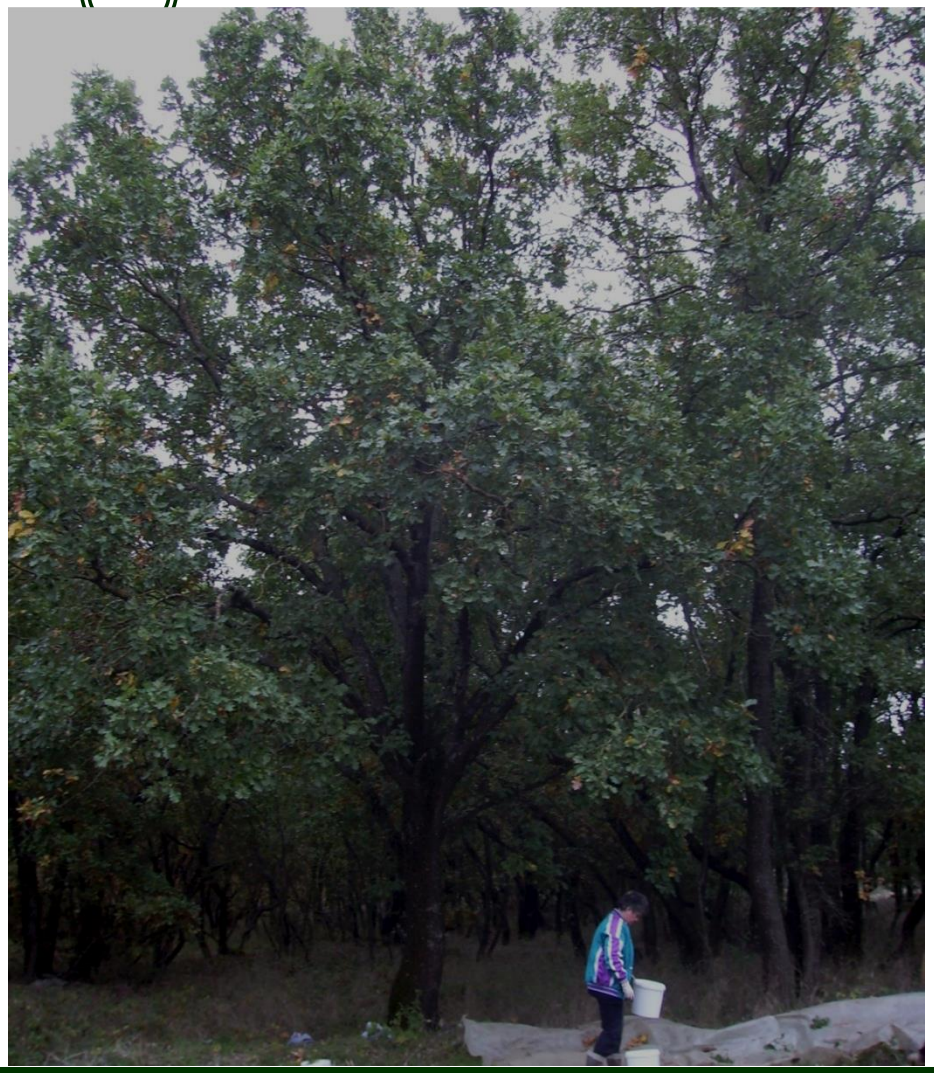
Increase Regeneration Success

Innovation Prototype

Democritus University of Thrace

ZEPHYR

Seed Collection



Mediterranean forest species

Prior to Collection

Criteria of tree selection

Criteria of tree selection	
1	Vigorous trees
2	Open crown trees
3	Middle age healthy trees
4	Collection from low crown part
5	Avoid isolated trees
Criteria of seed selection	
	Color of the fruit

Data sheet

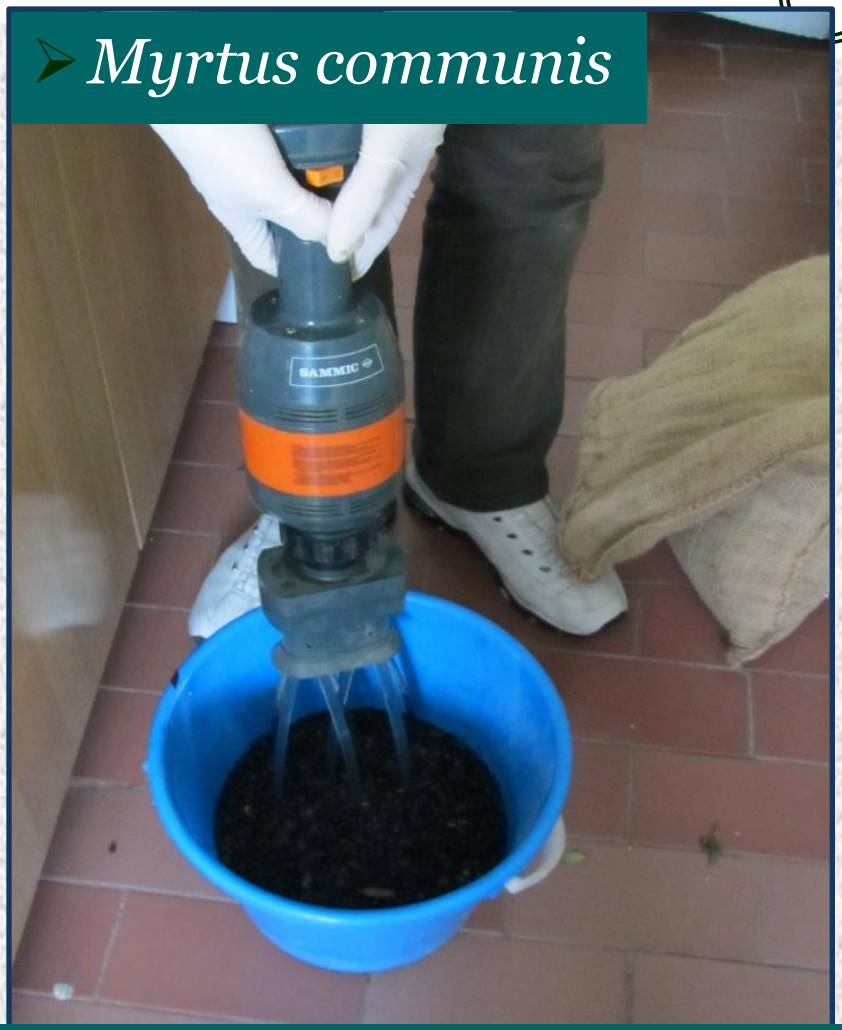
DATE	SPECIES	PARENT	AREA	COLLECTOR	POSITION OF PLANT (GPS)	ALTITUDE (m)	CROWN WIDTH (m)	PLANT HEIGHT (m)	CROWN AREA OF SELECTION	SEEDS COLLECTED (kg)
EXAMPLE BELOW										
5/11/2010	Acer pseudoplatanus	1	X	X	465361, 4568095	1477	2	20	Whole crown	5
	Acer pseudoplatanus	2	X	X	X	1400	3	25	Base of crown	3

Democritus University of Thrace

Seed Cleaning and storage

ZEPHYR

- *Myrtus communis*



- *Rosa canina*

Cleaning the seeds based on the species

Democritus University of Thrace

Seed Tests recommended by ISTA

ZEPHYR

Democritus University of Thrace

Seed Tests

ZEPHYR

Viability test

Celtis australis live

Democritus University of Thrace

ZEPHYR

Seed Tests

Moisture content and seed weight

Placement in the oven
103 ±2 °C for 17±1 hrs


➢ Development of seed germination protocols of the 26 species
Breaking dormancy-Protocols

Democritus University of Thrace

Germination *protocols*

ZEPHYR

Democritus University of Thrace

ZEPHYR

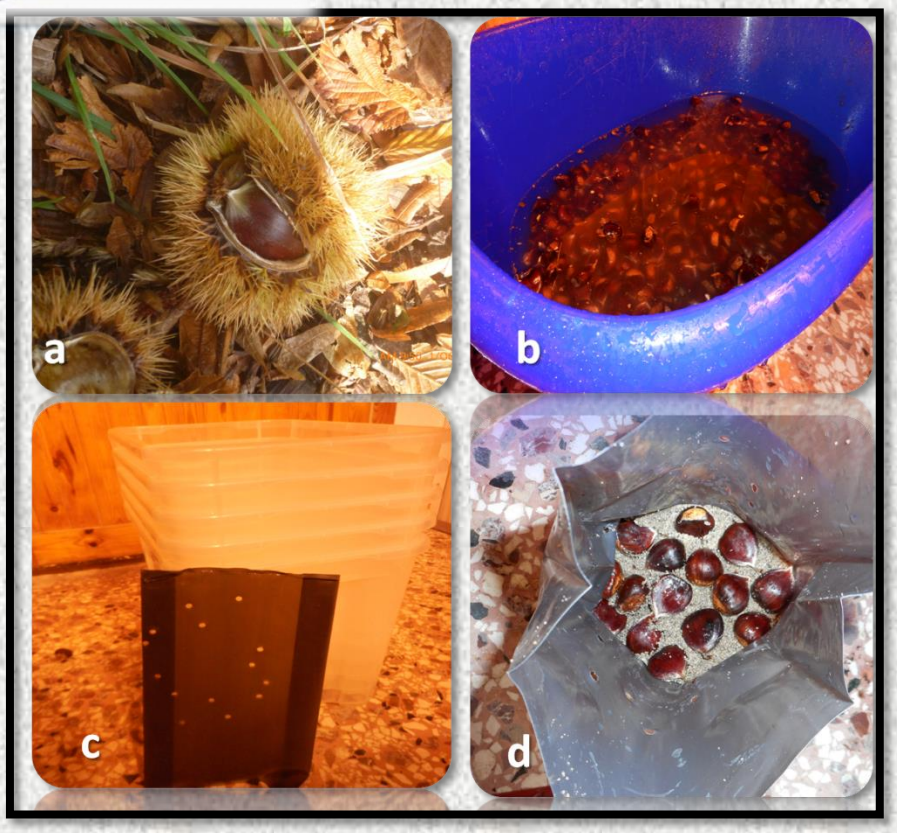
Germination protocols suggested for each of the tested species

- ***Hydration (24h in the water)***
- ***Pinus nigra* Arn.:**
- ***Platanus orientalis* L.:**
- ***Pinus sylvestris* L.:**
- ***Picea abies* Karst.:**
- ***Quercus ilex* L.:**
- ***Quercus ithaburensis var. macrolepis:***
- ***Ocimum basilicum* :**

- ***Cold stratification***
- ***Arbutus unedo* L.: *1 month***
- ***Fraxinus excesior* L.: *3 months***
- ***Myrtus communis* L.: 3 months**
- ***Cornus sanguinea* L. : 9 months**
- ***Punica granatum L.: 2 months***

- ***Warm stratification (20 C)***
- ***Prunus avium* L.:**

- **Still working on trts**



Castanea sativa

a) removing bur-like involucres that consist of numerous elongate, slender spines,

b) hydration of seeded nuts,

c) use polyethylene bags with several holes and plastic containers,

d) stratification in wet sand for months in refrigerator at 3-5^{0}C.

Quercus ithaburensis var. macrolepis

a) acorns,

b) removal of pericarp,

c) cut of 1/3 of cotyledons,

d) pre-germinated acorn

Democritus University of Thrace

Germination test

ZEPHYR

Chemical treatments

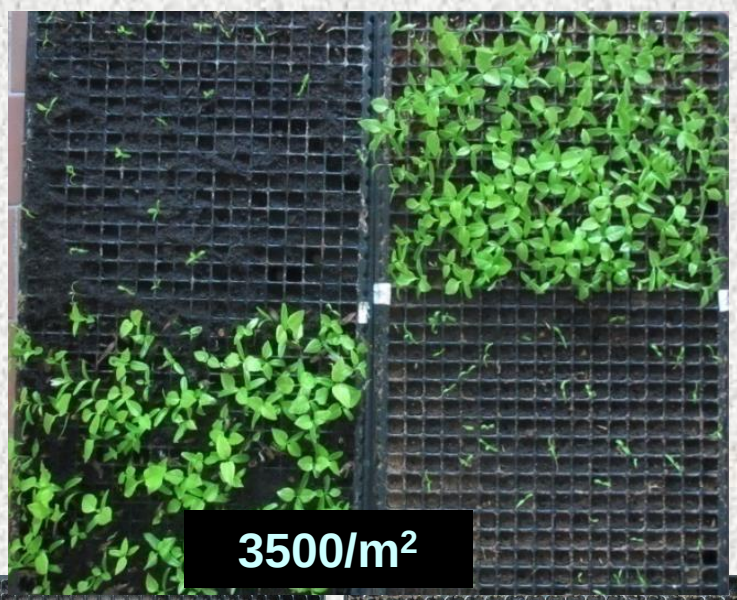
- Seed treatment of *Cercis siliquastrum* seeds with H_2SO_4 (A) and *Phillyrea latifolia* with GA_3 (B).

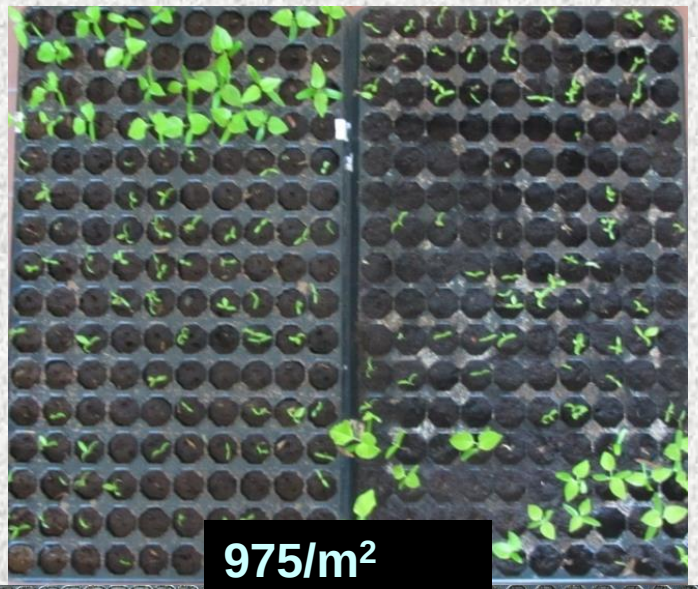
Democritus University of Thrace

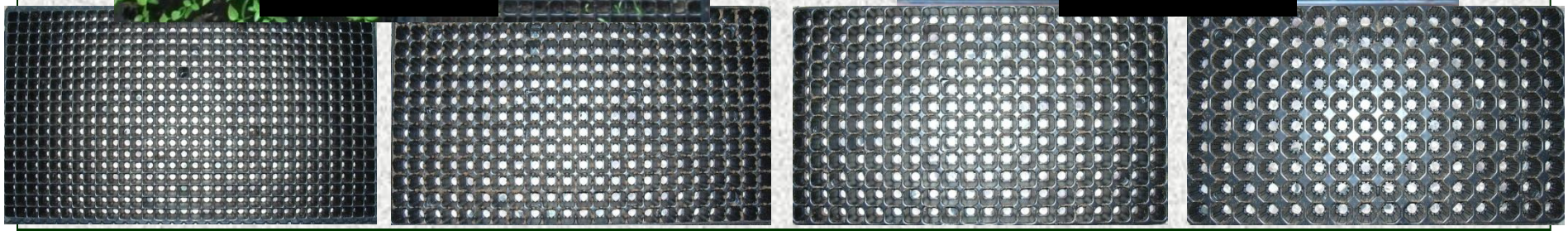
New way: Mini-plugs

ZEPHYR

Production of large seedling quantities through the use of «mini-plugs».







3500/m² 1820/m² 1460/m² 975/m²

QPD104 RW

cell dimensions: 33X33X45 mm
distance between:40 mm
volume: 27 cc.

(QuickPot ®, Herkuplast-Kubern GmbH, Ering, Germany)

Soil substrate: stabilized medium (SM)
ph: 3.7-4.3 rich in Br
(Preforma PP01, Jiffy Products International AS, Stange, Norway).

Democritus University of Thrace

ZEPHYR

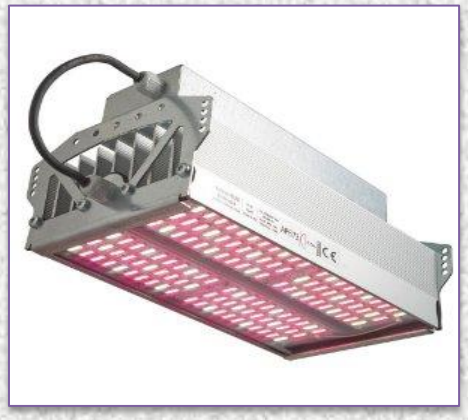
LED Lamps

metal halide

fluorescent (FL)

high-pressure sodium

(LEDs)



Democritus University of Thrace

Facilities and Growth conditions

ZEPHYR

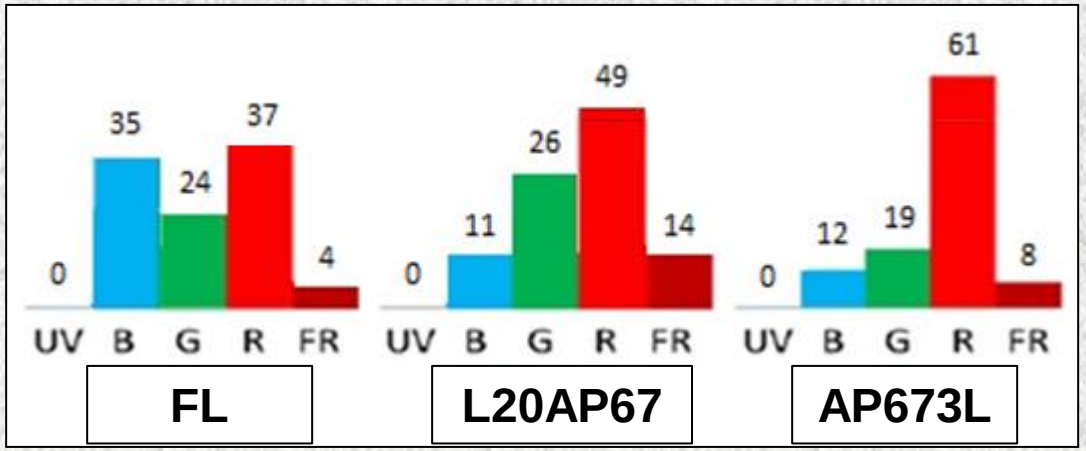
✓**Automated watering** ✓**Automated lights**

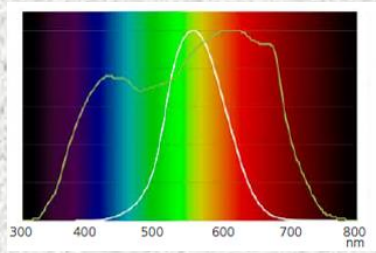
- **Diurnal cycle :** 14 hrs day/8 hrs night of 20/15 °C
- **PPFD :** 140 μmol m^{-2} s^{-1}
- **Relative humidity (RH)** : 80 ± 10%
- **Watering :** Twice a day with automatic sprinklers

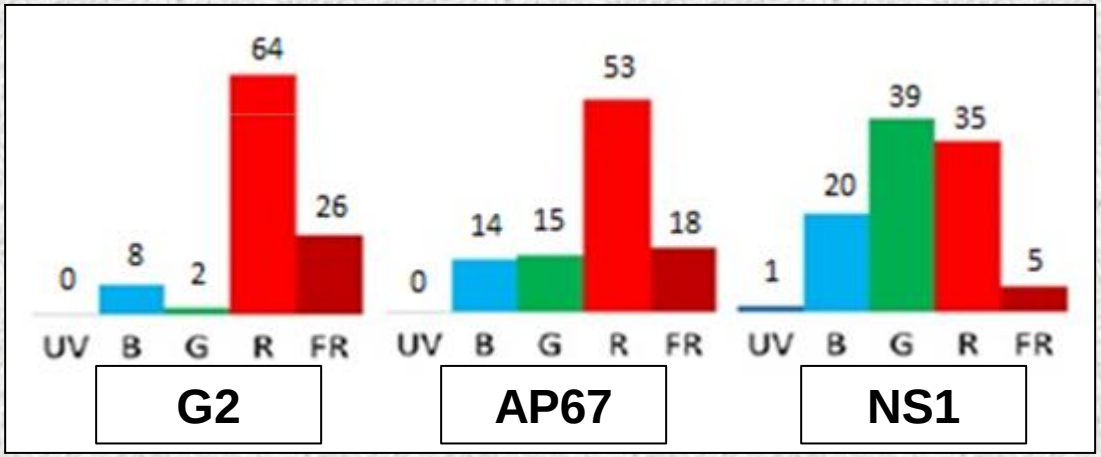
Democritus University of Thrace

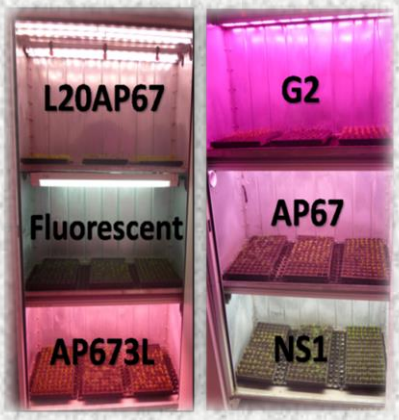
ZEPHYR

Materials and Methods
Studied Lights – Growth Chambers









Democritus University of Thrace

Materials & methods

ZEPHYR

Growth Chamber Measurements

Morphological & Physiological variables

✓**Seedling evaluation: every week for a total of 7 weeks**

- Seedling growth rates
- Evaluation of needle color & number

✓**At the end of the 7th week**

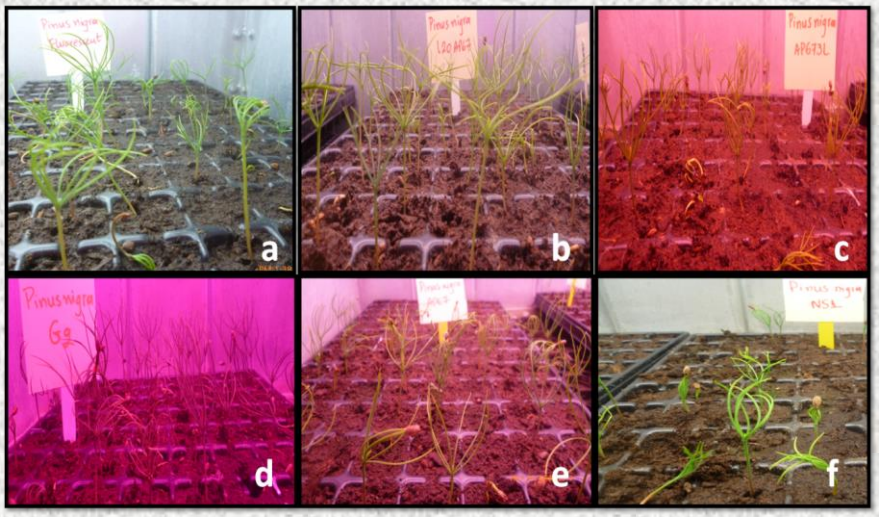
- Seedling shoot height, root length
- Seedling dry weights (leaves, shoot & roots) & root/shoot ratio

✓**Physiological quality testing of seedlings**

➢ **RGP** of each seedling was assessed by measuring the new root length (**NRL**) and new root dry weight (**NRDW**).

*Seedlings of **Castanea sativa Mill**. into the growth chambers under*

a) *L20AP67 LED,*
b) *Fluorescent conventional light,*
c) *AP673L LED,*
d) *G2 LED,*
e) *AP67 LED,*
f) *NS1 LED,*
g) *RGP light environment (FL & sodium lamps).*



*Seedlings of **Pinus nigra L**. into the growth chambers under*

a) *Fluorescent conventional light,*
b) *L20AP67 LED,*
c) *AP673L LED,*
d) *G2 LED,*
e) *AP67 LED,*
f) *NS1 LED.*

Democritus University of Thrace

ZEPHYR

Optimal light qualities suggested for some tested species

- ***Pinus sylvestris* L.: AP67, AP673L, G2**
- ***Picea abies* Karst.: AP67, AP673L**
- ***Pinus nigra* Arn.: AP67, AP673L**
- ***Quercus ithaburensis var. macrolepis*: NS1, AP673L**
- ***Castanea sativa Mill*: AP673L, G2**
- ***Myrtus communis* L.: AP673L, NS1**
- ***Ocimum basilicum* L.:AP67, G2, NS1**
- ***Ocimum basilicum* RR hybrid: AP67, G2, NS1**
- ***Cornus sanguinea* L. : AP673L, G2, AP67**
- ***Prunus avium* L.: AP673L, G2, AP67**
- ***Punica granatum L.*: L20AP67,**
- ***Platanus orientalis* L.: AP67**

Democritus University of Thrace

Evaluation of seedlings' quality

ZEPHYR

- Transplant from mini-plugs LED's to traditional nursery containers

Democritus University of Thrace

ZEPHYR

Growth chambers

Seedlings of Q. ithaburensis var. macrolepis in growth chambers under a)L20AP67, b) Fluorescent conventional light, c) AP673L d) G2 LED, e) AP67 LED, f) NS1 LED.

Nursery performance

Seedlings of Quercus ithaburensis var. macrolepis
a) for the Fluorescent light,
b) L20AP67 LED,
c) AP673L LED,
d) G2 LED,
e) AP67 LED,
f) NS1 LED,
after 6 month period at the nursery of Chalkidona.

Democritus University of Thrace

Field Performance

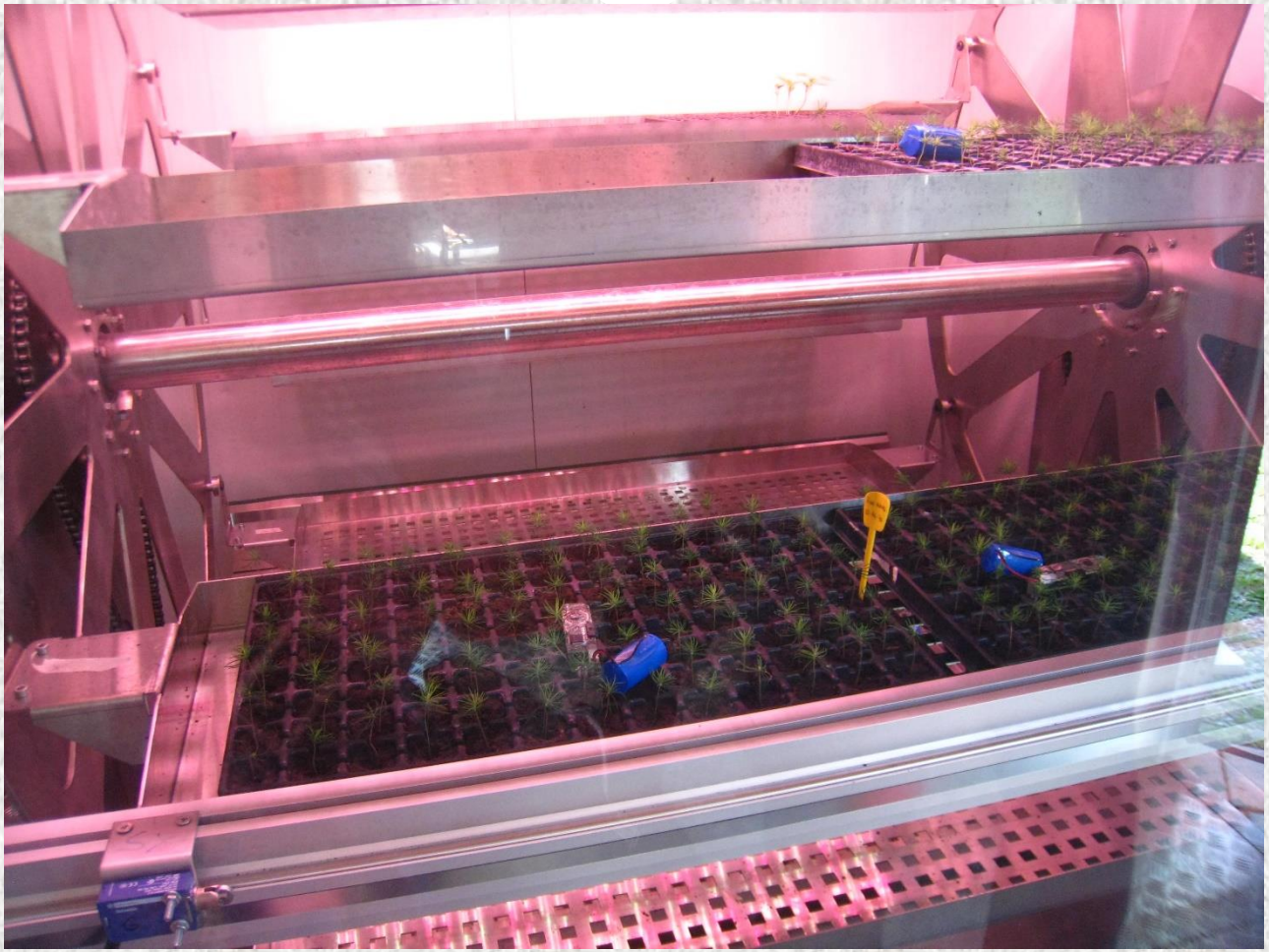
ZEPHYR

Seedlings grown both in LED lights and traditional nursery containers transplanted in the field area of nursery.

Democritus University of Thrace

Prototype

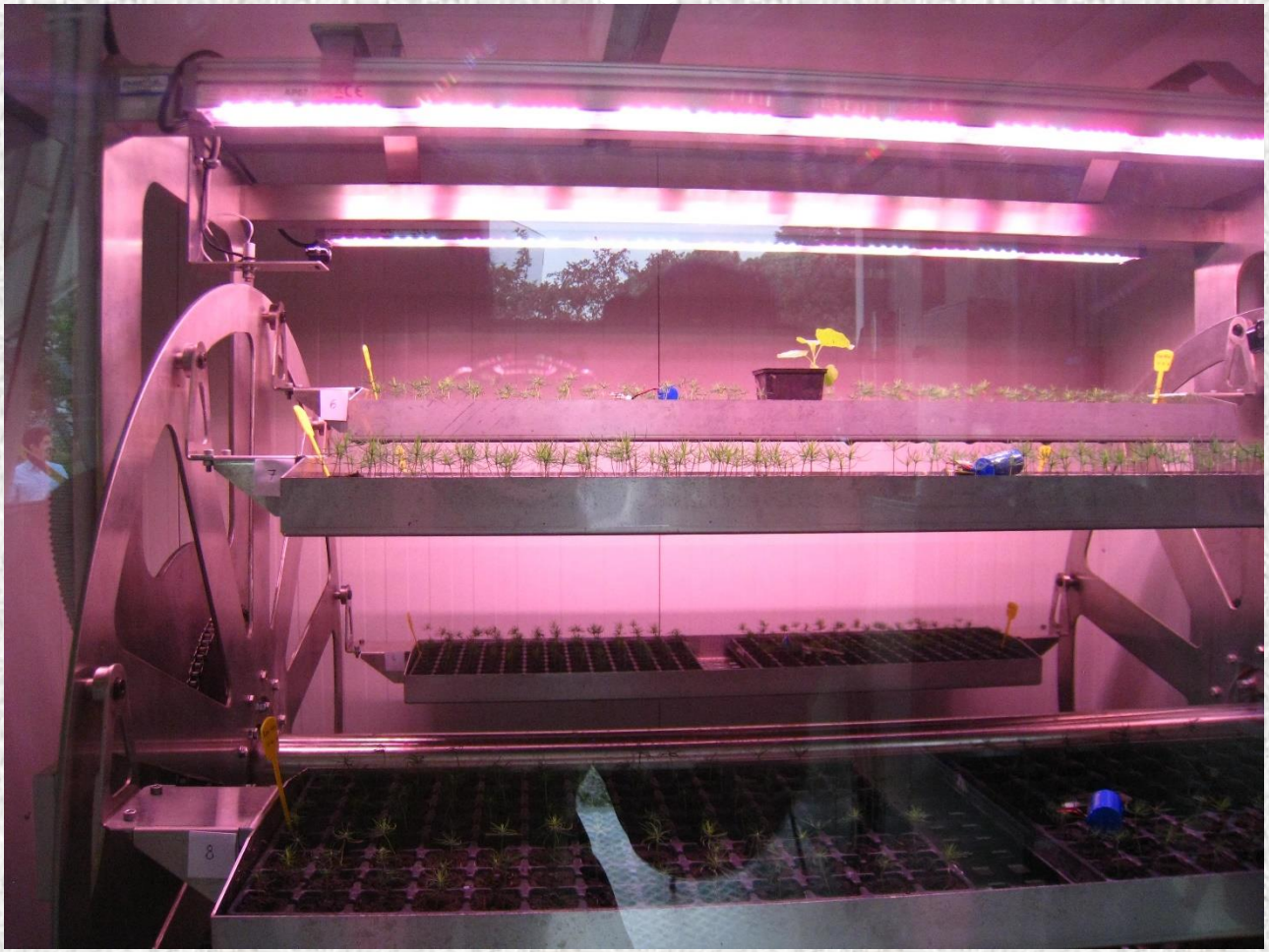
ZEPHYR



Democritus University of Thrace

Technical validation of the prototype with Mediterranean seedlings

ZEPHYR



Democritus University of Thrace

Energy independent prototype

ZEPHYR

Democritus University of Thrace

ZEPHYR

Conclusions

- Seedling production under **LEDs** resulted in the production of more **balanced seedlings (**regarding morphological & physiological attributes) for **Mediterranean species**.
- Industrial implementation of the prototype demands further cultivation protocols for more Mediterranean species.

Furthermore:

- **Seedling outdoor performance is needed to predict the chances for survival within a forest restoration program with high number of species, produced in the prototype**
- **Thus Nurseries can improve their production by increasing the number of species they produce by using the innovative proposed approaches**

Democritus University of Thrace

ZEPHYR

Thank you for your attention