The project PIF-VIAA

Vivaistica Innovativa ad Alta Adattabilità

PSR FEASR 2014-2020 Regione Toscana
PIF Verdi Connessioni – Mis. 16.2

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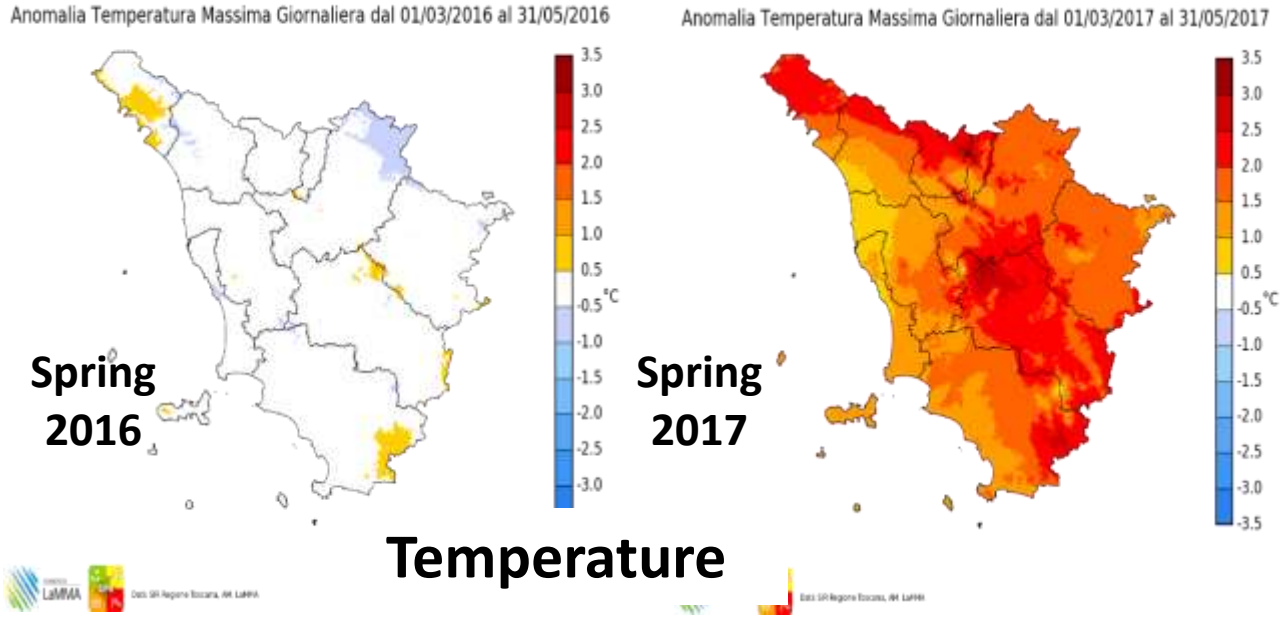
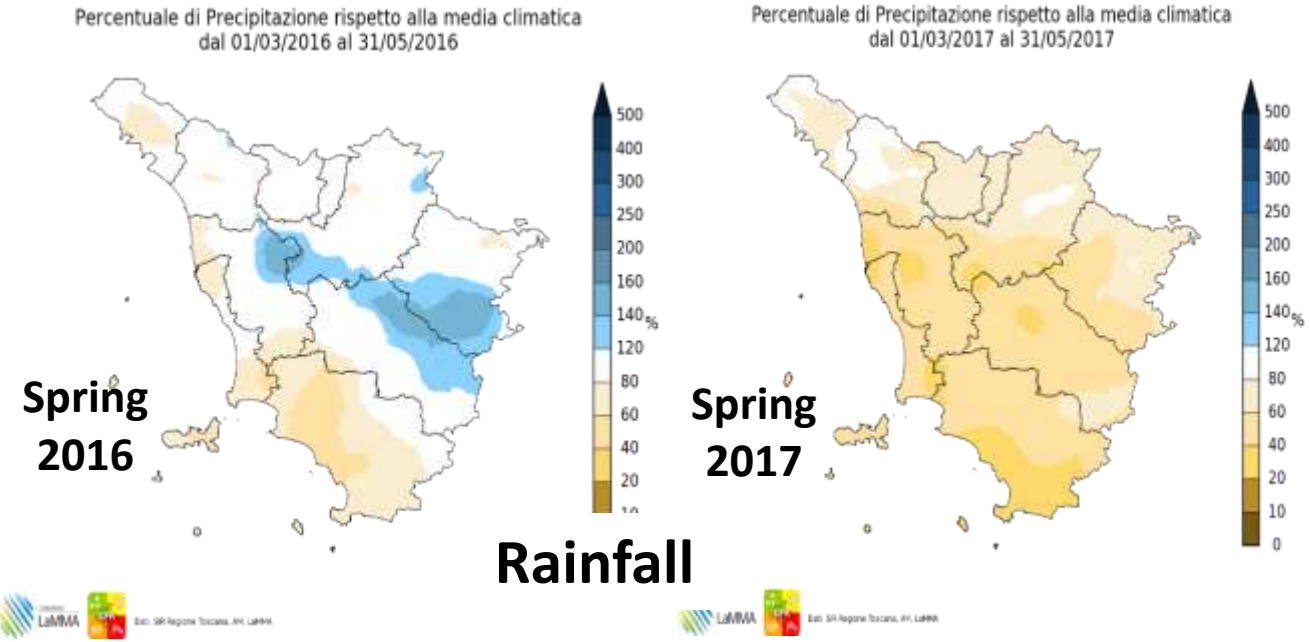




Temperature and rainfall: spread between 2016 & 2017 and climate mean values in Tuscany

-Weather high variability

-Dry periods: not only harsher, but also occurring in unusual seasons (spring and fall)

-Harder condition for plants immediately after planting (in Mediterranean area)

-Excluding urban or peri-urban contexts, in forest restoration or plantations, general lack of cultural practices to promote post-planting survival and growth (in Italy)

Sustainable use of the resources - Sustainability of nursery production

Peat is the most used growing medium component in nursery production at world level

Many concerns have been raised about widely documented environmental impact of peat extraction

Peatlands: fragile ecosystems, exploitation increases C emissions, long lasting time of the natural processes of peat (re-)production, so that is considered a
NON RENEWABLE RESURCE

Coir or coconut fiber is considered one of the valid alternatives to peat

Coir or coconut fiber, a waste product of coconut industry, is renewable and largely available resource
(25% of over 50 million tons of coconut produced annually are waste coir)

Substrate used in 2017 by VannucciPiante: 50000 m^3 coconut fiber and husk; no more peat
(in the last 5 years the amount of needed substrate has increased by 10%)

Direct comparison between the two substrates (not in a mixture) to assess the effect on plant traits is still missing

Are different combination of nursery substrate and fertilization useful to provide a higher stress resistance to seedlings in occurrence of dry period post-planting?

18 combinations of stocktypes (species x substrate x fertilization)

2592 seedlings, 144 per stocktype

3 species

more

less

Arid/Mediterranean attitude

Quercus ilex *(a)*

Quercus pubescens *(b)*

Quercus robur *(c)*

Holm oak

Downy or pubescent oak

Peduncolate oak

2 substrates

Peat (Pe)

Coir (Co)
(or coconut fiber)

3 fertilizations

Standard (St) **(NPK 1:0.6:0.7)**
Enriched in P (P) **(NPK 1:2:0.7)**
Enriched in K (K) **(NPK 1:1:1.6)**

not different levels of P and K, **but** 3 different fertilizations

Standard: the fertilization currently used by the VannucciPiante for this kind of cultivation

Why starting from the seed and not using a Vannucci piante product?

To assess the effect of growing medium and fertilization it is important to eliminate, as far as possible, other factors that could alter plant response (such as the effect of previous fertilization, pruning, and other cultural practices that could have already influenced the plant natural response).

Secondly, the produced stocktypes are typical forest nursery products, and this provided further important results related to forest restoration practices.

2016-2017 – Nursery production

2016 Oct

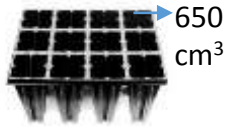
Seed collection

2016 Nov
2017 Mar

Seed conservation

2017 Mar

Sowing and labelling



2017 Apr
2017 Sept

Data collection (morphology & physiology)

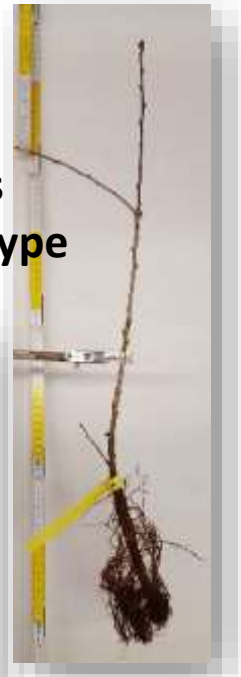
Emergence

Height and growth flushes (weekly)

Chlorophyll content
Chlorophyll fluorescence
Leaf spectroscopy (monthly)

2017 Nov

Destructive analysis on 20 plants per stocktype



Detailed analysis of stocktypes morphology: root- and shoot-system biomass (total, partial), Root volume first order roots, RcD, …..

2018 – Water stress in greenhouse (speed test on potential water stress resistance)

2018 Mar

Transplant in bigger container

2018 Apr

Trial set up in greenhouse

2018 Jun

Species specific water stress beginning

15 days each species

2018 Jul

Species specific water stress end

2018 Sep

Recovery assessment

Two parallel trials

Site preparation and trial set up

2018 Mar

Planting

2018 Apr

First growing season: data collection

2018 May

2018 Oct

Second growing season: same measurements

2019 Apr

2018 – Field performance (response to real field condition – no further irrigation or fertilization)

Field performance still in progress ….

50 seedlings per stocktype per species, 900 in total

Chlorophyll content
Chlorophyll fluorescence
Height

Site preparation and trial set up — 2018 Mar

Planting — 2018 Apr

2018 May

First growing season: data collection (monthly: growth and physiology + meteo-station) — 2018 Oct

Second growing season: same measurements — 2019 Apr

2018-2019 Field performance (response to real field condition – no further irrigation or fertilization)

2018 – Water stress in greenhouse (speed test on potential water stress resistance)

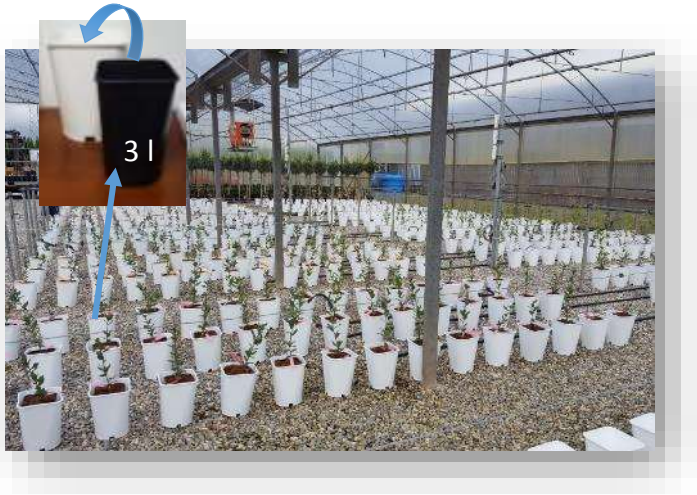
2018 Mar → 2018 Apr → 2018 Jun → 15 days; 3 different species-specific irrigation regimes → 2018 July

Transplant in bigger container

Trial set up in greenhouse

Species- specific water stress beginning

Species specific water stress end



- Control: water to field capacity
- Medium stress: -50% of water provided to field capacity
- High stress: maintenance of a VWC (soil humidity) defined by literature as highly stressful for each species (no or min leaf water uptake)

Data collection aimed to verify incremental response (growth) and physiological reaction (leaves status and photosyntesys efficiency)

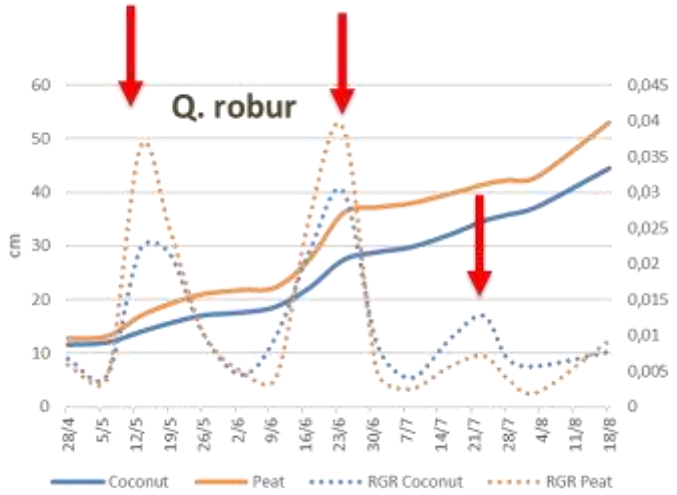
Height growth

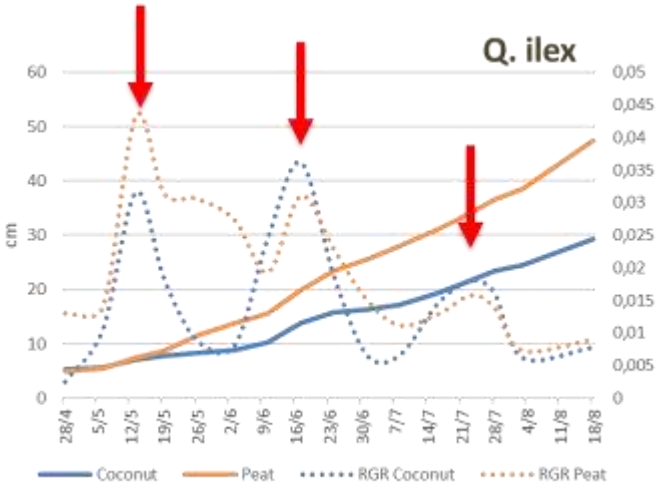
Leaves water potential

Chlorophyll fluorescence (kinetic fast + modulated)

Leaf spectroscopy

Were the tested combinations effective in producing different stocktypes within species?





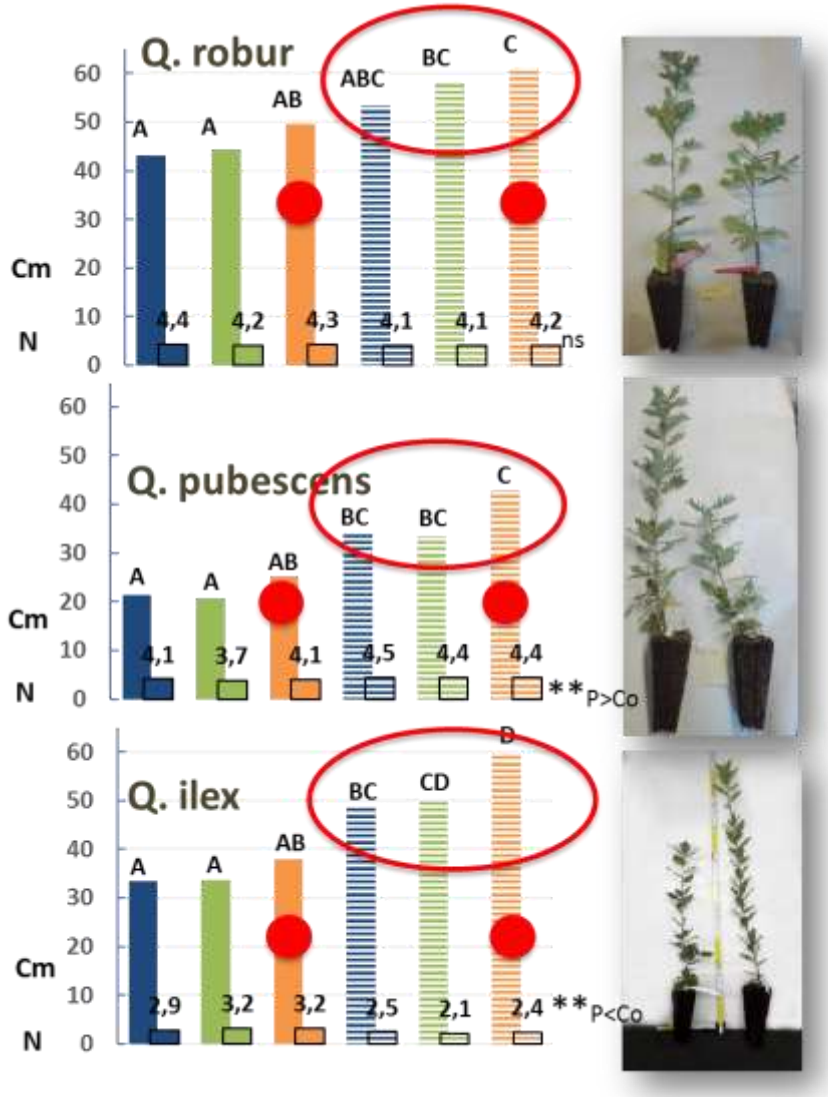
Pe Co

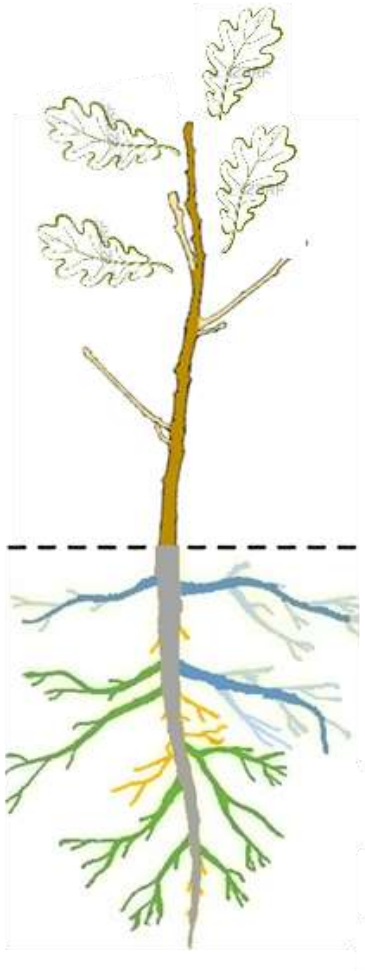
HEIGHT

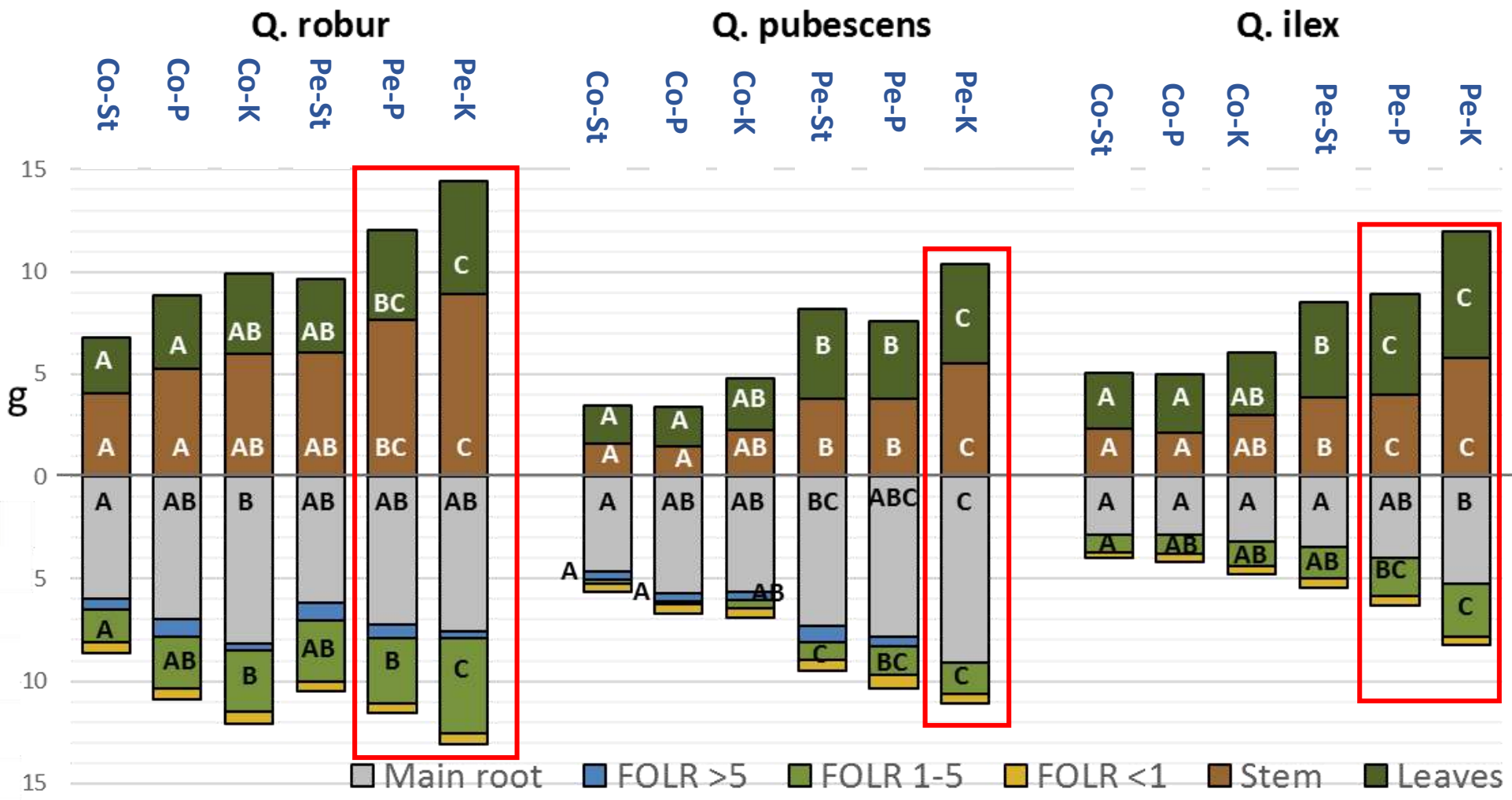
Peat > Coir in all species
(during and at the end of growing season)

K was >
in both substrates in all species

Co - St
Co - P
Co - K
Pe - St
Pe - P
Pe - K





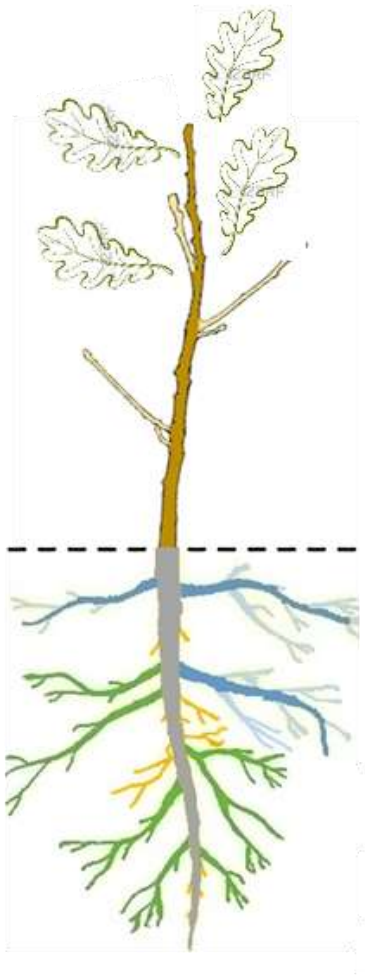


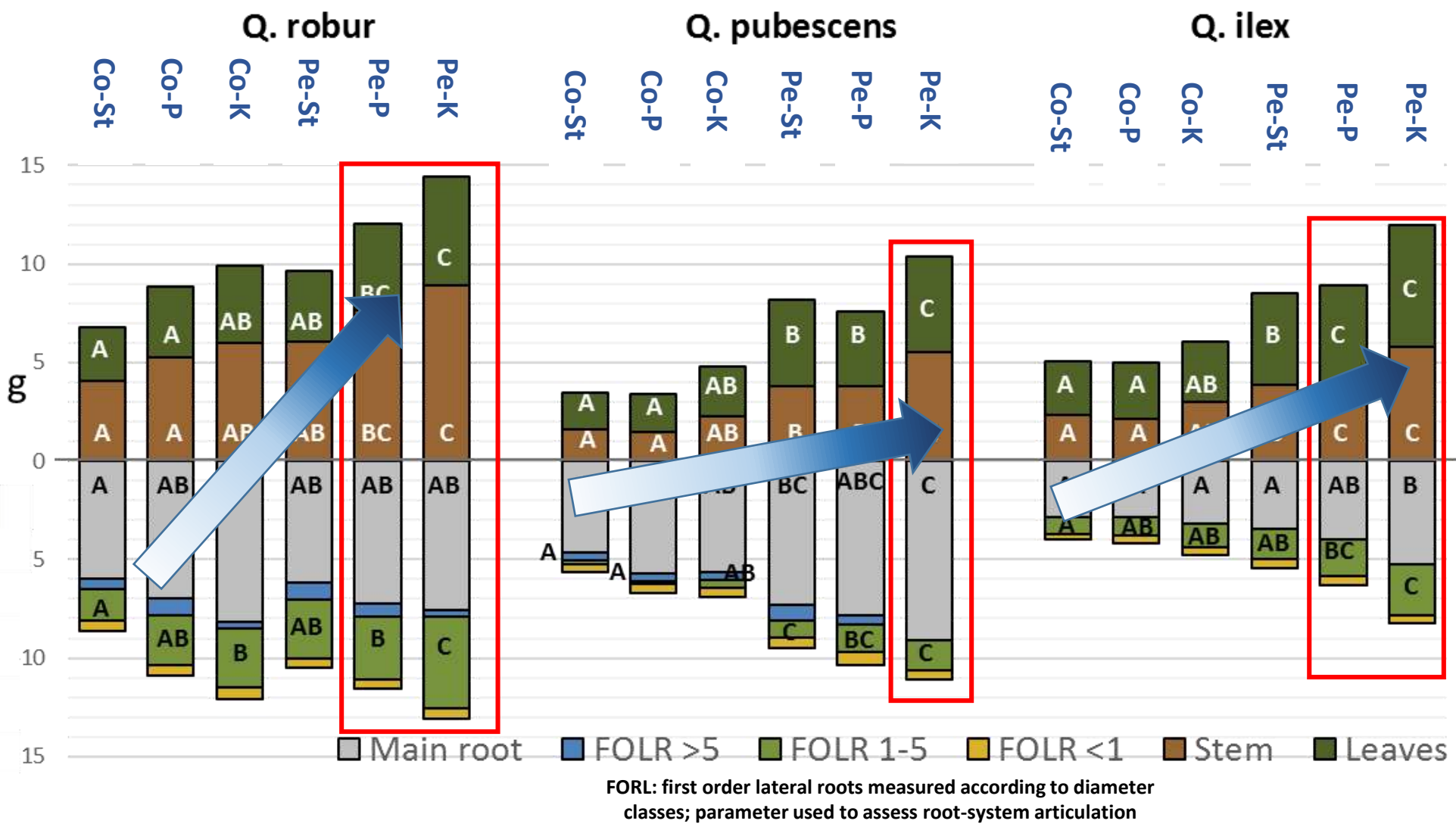
FORL: first order lateral roots measured according to diameter classes; parameter used to assess root-system articulation

Biomass

Pe>Co

K>St





FORL: first order lateral roots measured according to diameter classes; parameter used to assess root-system articulation

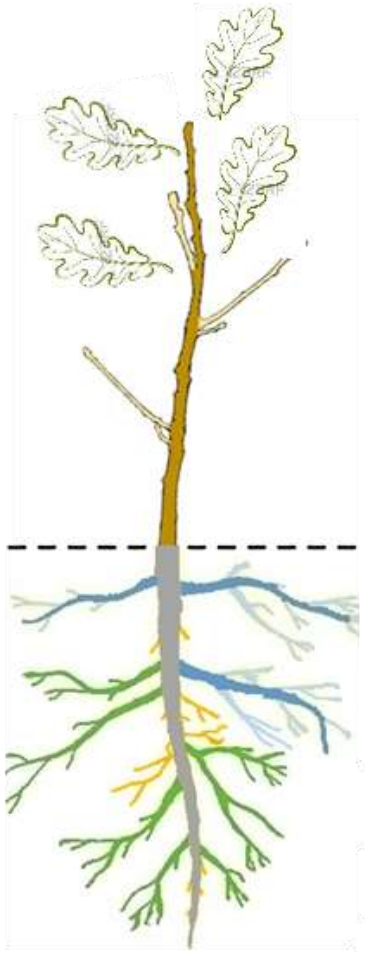
Biomass

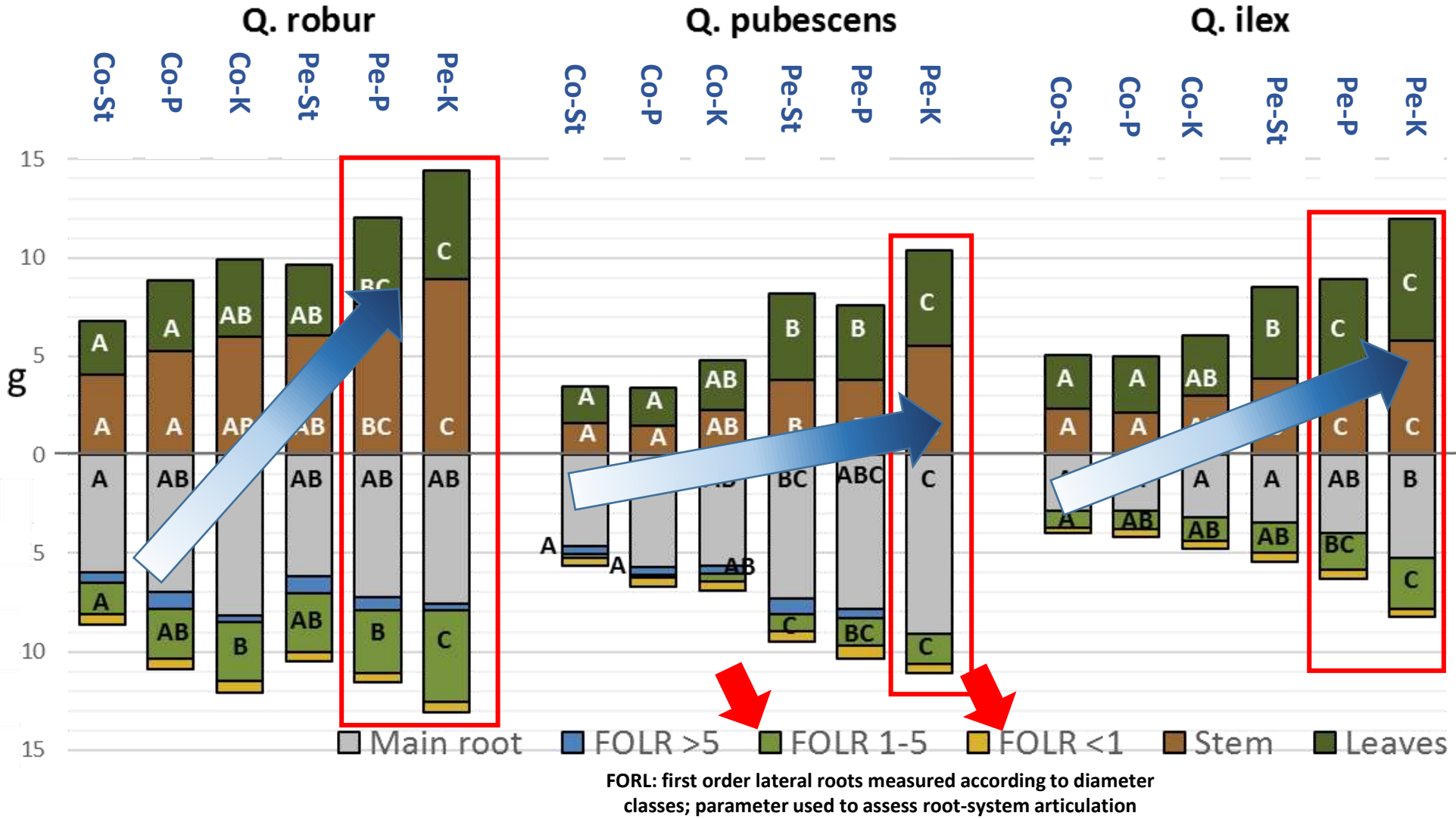
Pe>Co

K>St

Shoot/root ratio

(in relation to water stress, better lower values; Co<Pe)





FORL: first order lateral roots measured according to diameter classes; parameter used to assess root-system articulation

Biomass

Pe>Co

K>St

Shoot/root ratio

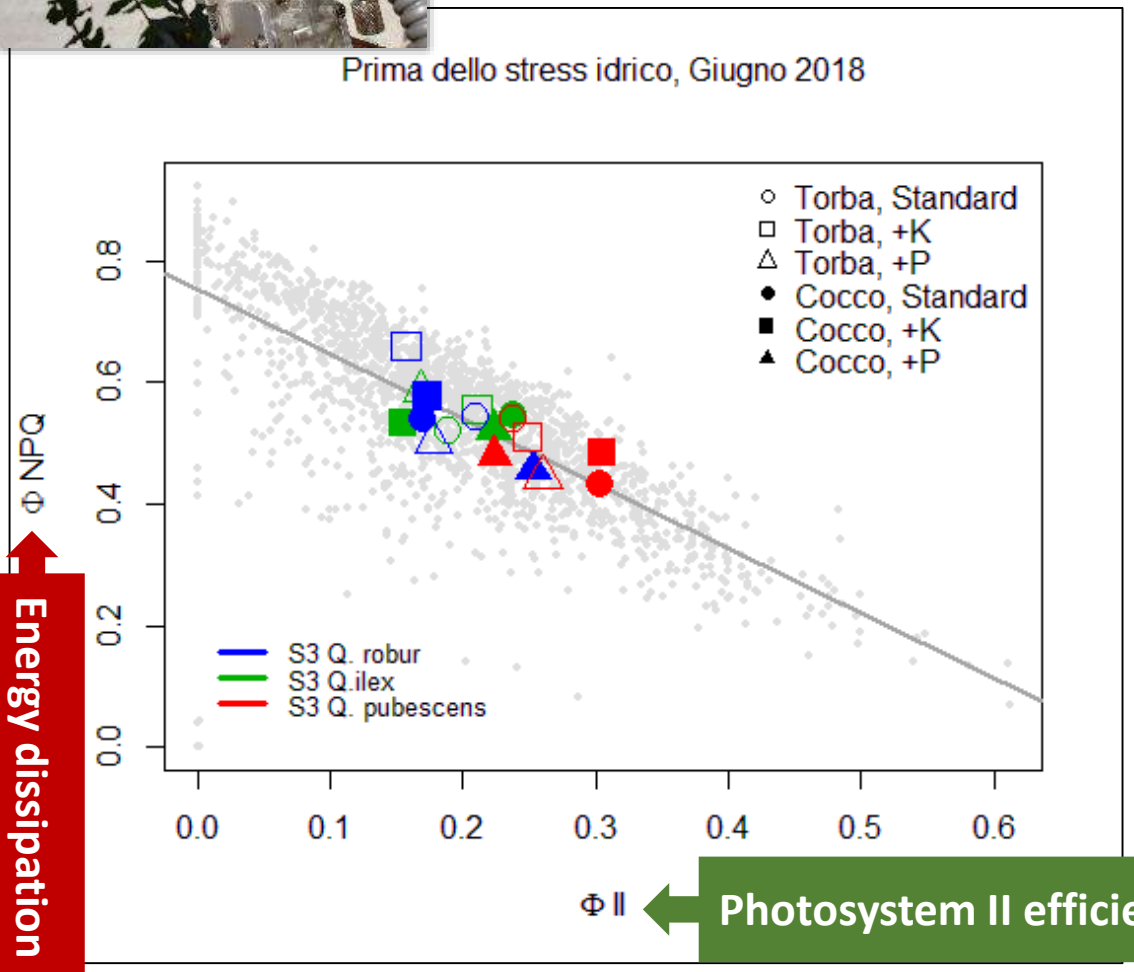
(in relation to water stress, better lower values; Co<Pe)

Root-system articulation

Co≈Pe (proportionally)

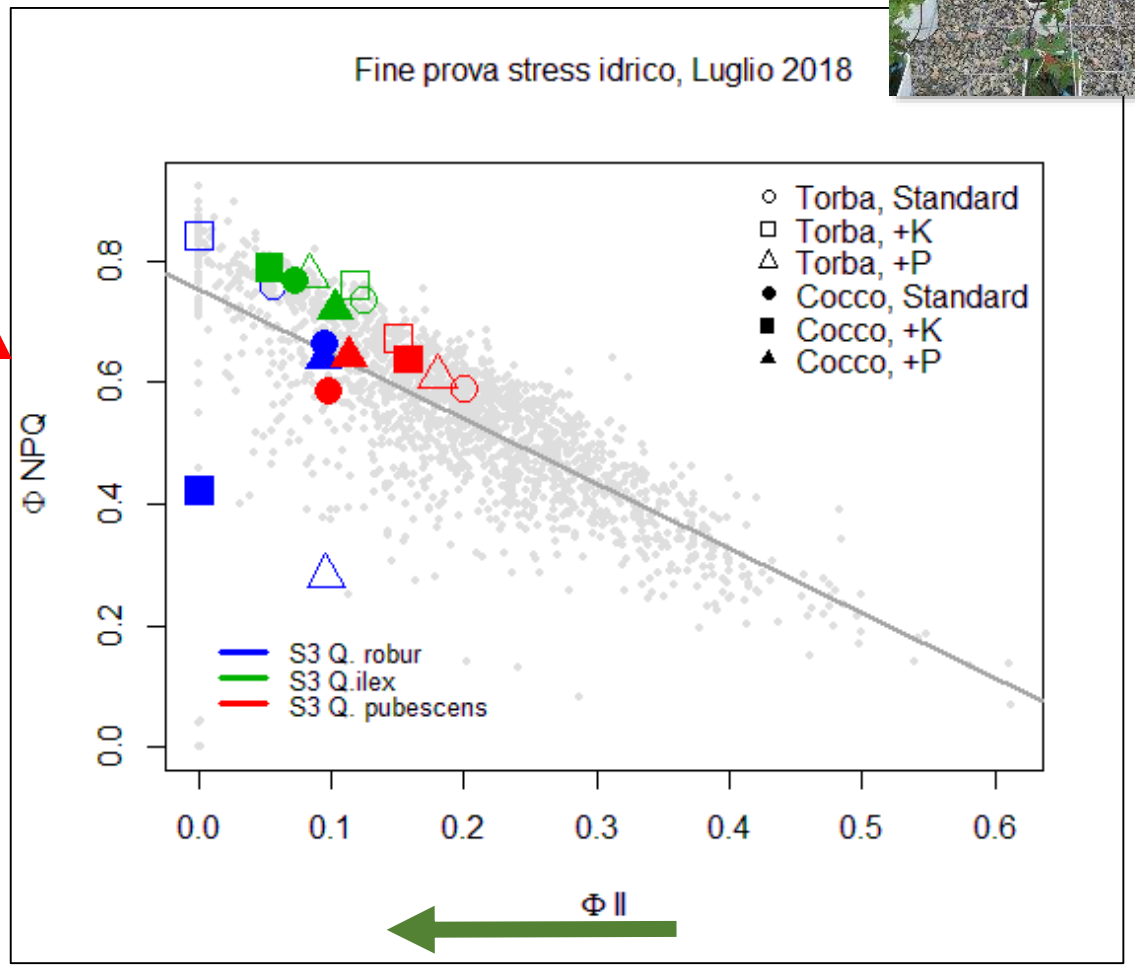
Were the tested combinations effective to water stress resistance?

1 - Do nursery products with different characteristics show differences in physiology during stress?

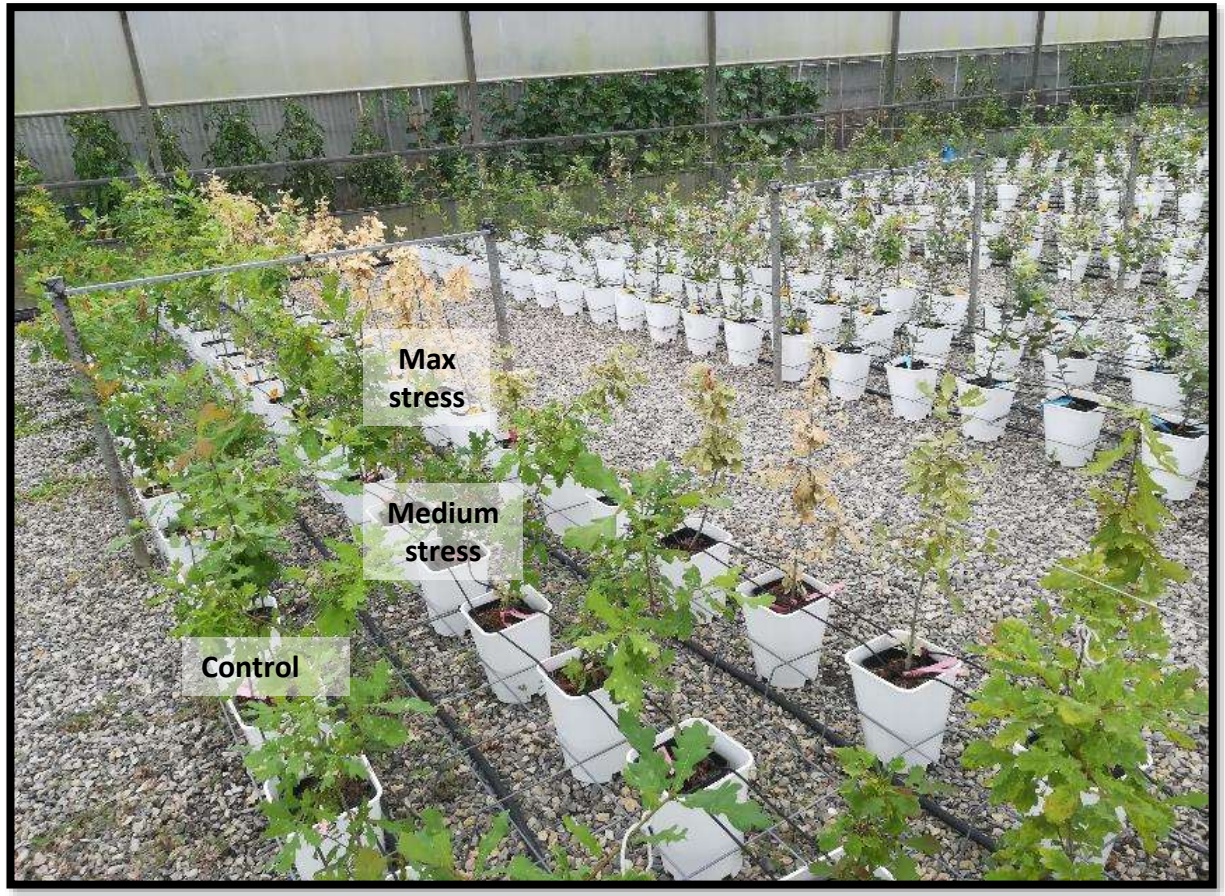


Energy dissipation

Photosystem II efficiency



2- What effect did water stress have on the stocktypes' survival and growth?



No mortality in control and insignificant in medium stress (-50%)

2- What effect did water stress have on the stocktypes' survival and growth?

survival

= >60% in harder stress

= >90% in harder stress

= <20% survival (assessed observing leaf mortality)

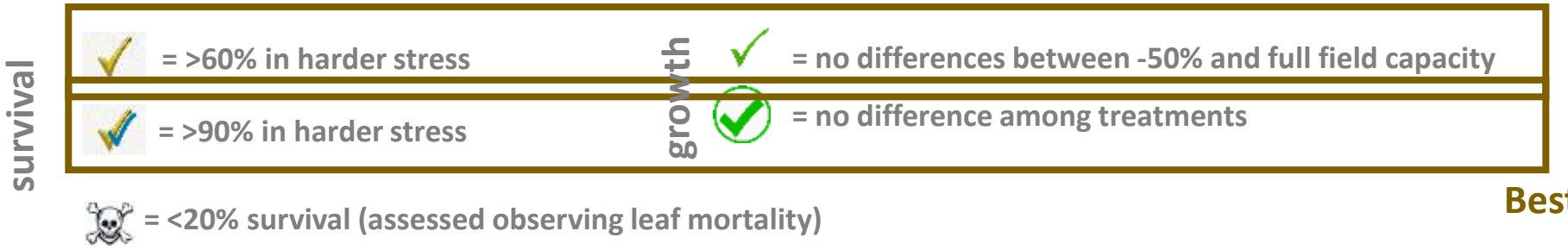
growth

= no differences between -50% and full field capacity

= no difference among treatments

No mortality in control and insignificant in medium stress (-50%)

2- What effect did water stress have on the stocktypes' survival and growth?



Good response, mostly in growth, especially in relation to difficult environmental conditions

Best combination of survival and growth

No mortality in control and insignificant in medium stress (-50%)

2- What effect did water stress have on the stocktypes' survival and growth?

	Q. robur			Q. pubescens			Q. ilex			
	St	P	K	St	P	K	St	P	K	
Pe		✓	☠	☠	☠	✓		✓		*survival*
	✓	✓	✓	✓	✓	✓	✓	✓	✓	*H increment*
Co			☠			✓		✓	✓	*survival*
	✓	✓	✓	✓	✓	✓	✓	✓	✓	*H increment*

Recovery

survival

- ✓ = >60% in harder stress
- ✓ = >90% in harder stress

growth

- ✓ = no differences between -50% and full field capacity
- ✓ = no difference among treatments

☠ = <20% survival (assessed observing leaf mortality)

● No difference in physiological response between max stress and full field capacity

No mortality in control and insignificant in medium stress (-50%)

2- What effect did water stress have on the stocktypes' survival and growth?

	farnia			roverella			leccio			
	St	P	K	St	P	K	St	P	K	
To	✓	✓	✗	✓	✓	✓✓	✓	✓	✓	*survival*
	✓	✓	✓	✓	✓	✓	✓	✓	✓	*H increment*
Co	✓	✓	✗	✓	✓	✓✓	✗	✓	✓	*survival*
	✓	✓	✓	✓	✓	✓	✓	✓	✓	*H increment*

Recovery after 1 month

survival

✓ = >60% in harder stress

✓✓ = >90% in harder stress

growth

✓ = no differences between -50% and full field capacity

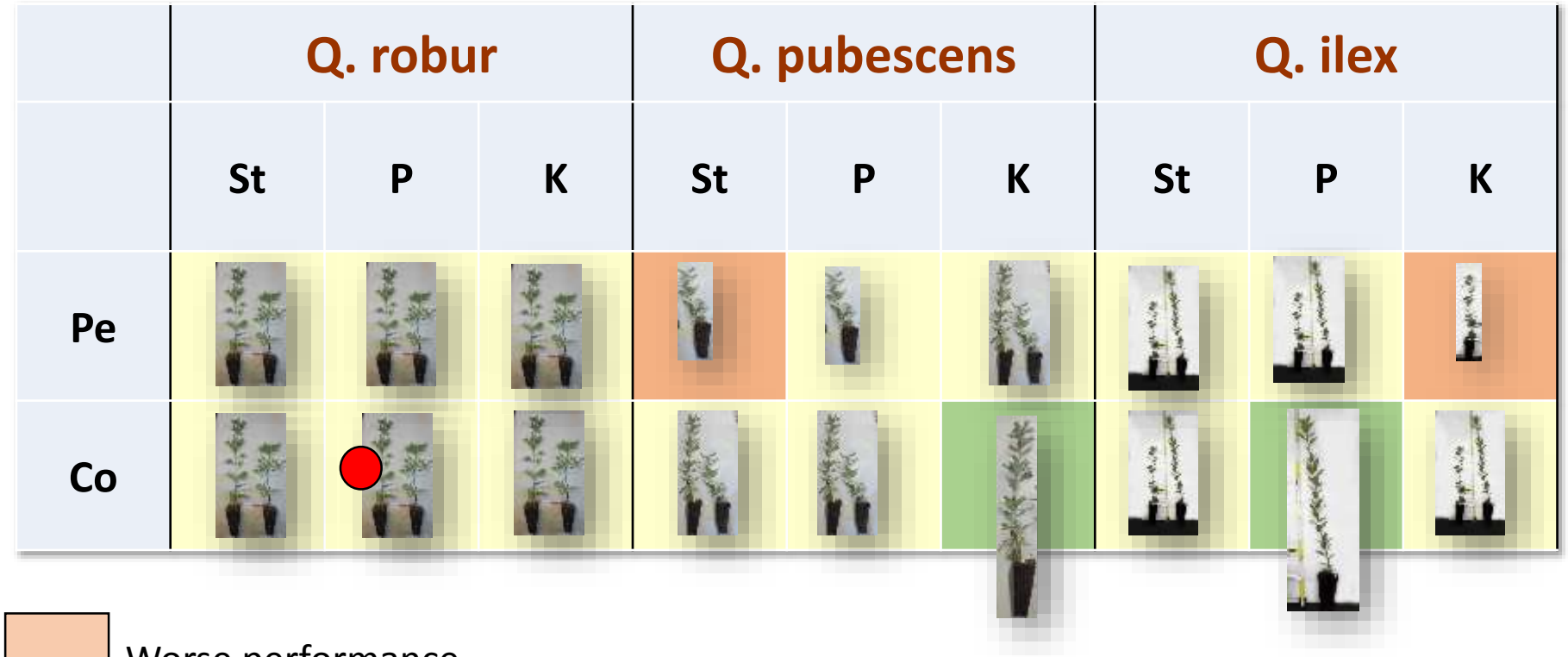
✓ = no difference among treatments

☠ = <20% survival (assessed observing leaf mortality)

● No difference in physiological response between max stress and full field capacity

No mortality in control and insignificant in medium stress (-50%)

3 - Which stocktype showed the best incremental reaction to maximum water stress?



Comparison among stocktypes grown in max stress within species

Worse performance

No difference or intermediate performance

Best performance

Best phisiological response

H Increment values in Co were > than in Pe under max stress

Main conclusions

- In all studied species the combinations of substrates and fertilizations resulted in the development of different nursery stock
- Bigger size seedlings were grown in peat and/or K-enriched fertilization
- But seedlings grown in coconut fiber should not be assessed as downgraded material
- Coconut fiber promoted a lower S/R ratio and, proportionally, a good roots articulation, which are considered an important attributes in relation to the occurrence of dry periods
- Under stress condition, higher growth was observed in Co in all species
- Despite being physiologically stressed, very good results were observed in Pe-P in Q. robur, in Pe-K and Co-K in Q. pubescens, in Pe-P, Co-P, Co-K in Q. ilex

VIAA project «Spin-off»

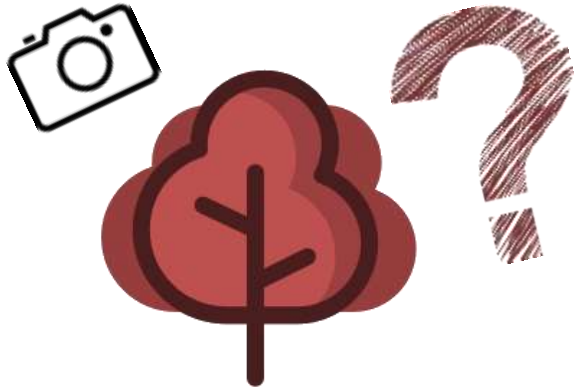
in collaboration with

Prof. G.Chirici - Dott.ssa F. Giannetti

geoLAB - Laboratory of Forest Geomatics

Is it possible monitoring plant physiological condition with a Near Infrared (NIR) commercial digital camera in forest nursery stock?

NO WATER STRESS



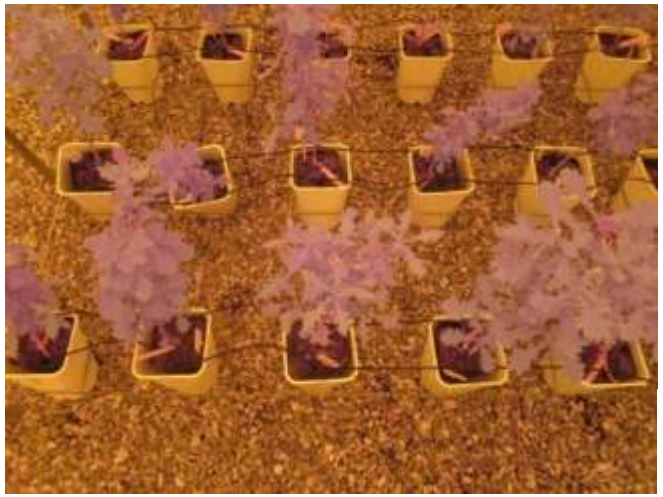
WATER STRESS

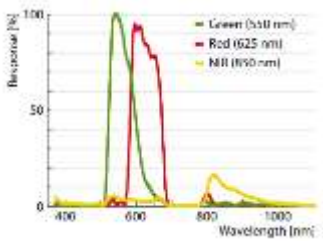
We compared the spectroscopical information coming from images taken by a NIR camera image analysis (i.e. CANON S110 NIR) with data collected on leaves by a high precision spectrometer.
Concurrently, we related the results to what obtained on the same leaves by a high precision fluorimeter (chlorophyll fluorescence) → physiology)

The final aim is to evaluate if NIR camera could offer a reliable tool to assess seedling physiological status (and, thus, nursery stock) in order to enhance production sustainability (use of water resources)

DATA ACQUISITION

CAMERA IMAGES

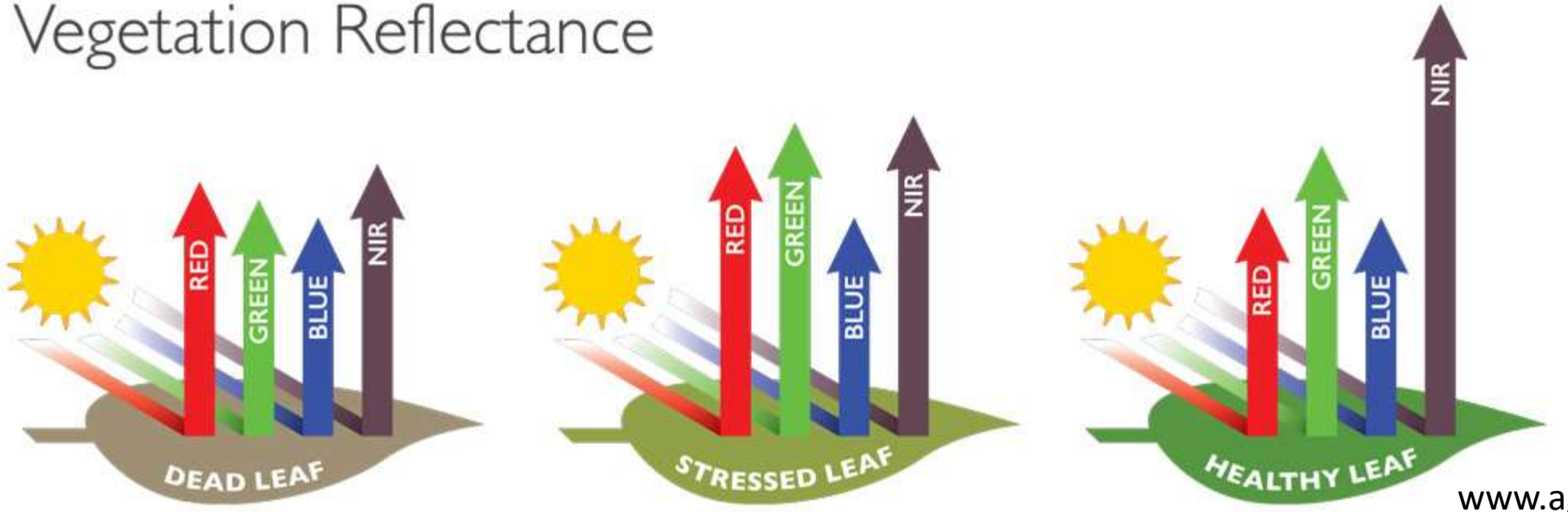




SPECTROMETER

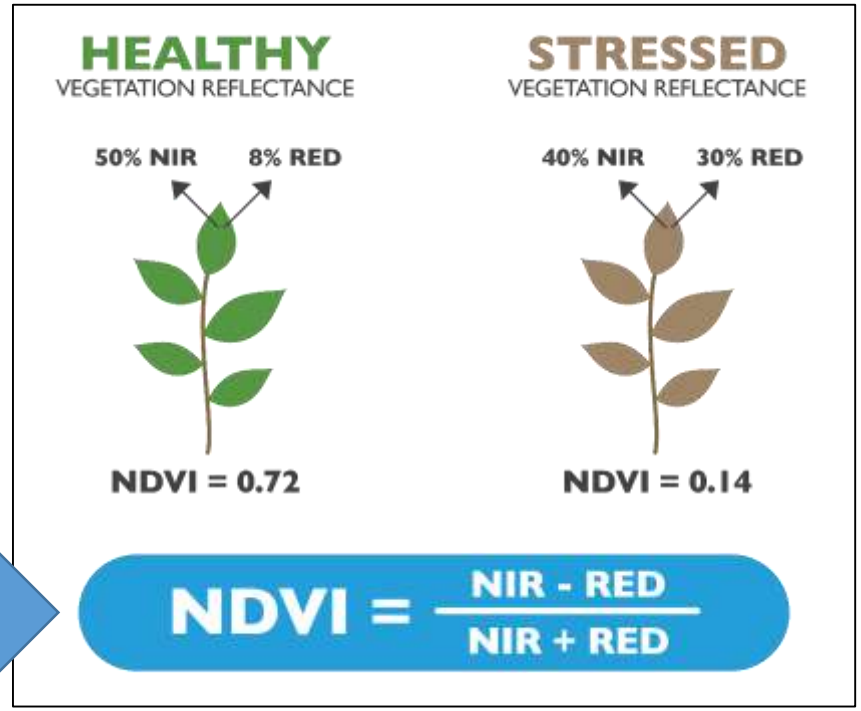
The experiment was carried out during the speed water stress in the green house to detect images from 3 different seedling physiological status

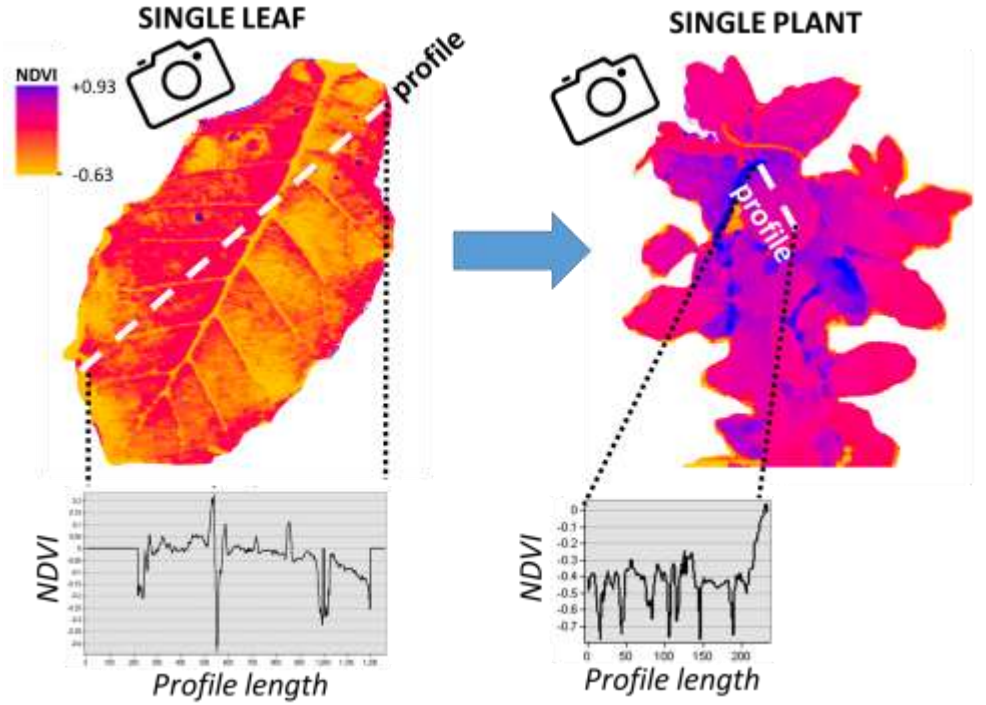
Vegetation Reflectance

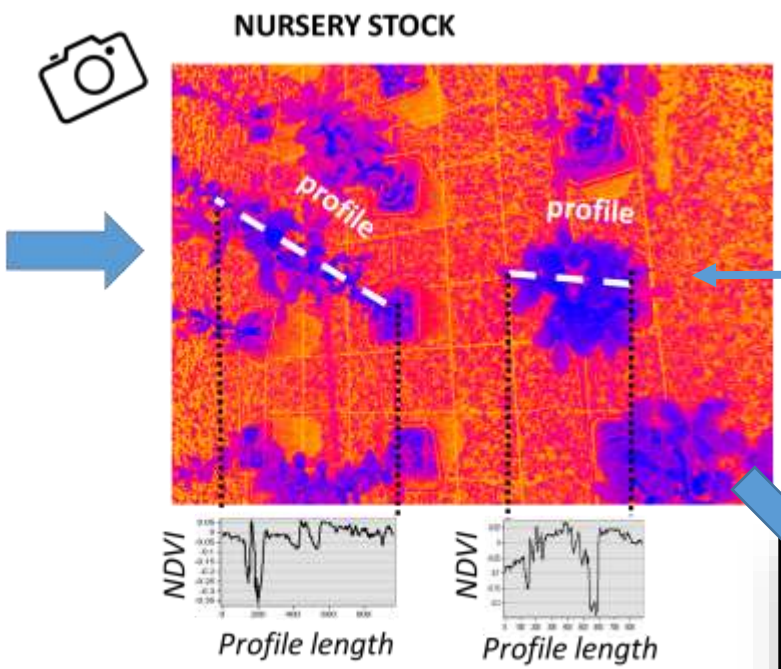


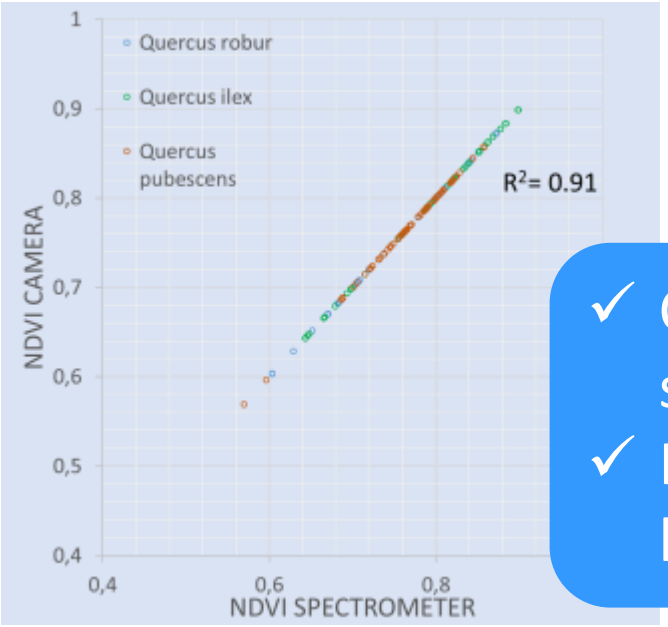
www.agricolus.com

We related NDVI by camera and NDVI by spectrometer









- ✓ Camera provided high detailed information at different levels: leaf, single plant and nursery stock
- ✓ High correlation between the NDVI derived by NIR camera and high-resolution spectrometer bands

In progress…

Outcomes

Data on the effect of peat and coir on morphological traits → Information on effective combination of substrate and fertilization to grow seedlings with desired traits

Information related to different response in relation to specific morphological traits→ Different stocktypes respond differently to water stress

Information about how much water it is possible to save after planting: at least -50% of soil full capacity

Future application of remote sensing techniques → early detection to save water resource:

In nursery:	-water regimes management in relation to early detection of stress
	-early selection of more resistant material
In field:	-water regimes management in relation to early detection of stress

REGIONE TOSCANA

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PIF Verdi connessioni – Mis. 16.2 VIAA *Vivaistica Innovativa ad Alta Adattabilità*

Thank you!

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