

Filtres lumineux et éclairage LED : 2 techniques de modification du spectre lumineux

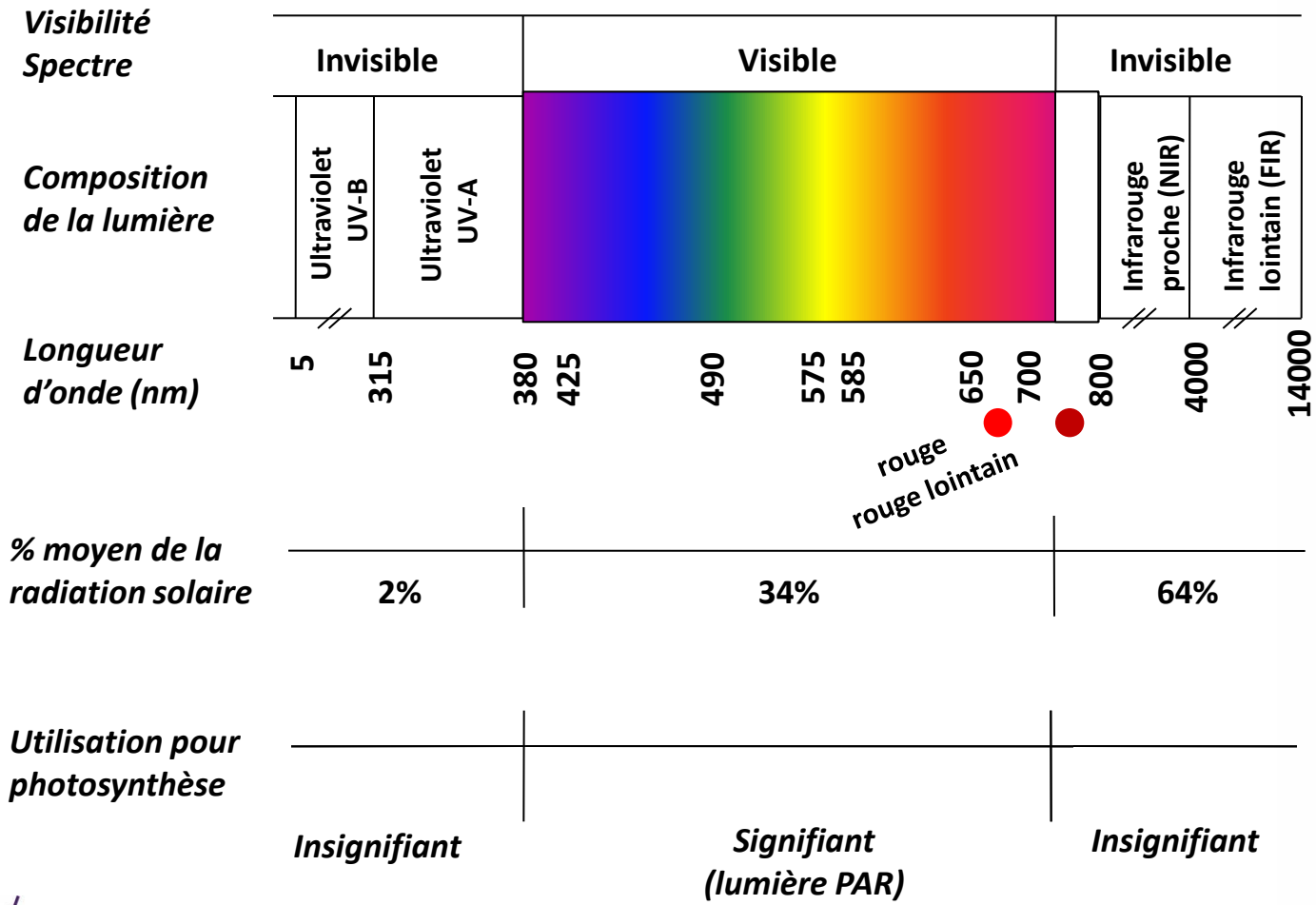
Oscar STAPEL



**Astredhor
Loire-Bretagne**



Composition et caractéristiques de la lumière naturelle



Filtres lumineux: l'amélioration de la qualité lumineuse dans la culture

Matériel

- Couvertures/bâches PE >180µm
- Films PE 100-150µm
- Filets (Polysack)
- Peintures (ReduHeat, TransPAR...)
- Ecrans serres

Rayons filtrés (absorption/réflexion)

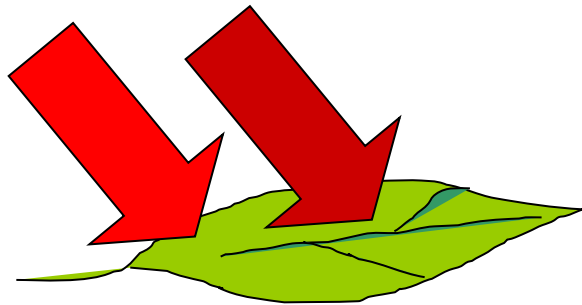
- Rouge lointain
- Infra rouge proche
- Ultra violet (UVA/UVB)
- Bleu et vert transformés en rouge
- UV transformé en bleu



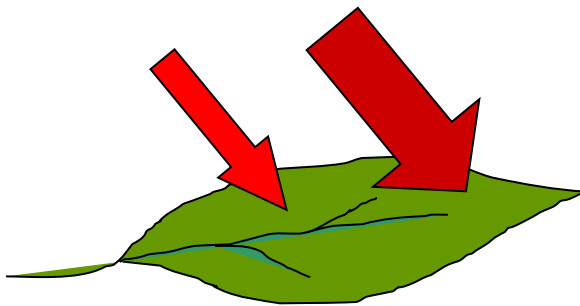
Modification de la lumière naturelle et réponse de la plante

Rapport lumière rouge / rouge lointain

Syndrome d'évitement de l'ombre



$R/RL = 1$
Plante normale



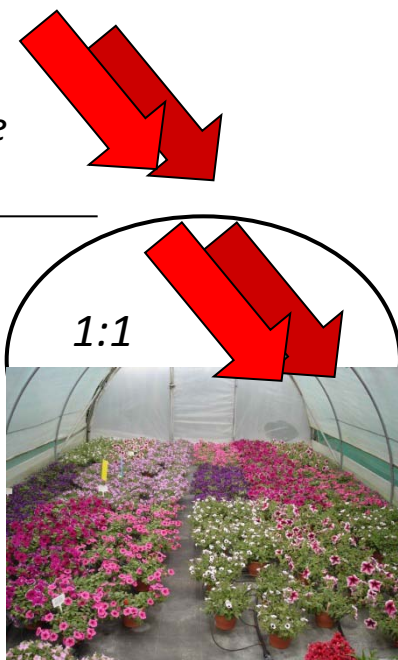
$R/RL < 1$
Plante étiolée



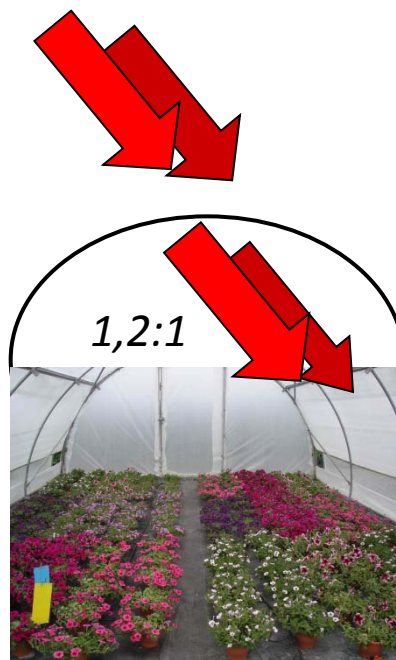
Application en horticulture ornementale, filtres RL

Lumière
extérieur serre
 $R/RL = 1:1$

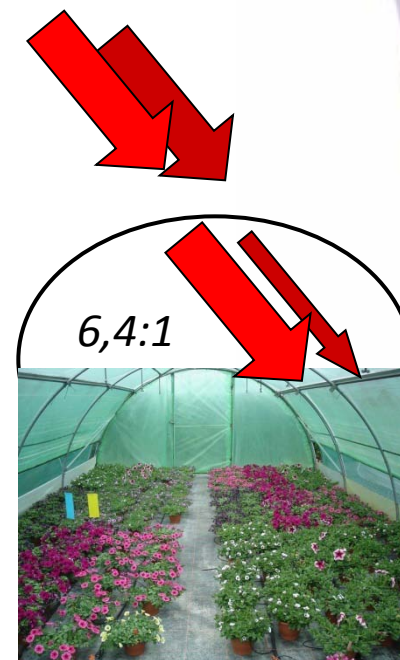
Lumière
intérieur serre
 R/RL



PE classique



PE classique +
ReduHeat ou TransPAR



Solatrol



Lumière rouge



Lumière rouge lointain



Application en horticulture ornementale, filtres RL



Sans Alar – 3X Alar
Témoin PE

Sans Alar – 1X Alar
Solatrol PE



Transfert en entreprise

Résultats ASTREDHOR filtres R/RL

- Plante compacte (majorité des taxons horticoles)
- Couleur végétation vert foncé
- Plus de ramification
- Economie sur traitements de régulateurs de croissance
- Attention : incidence sur la précocité de la floraison



Application en production de plants potagers, filtres UV

Couverture classique



Choux

Couverture UV transparente



Salade

Résultats
ASTREDHOR
couvertures UV
transparentes

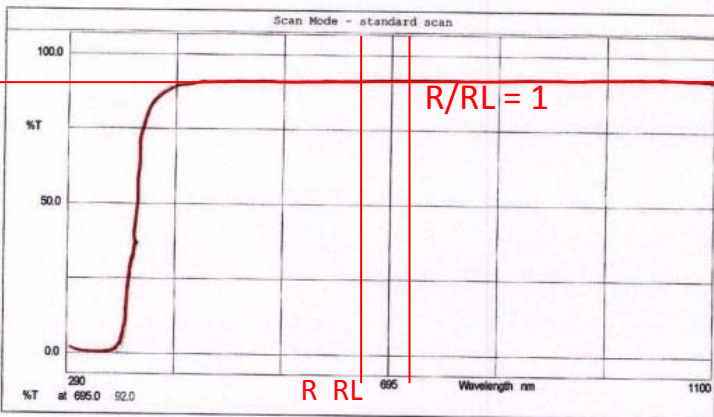
- Plant compact
- Plant durci
- Moins de stress à la transplantation et reprise rapide



Profiles de transmission, une information indispensable

Camspec M350 - Scanning Mode

Time & Date : 13:51 10/8/09
 Analysis Title : PAR transmission
 Method Title : standard scan Method File : PAR.SMI
 Data Interval : 5.0nm
 Lampchange Wavelength : 320nm
 Filterchange 1 : 380nm
 Sample Name : thb
 Instrument : M350
 File Name : CAM316.SR1



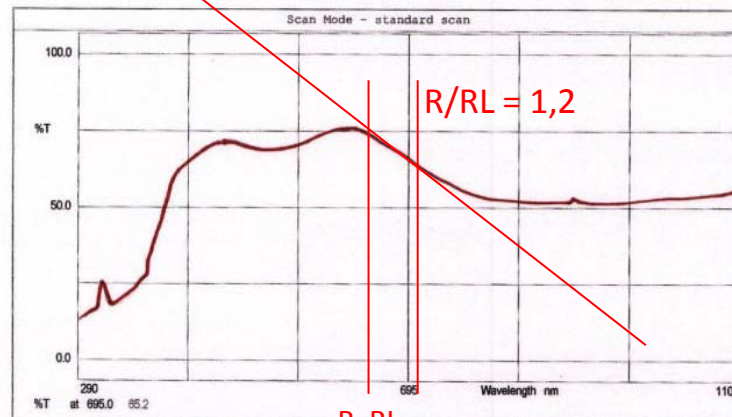
1 - thb 1



Bâche PE témoin

Camspec M350 - Scanning Mode

Time & Date : 14:01 10/8/09
 Analysis Title : PAR transmission
 Method Title : standard scan Method File : PAR.SMI
 Data Interval : 5.0nm
 Lampchange Wavelength : 320nm
 Filterchange 1 : 380nm
 Sample Name : transpar
 Instrument : M350
 File Name : CAM318.SR1



1 - transpar



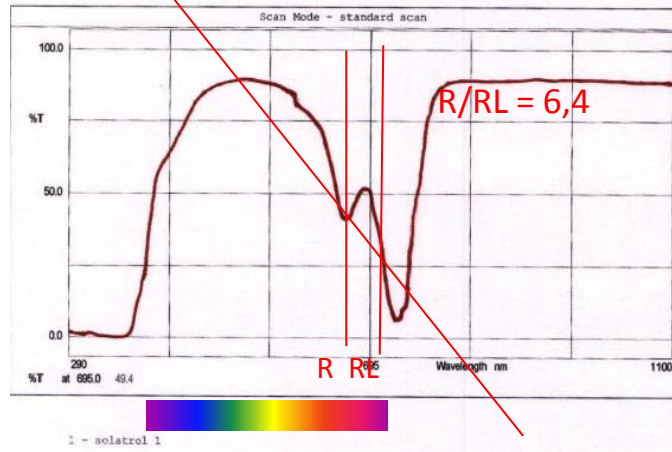
ReduHeat/TransPAR



Profiles de transmission, une information indispensable

Camspec M350 - Scanning Mode

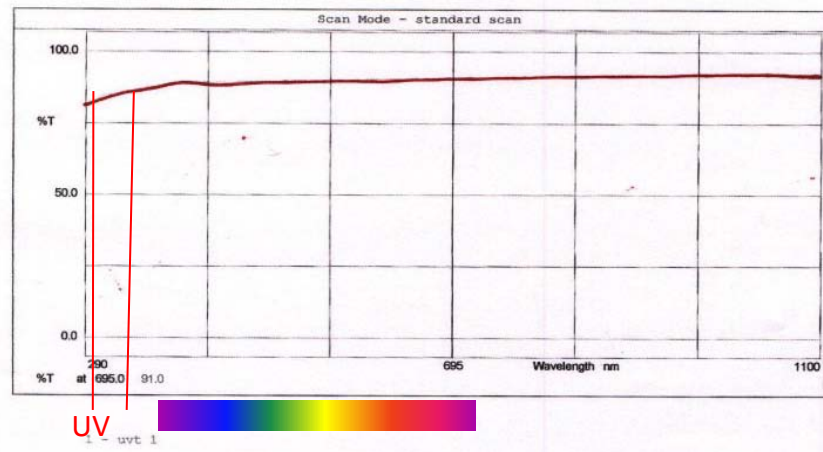
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 Analysis Title : PAR transmission
 Method Title : standard scan Method File : PAR.SMI
 Data Interval : 5.0nm
 Lampchange Wavelength : 320nm
 Filterchange 1 : 380nm Filterchange 2 : 600nm
 Sample Name : solatrol Operator : neal
 Instrument : M350
 File Name : CAM315.SR1



Solatrol

Camspec M350 - Scanning Mode

Time & Date : 13:56 10/8/09
 Analysis Title : PAR transmission
 Method Title : standard scan Method File : PAR.SMI
 Data Interval : 5.0nm
 Lampchange Wavelength : 320nm
 Filterchange 1 : 380nm Filterchange 2 : 600nm
 Sample Name : uvt Operator : neal
 Instrument : M350
 File Name : CAM317.SR1



Lumisol UV transparent



Filtres lumineux en développement pour la production végétale

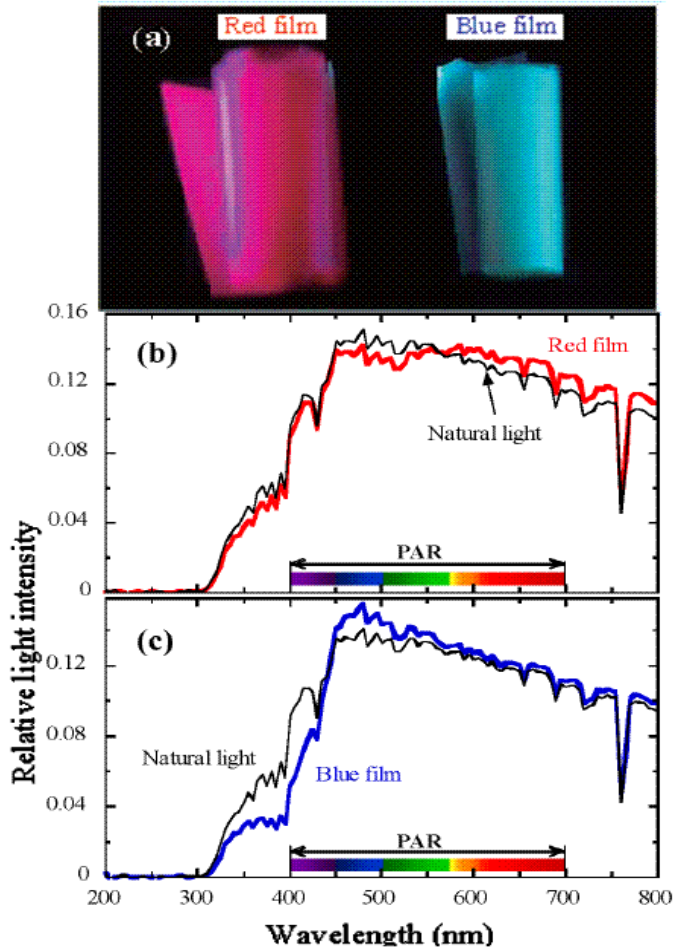
Convertisseurs spectrales

« Red film »

Conversion des rayons bleus et verts en rayons rouges
-Biomasse plus importante
-Germination accélérée

« Blue film »

Conversion des rayons UV en rayons bleus et verts
- Port de la plante altéré (feuilles allongées)

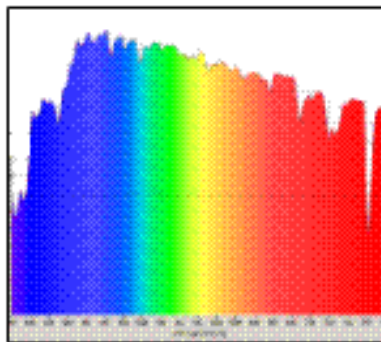
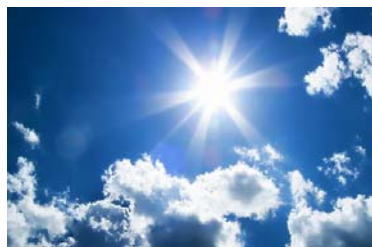


Hidaka et al, 2008

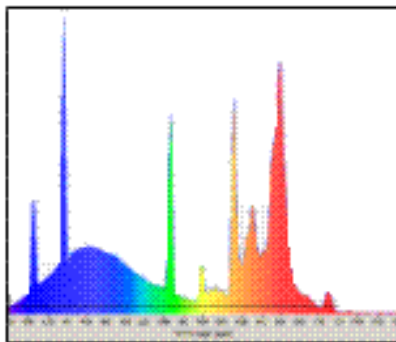


Eclairage en horticulture

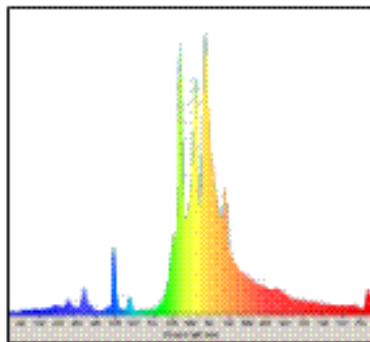
Spectre PAR émis par différentes sources lumineuses



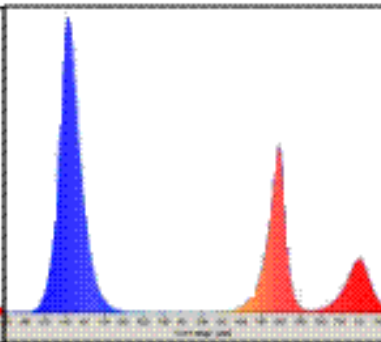
Soleil



Lampe
luminescente

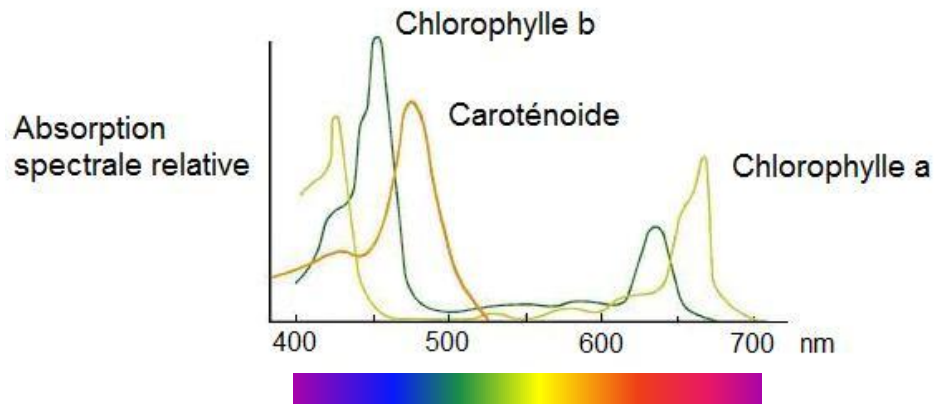


HPS SON-T



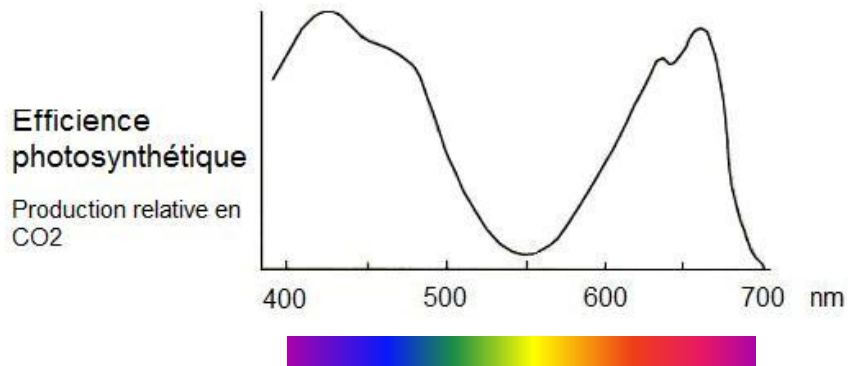
LED horticole

Utilisation lumière par la plante



Absorption du spectre lumineux par les feuilles

Principalement :
Rayons rouges
Rayons bleus

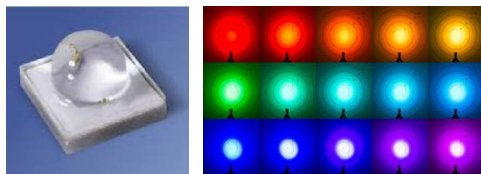


Photosynthèse en fonction du spectre lumineux

Plus efficace :
Rayons rouges
Rayons bleus



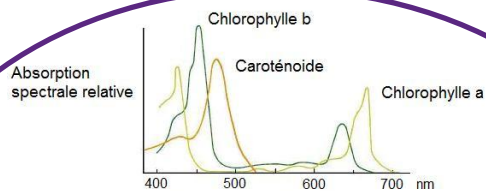
LED : une technologie de pointe pour une croissance optimale



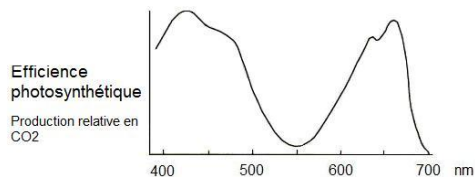
LED : lumière monochromatique



Spectre PAR



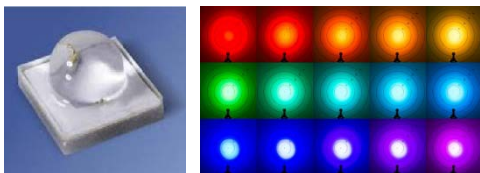
Absorption lumière



Effizienz photosynthétique

Optimisation croissance de la plante

LED : une technologie de pointe pour une meilleure qualité de plante



Qualité : 80R/15B/5RL, 85R/15B...
Quantité : μmol de photons/m²/s

Compacité (UV, R/RL, R/B)
Ramification (B, R/B)
Période de floraison (R, RL)
Floribondité (R/RL)

LED : lumière monochromatique

UV + spectre PAR + RL

Développement des « recettes » d'éclairage

Qualité de plante

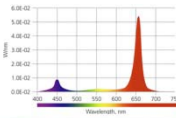


LED : recettes d'éclairage en fonction de l'objectif de production

Recettes d'éclairage proposées pour différents usages (Illumitex)

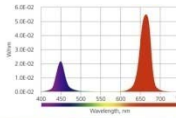
F3 SPECTRUM

Best for Germination and Flowering
This spectrum produces the fastest germination for plant species whose germination requires light. It also gives the best flowering results among all Surex™ spectra. Recommended for use in germination chambers and for flower production.



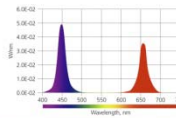
F1 SPECTRUM

General Purpose, High Efficiency
The F1 spectrum is suitable for a variety of plant species throughout their growth cycle. It contains a high proportion of red light, which spurs photosynthesis during the vegetative growth stage and facilitates the flowering stage. It has the highest photon yield efficacy of all custom Surex™ spectra and is recommended for applications with a tight electrical energy budget.



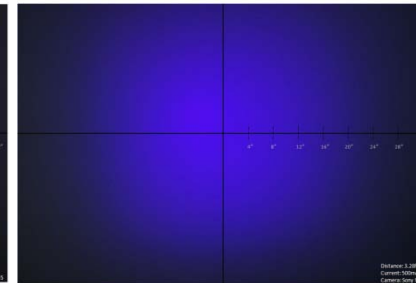
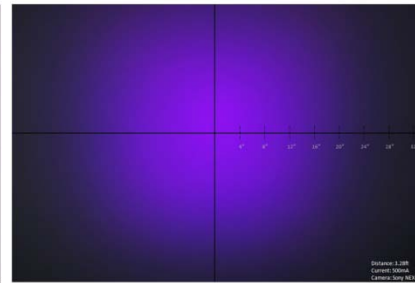
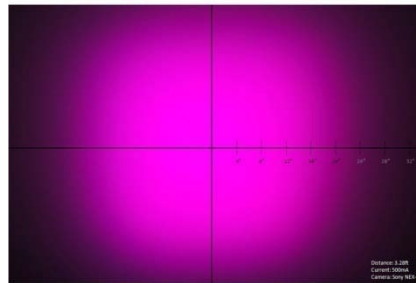
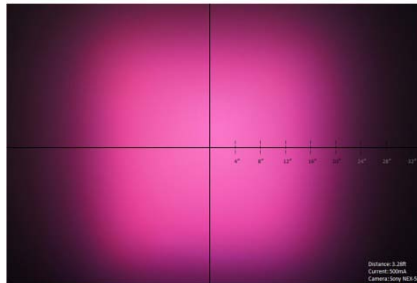
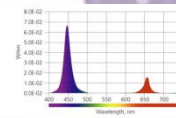
F6 SPECTRUM

Best for Vegetative Growth
The F6 spectrum has an enhanced blue region and provides the fastest vegetative growth results. The increased blue content reduces plant height, thereby improving plant appearance and space utilization. Recommended for the production of leafy green vegetables.



F7 SPECTRUM

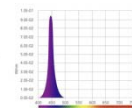
Best for Seedlings
This spectrum has the highest blue content of all Surex™ spectra and produces stocky plants with short internodal distances, highly desirable at the seedling stage. Recommended for growing seedlings prior to transplantation.



Leds monochromatiques pour développer recettes d'éclairage à la carte

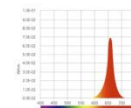
450 nm BLUE

This light enacts regulation by cryptochromes and phototropins, mediating various plant responses, such as phototropic curvature, inhibition of elongation growth, chloroplast movement, stomatal opening and seedling growth regulation. Can be directly absorbed by chlorophyll in photosynthesis. Recommended as supplemental light for seedlings and young plants during the vegetative stage of their growth cycle, especially when "stretching" must be reduced or eliminated.



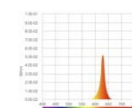
660 nm DEEP RED

This wavelength has a very strong photosynthetic action and also exhibits the highest action on red-absorbing phytochrome regulated germination, flowering and other processes. Most effective for light cycle extension or night interruption to induce flowering of long-day plants or prevent flowering of short-day plants. Most energy-efficient source for photosynthesis among all available supplemental LEDs.



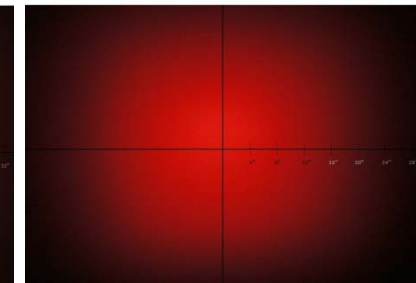
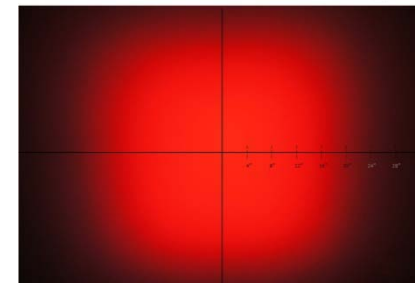
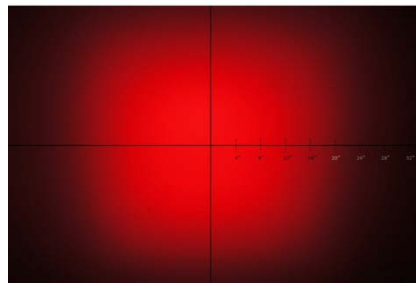
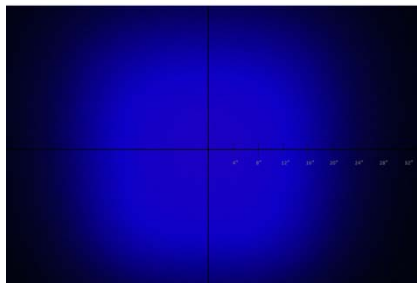
624 nm RED

This wavelength region has the highest photosynthetic relative quantum yield for a range of plants. At the same time, its action on red-absorbing phytochrome is considerably weaker compared to that of 660 nm red light and can be used to balance the phytochrome equilibrium towards lower values (closer to those of daylight) than those achievable with 660 nm red light, especially when used together with 730 nm red light.



730 nm Far RED

Although this wavelength is outside the photosynthetically active range, it has the strongest action on the far-red absorbing form of phytochrome, converting it back to the red-absorbing form. It becomes necessary for plants requiring relatively low values of the phytochrome protoequilibrium to flower. Can be used at the end of each light cycle to promote flowering in short-day plants.



Eclairage LED en horticulture ornementale?

Inconvénients

- Aujourd'hui : investissement important. Demain?
- Evolution importante de la technologie LED
- Qualité d'éclairage très spécifique. Recettes d'éclairage en fonction de la culture et de l'objectif de production

Avantages

- Economie d'énergie?
- Durée de vie importante
- Eclairage monochromatique
- Facilement adaptable aux différents systèmes de production



Applications LED en production végétale



**Système multi étage
« plant factory »
Légumes / plantes aromatiques**



**Eclairage inter rang
Tomate / rosier**



**Eclairage par le dessus
Système fixe ou mobile
Plantes en pots /
plantes aromatiques**



Conclusions

Améliorer la qualité de la lumière en production végétale

Production végétale optimale

Filtres lumineux → convertisseurs spectrales

Eclairage LED (> 100 $\mu\text{mol}/\text{m}^2/\text{s}$)

Qualité optimale du végétal

Filtres lumineux → R/RL, UV...

Eclairage LED

- photosynthétique (> 100 $\mu\text{mol}/\text{m}^2/\text{s}$)
- photopériodique (1-3 $\mu\text{mol}/\text{m}^2/\text{s}$)



Merci pour votre attention



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