Growing Lettuce Under Multispectral LED Lamps With Adjustable Light Intensity

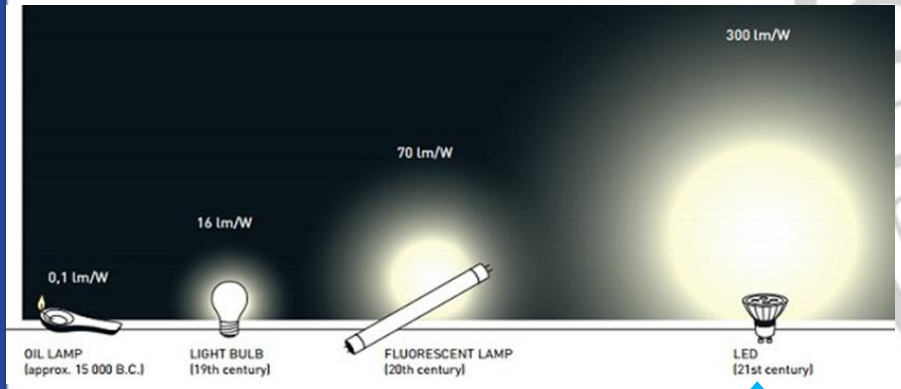
Giacomo Tosti, Euro Pannacci, Marcello Guiducci, Paolo Benincasa, Rossano Cortona, Michela Farneselli, Andrea Onofri, Francesco Tei, Mario Giulietti*

dsa3

* GNC s.r.l.

UNIVERSITÀ DEGLI STUDI DI PERUGIA

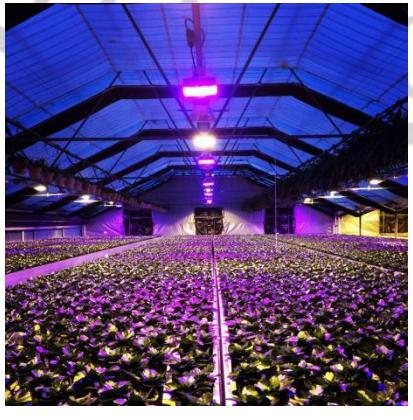
Evolution of artificial lighting



- High efficiency
- Low temperature
- Durability
- Monochromatic

Several applications:

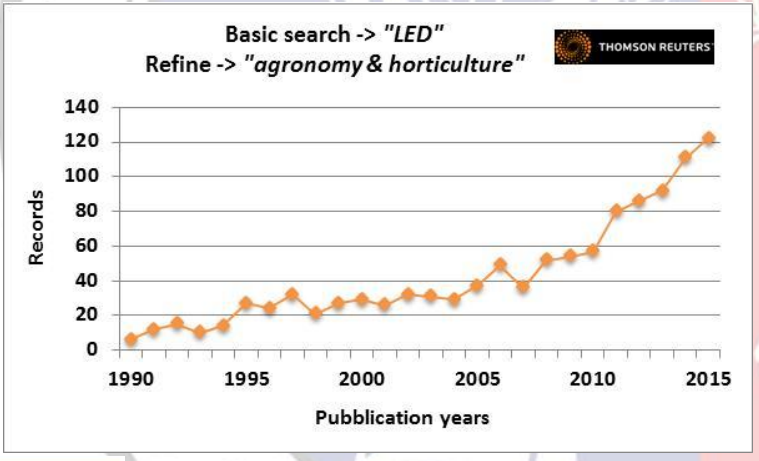
Illuminating engineering

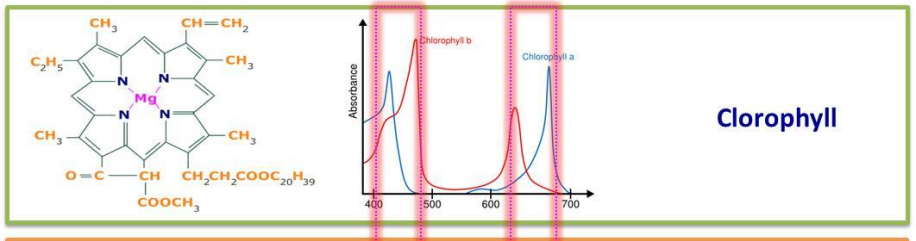


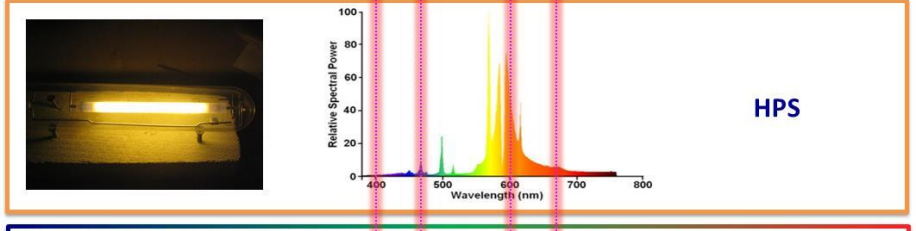
Plant cultivation

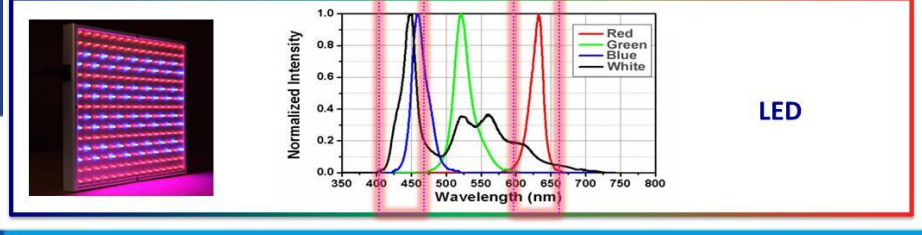
Increasing interest of scientific research

LED technology represents an opportunity to affect both growth and phytochemical traits, as several processes are under light control (gene expression…)









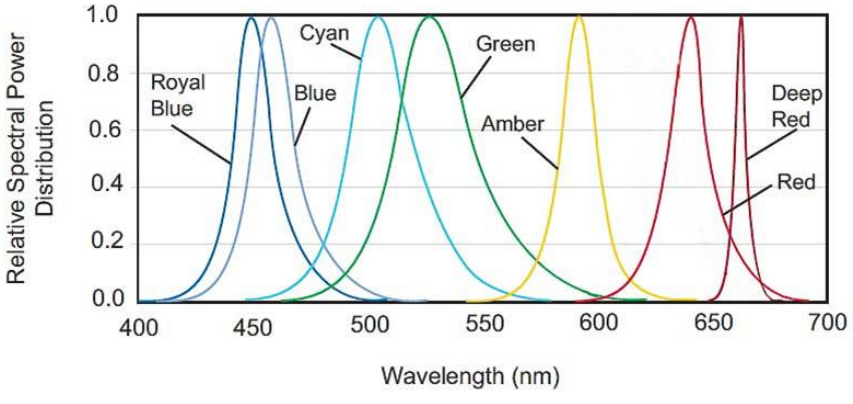
Main open questions:

- **BLUE:RED ratio**
- **Center part of the PAR spectrum**

Sassari
22-09-16

The *DSA3 lamp*:

Custom LED lamps designed and built in collaboration with the cutting edge company GNC®. Seven wavelengths (Royal Blue, Blue, Cyan, Green, Amber, Red, Deep Red) singularly adjustable. Max power = 80 W

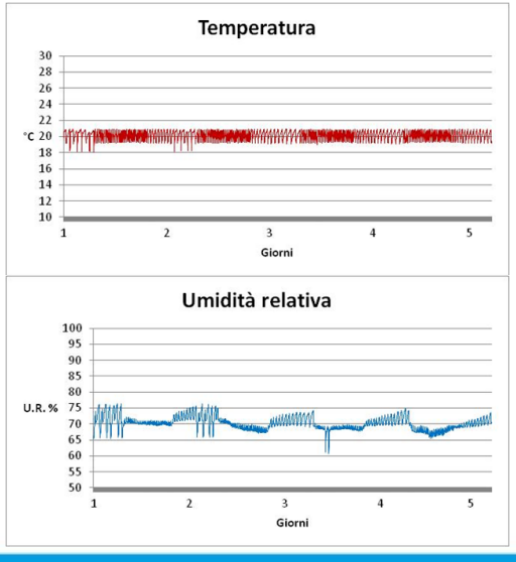


Sassari
22-09-16

Growing chamber:

Walk-in (2 X 1.5 X 2.5m), temperature and humidity continuously monitored.

Three shelfs with six compartments each.



Sassari
22-09-16

Crop management:

Substrate: 4 kg quartz sand, 40 g vermiculite.
Seeding: 59 seeds per tray, hexagonal arrangements (3.5 cm) -> 952 plants/m^2
Standard nutrient solution (open cycle)

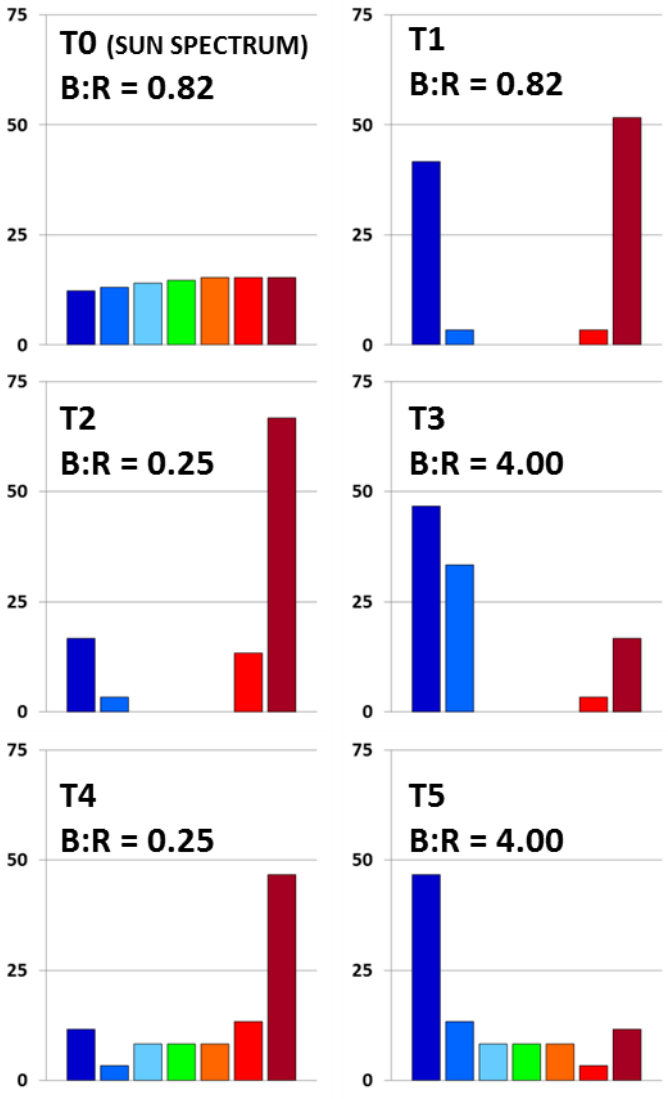
Objectives:

Compare different light spectra on lettuce (*Lactuca sativa* L.) growth, in details:

- **Canopy growth rate**
- **Total dry biomass**
- **RUE and Global Efficiency**

Sassari
22-09-16

Treatments



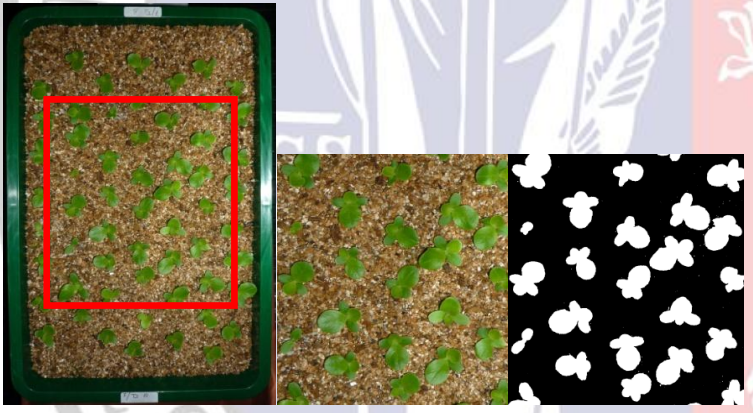
Constant PFD = 300 µmol m^{-2} s^{-1}

Sassari
22-09-16

Measurements

- **Image analysis**

Soil cover: software Imaging Crop Response Analyzer (Rasmussen et al. 2007)

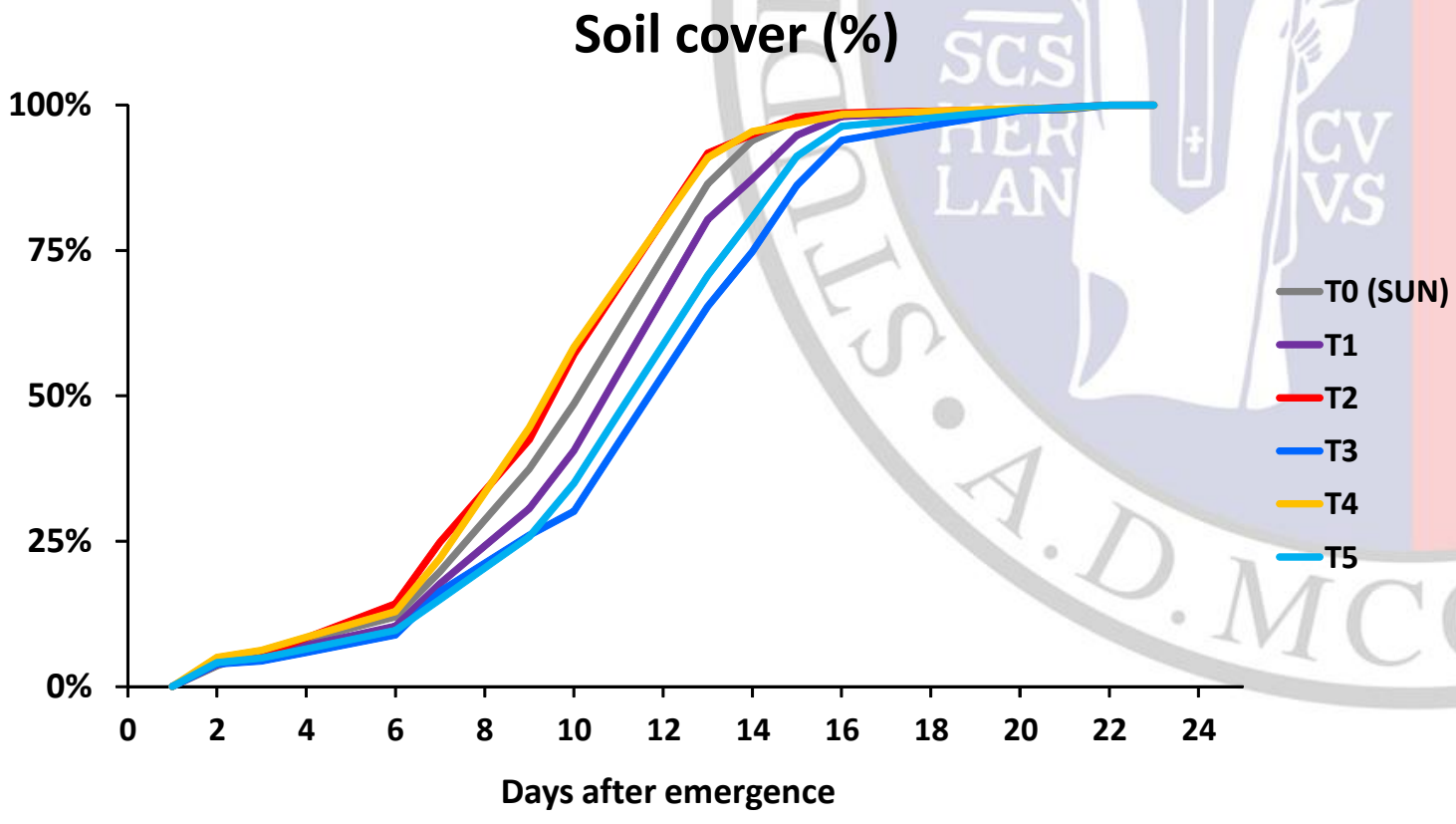


- **Absorbed radiation (Qa)**
- **Aboveground dry biomass**

- **Radiation Use Efficiency**
- **Electric energy consumption**
- **Overall Efficiency**

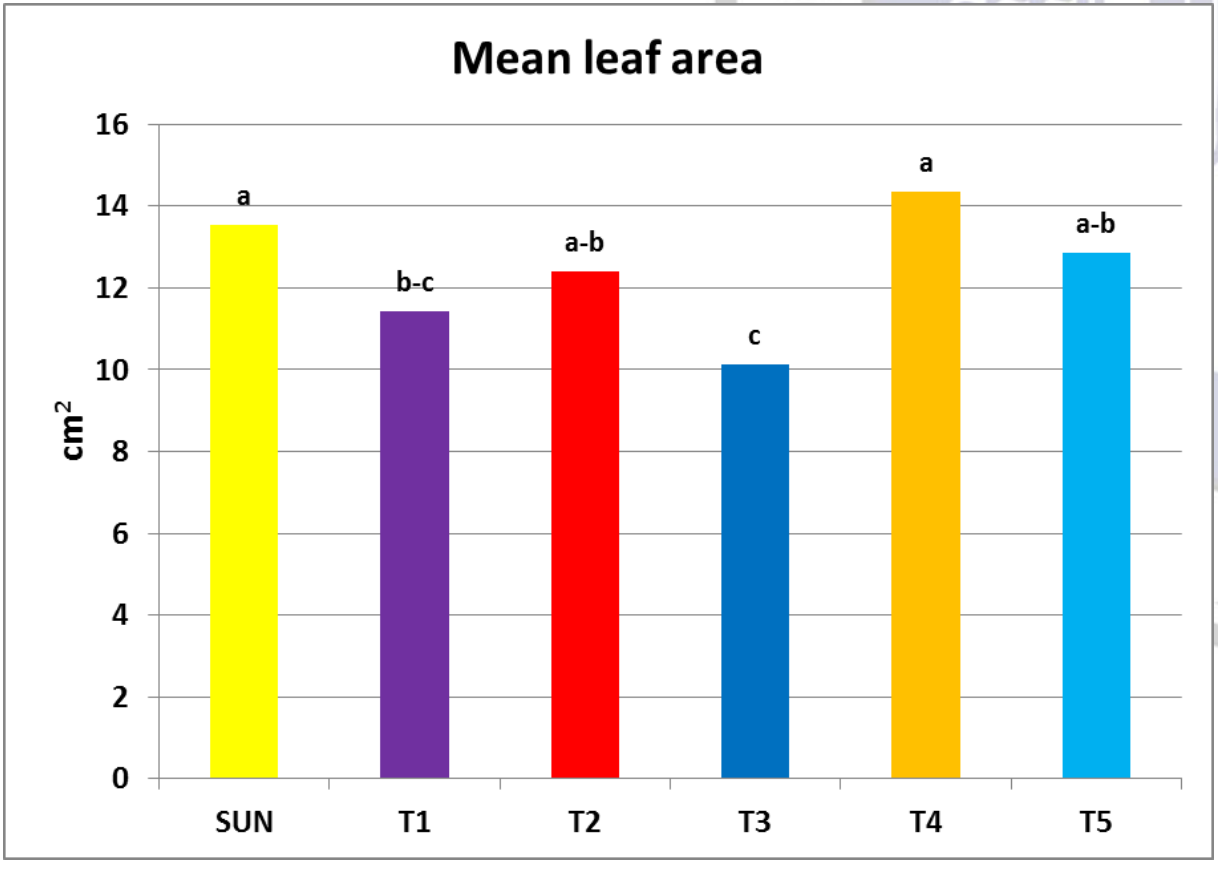
Sassari
22-09-16

Results



Sassari
22-09-16

Results

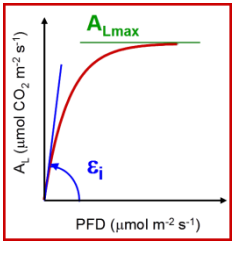


Sassari
22-09-16

Results

	Biomass ($g\ m^{-2}$)	Cumulated Qa ($mol\ m^{-2}$)	RUE ($g\ mol^{-1}$)	Overall* Efficiency ($J\ KJ^{-1}$)
T0 (SUN)	207 b	287 a-b	0.72 b	2.93 d
T1	183 c	279 b-c	0.66 c	5.03 b
T2	231 a	296 a	0.78 a	6.32 a
T3	168 c	265 d	0.64 c	3.72 c
T4	217 a-b	286 a-b	0.76 a-b	4.12 c
T5	180 c	272 c-d	0.66 c	3.05 d
SEM	5.3	3.6	0.016	0.206

* = Lamp efficiency x Absorbed radiation x Crop radiation use efficiency



Conclusions

- Soil cover rate enhanced by red/deep red spectrum
- Leaf distension improved by red/deep red -> biomass increase
- Center PAR frequencies (cyan, green and amber) increase energy consumption, but do not improve biomass accumulation.
- Influence of center PAR frequencies (intensity and ratios) on secondary metabolites needs to be better investigated.

Sassari
22-09-16