

Led technology and germination test

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Germination test – Effect and requirement of light

- Germination test : ISTA standardized test.
- Enlarged definition of germination : from dry seed, to seedling evaluation as normal, abnormal or non germinated seed
- Light in germination test :
 - Effect
 - Effect of light known for germination (*sensu stricto*) of some species
 - Light has a strong effect on seedling growth and seedling evaluation
 - Requirements
 - Light is not mandatory but highly recommended in germination test
 - For some species light or darkness is a treatment during germination to break physiological dormancy. For this, lighting from 750 to 1250 lux from cool white lamps is required



alfalfa seedlings
from seedling
growth conditions
with and without
light



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Light for Germination test – Experience, expectation, validation

- Our experience using light for germination test
 - Use of fluorescent light since 1993 in Beaucouzé with various configurations
 - Use of plastic proof containers : potential greenhouse effect on temperature
 - Important to measure useful wavelengths – PAR Quantum sensors instead Luxmeters
 - Fluorescent light from 3000 to 4000 Kelvin are adapted for germination test
 - Importance of maintaining light homogeneity
- Hoped for results using LED for germination test
 - Decreased costs
 - Benefit of using new technologies
 - Same germination results as achieved using fluo
- Validation
 - Need to check if LED fit for purpose of germination test
 - QA requirement

GEVES project to compare 3 LED suppliers



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Rooms germinators – climatics chambers



2 configurations tested : 5 m², vertical or horizontal light among 6 configurations (from 2.5 to 25 m²)

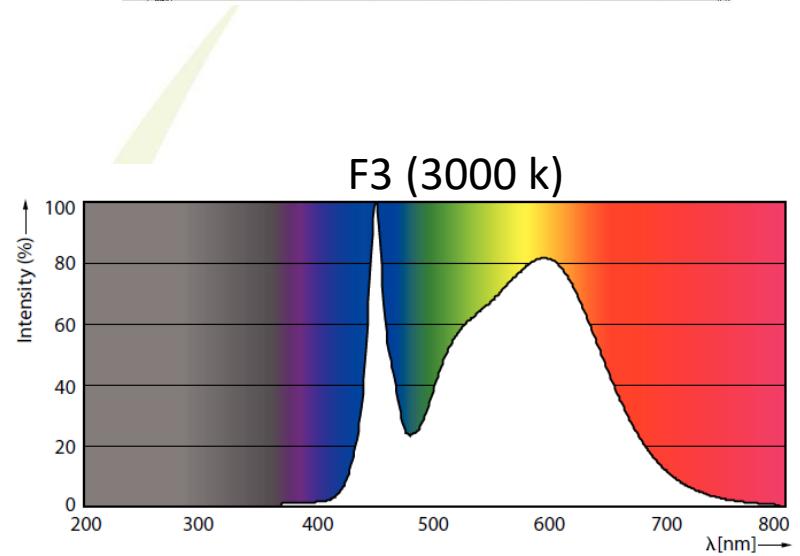
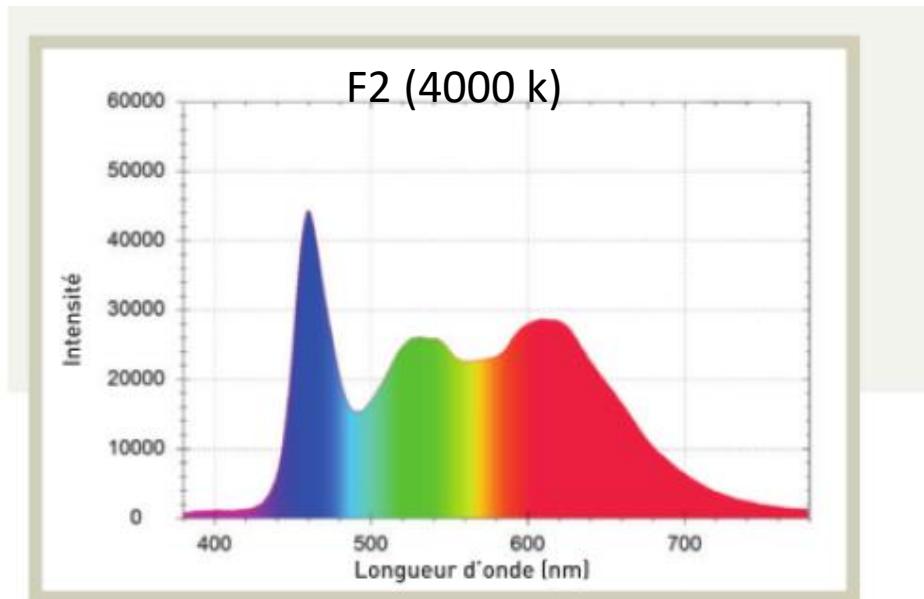
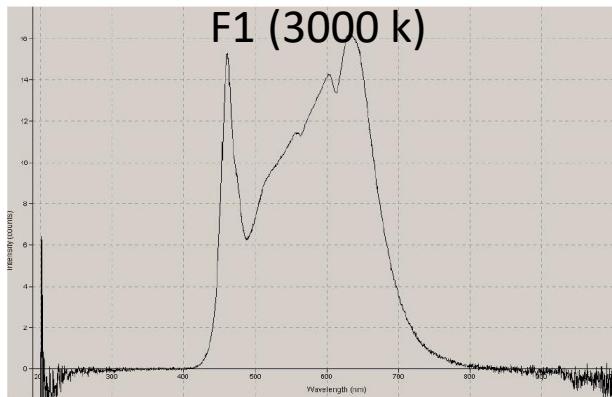
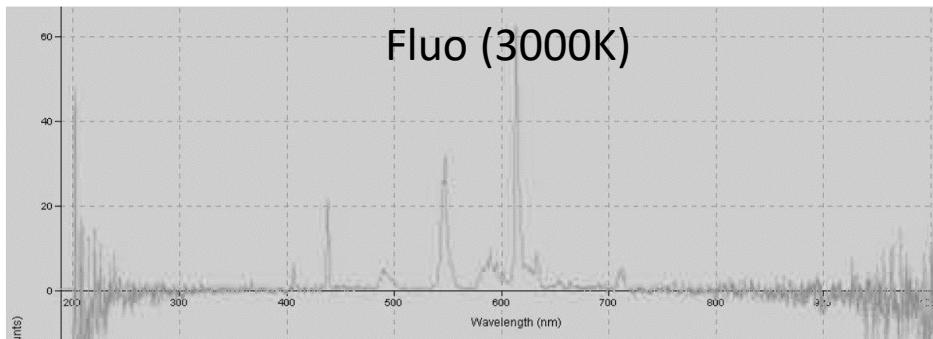
Constraints : trolley and germination box sizes



Lighting spectrum

Couleur	Longueur d'onde [nm]	Indice
Bleu	440	20
Vert	550	32
Rouge	610	60

Couleur	Longueur d'onde [nm]	Indice
Bleu	460	15
Vert	500/600 pente	11
Rouge	620	16



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Temperature management

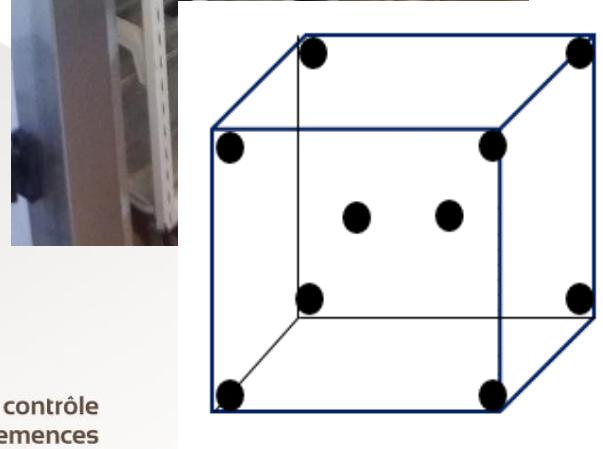
Need to do all tests at the same temperature (near the seed) to study only light properties on germination and seedling growth and not temperatures due to various greenhouse effects

Temperature profil : With 10 probes 30 measurements (1/minute) :

To monitor and check that the expected temperature is achieved near the seed

To determine the target need with a probe positionned toward the top of climatic chamber

To check temperature homogeneity (+/-2°C tolerance)

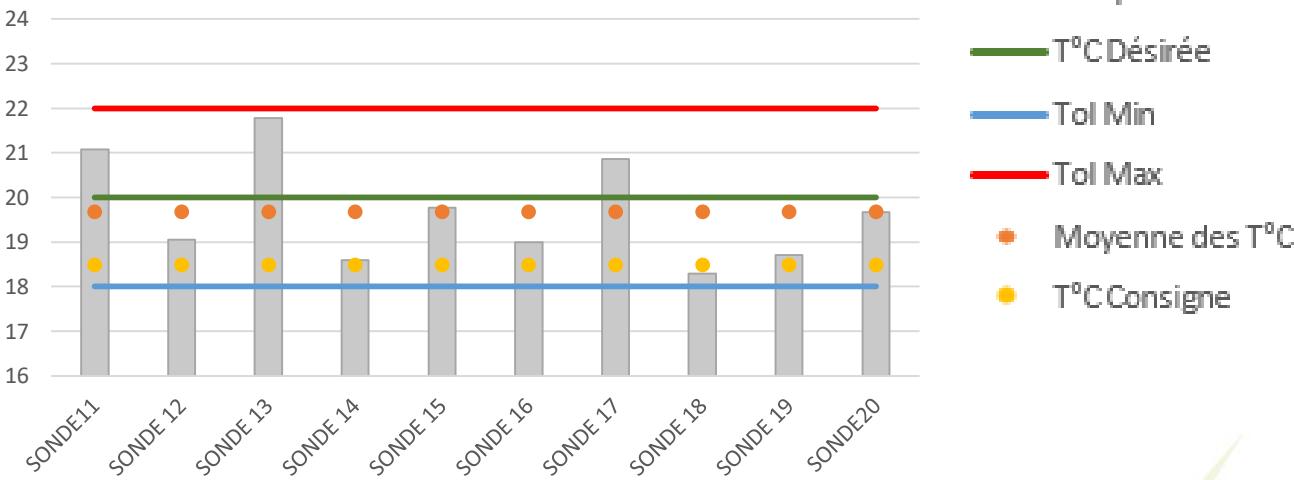


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Adjustment of temperature setting to obtain 20°C near the seed

F1 With 18.5°C setting – Room MOD 19



Mean = 20°C
Acceptable
heterogeneity

Temperature settings to obtain a mean of 20°C near the seed with a probe on the top of the room

	<i>fluo</i>	<i>F1</i>	<i>fluo</i>	<i>F1</i>	<i>fluo</i>	<i>F2</i>	<i>fluo</i>	<i>F2</i>	<i>fluo</i>	<i>F3</i>
	<i>MOD 18</i>	<i>MOD 18</i>	<i>MOD 19</i>	<i>MOD 19</i>	<i>MOD 17</i>	<i>MOD 17</i>	<i>MOD 20</i>	<i>MOD 20</i>	<i>MOD 6</i>	<i>MOD 6</i>
orientation	V	V	H	H	H	H	V	V	H	H
T°C setting	18.5	19	18.5	18.5	18.5	18	20	18	18.5	18

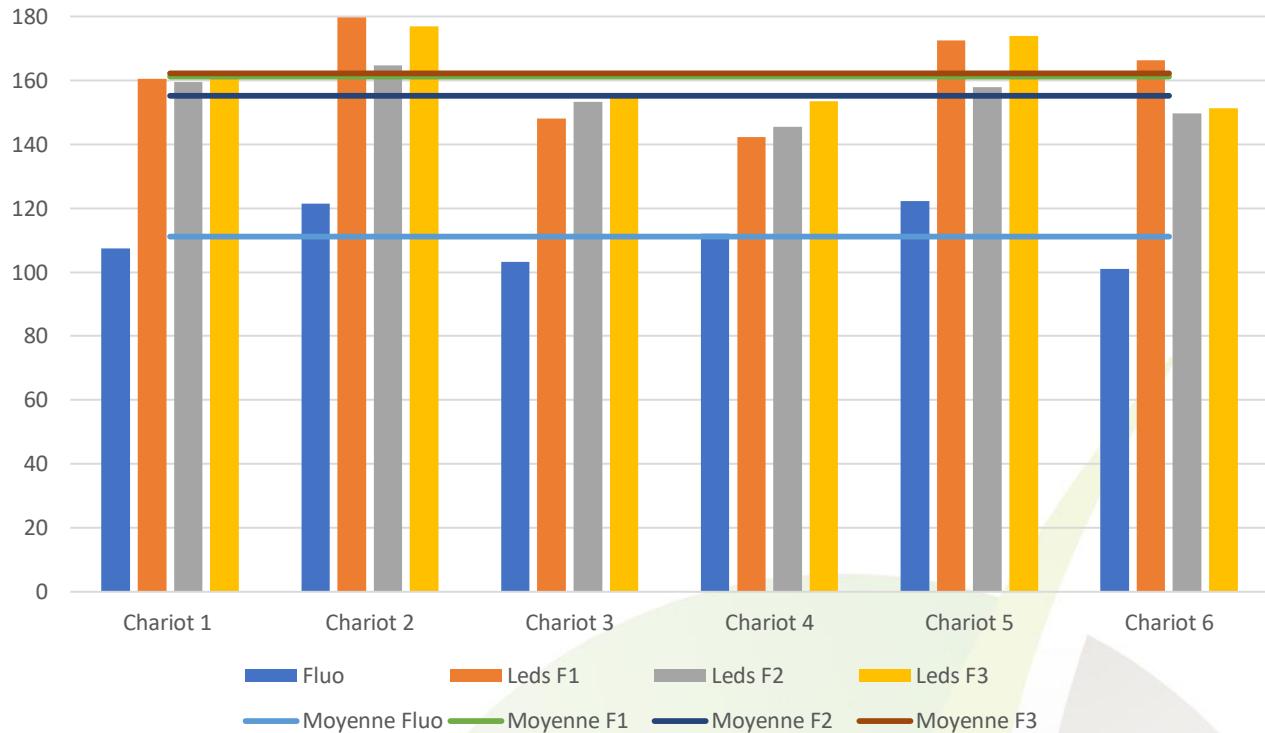
Need of temperature profil for each room germinator
Difference of greenhouse effect between F1 and F2 & F3



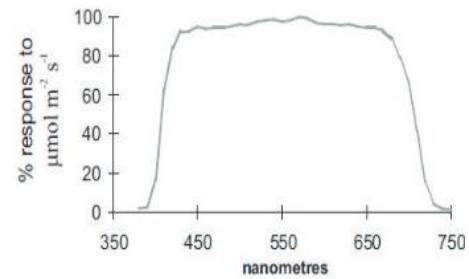
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Lighting intensity and variability

Chamber MOD 19 – H : Comparison between Fluo and LEDs
Measurment of photons flux density with a photoreceptor in
 $\mu\text{mol.m}^{-2}.\text{s}^{-1}$



PAR QUANTUM SENSOR SKP 215



- Higher intensity with LEDs
- No large differences between 3 LEDs models
- Almost same heterogeneity for fluo and LEDs



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Workshop PathoLED - May 2019

Skye sensor and
multimeter

3 step trials

- **Preliminary trials** : Comparison between Fluo F1 and F2
 - 12 species, 400 seeds/species – Conclusion : Relevance of studying LEDs
- **First trial** : 6 major species, 15 samples/species and 200 seeds/test, Comparison Fluo F1 F2 and F3

Second trial : 6 major species 30 samples/species and 400 seeds/test comparison Fluo/F1 and separately Fluo/F2

Aspects Visuels sur l'ensemble des boites

Espèce :	Echantillon :	Condition :
Intensité verte :	Faible	<input type="checkbox"/>	Normale	<input type="checkbox"/>	Forte <input type="checkbox"/>
Levée Homogène :	Oui	<input type="checkbox"/>	Non	<input type="checkbox"/>	
Hauteur des plantules :	Peu Développées	<input type="checkbox"/>	Moyennement développées	<input type="checkbox"/>	Très développées <input type="checkbox"/>
Cotylédons	Ouverts	<input type="checkbox"/>	Fermés	<input type="checkbox"/>	
Développement des cotylédons :	Oui	<input type="checkbox"/>	Non	<input type="checkbox"/>	
Développement des cotylédons :	Si oui				

→ **Two characterisations :**

Qualitative evaluation of boxes :

Evaluation chart

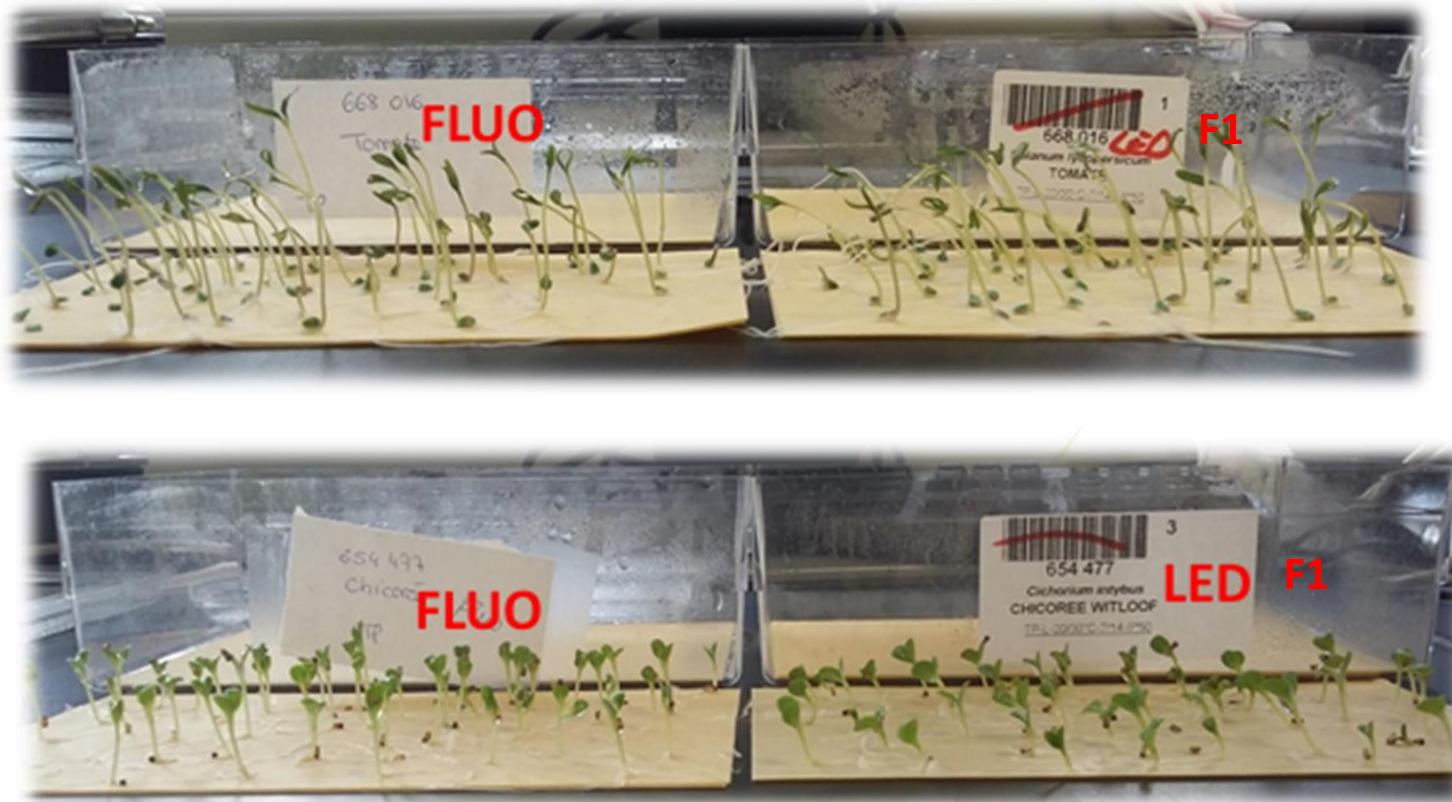
Germination test results : Normal seedlings, abnormal seedlings, non germinated seeds + abnormalities detail



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Qualitative evaluation of seedling development – Paper



**Tomato, chicory, often difficult species to analyse,
less etiolated seedling easier to evaluate**

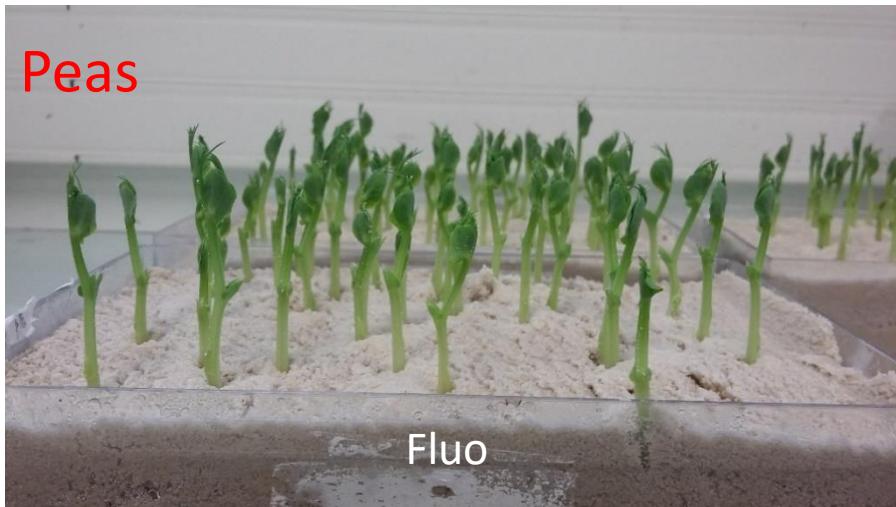


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Qualitative evaluation of seedling development – sand or soil

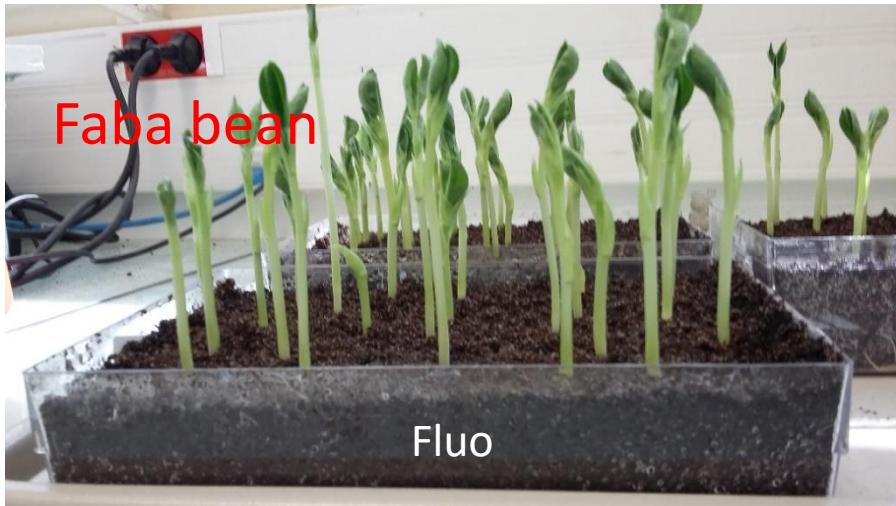
Peas



Peas



Faba bean



Faba bean



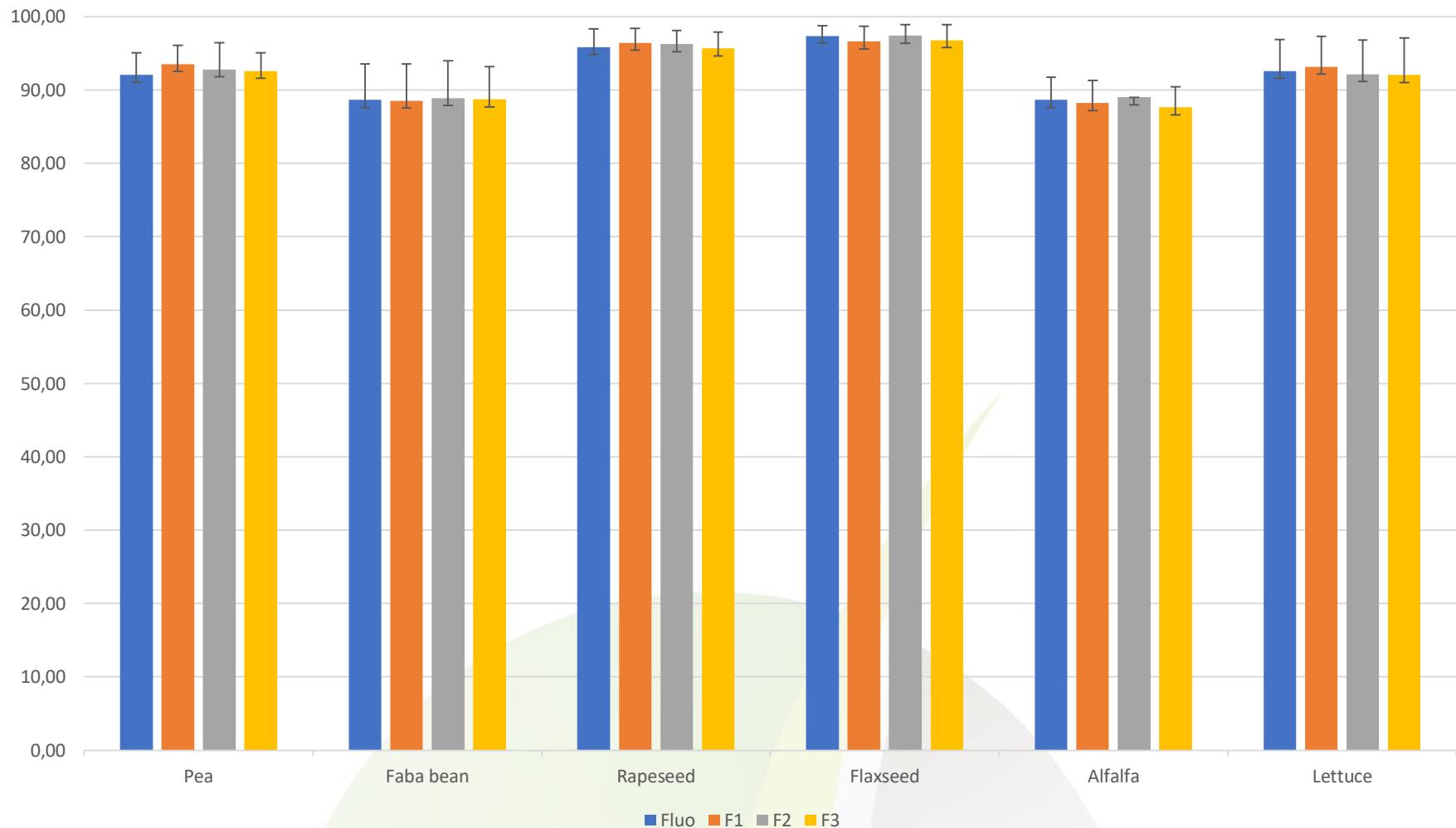
Less etiolated seedling easier to evaluate with Leds



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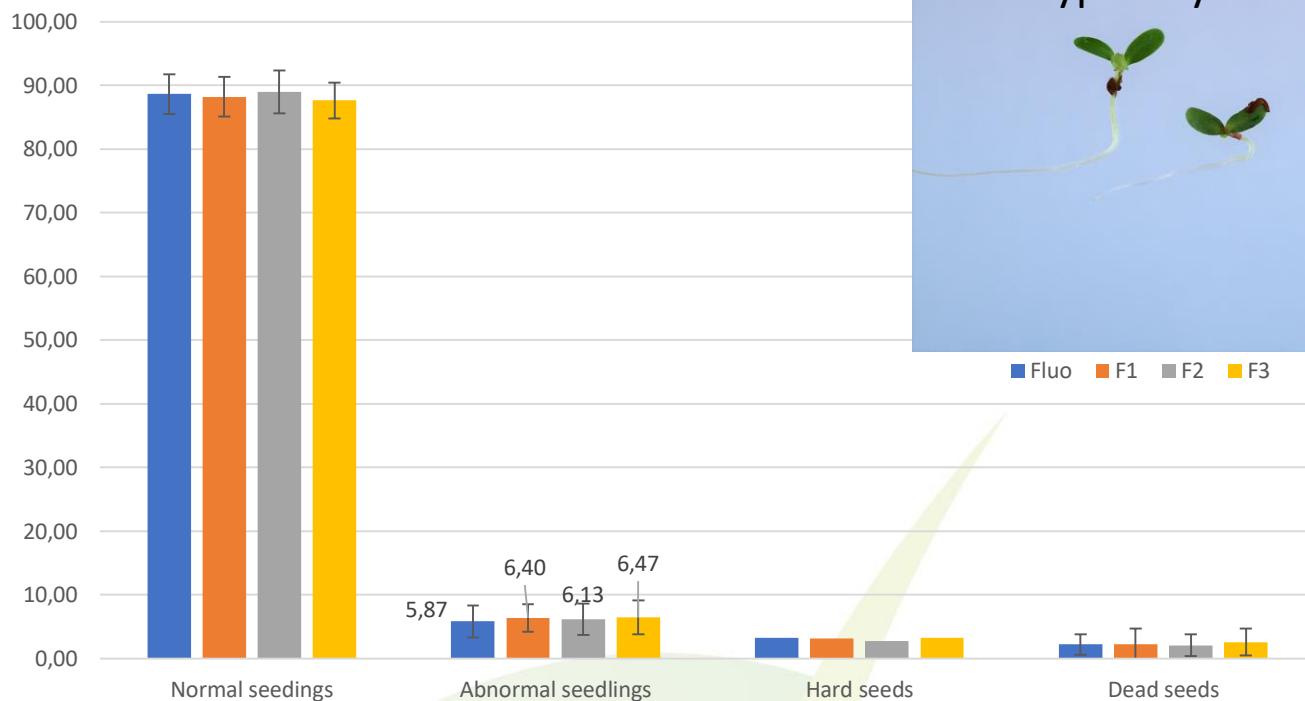
Comparison of the percentages of normal seedlings for the four lightings



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Focus on alfalfa results



Hypocotyl break



Abnormal seedling :

No statistical differences but systematic higher rate of abnormal seedling with LED lighting (difference up to 4% for some samples).

Unsolve question :How to decrease these abnormalities with led light?



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Conclusion

- **Biological point of view**
- Light homogeneity and temperature near the seeds are key point to replace fluo by LED
- LED lighting required higher luminous power (+50 µmol/m²/s) to have enough light homogeneity compare to our current fluo lighting conditions
- Consequently seedlings are less etiolated with LED lighting and this is better for seedling evaluation
- On the overall, there is no statistical differences between results from LED lightning compare to fluo
- The effect of light on alfalfa abnormalities lead to check LED lightning on all species or at least all species groups
- **Technical point of view**
- Several technical differences between the 3 LEDs tested (like color 3000 and 4000K)
- The Philips transitional model with the same connectivity as fluorescent lamps is costless in the short term but probably unfavorable in the long term as there is no longer any supply of tube connectors,
- For alternate method from 20°C darkness to 30°C Light : Higher delay to stabilize temperature with LEDs (2 hours) compare to fluo (1 hour)



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Prospect

Equipment

SNES Germination laboratory will equiped 4 climatic chambers in 2019 and one experimental flexible large room (with 4 kinds of dimable LEDs ultra white, white, red and blue)

The current hypothesis is

- To equip 2 chambers with Colasse and 2 chambers with Cesbron lighting (H+V).
To determine temperature targets in those newly equiped chambers
- To use these chambers for already tested species
- To identify the « best » lighting spectrum for germination test from bibliography and from tests in experimental chamber with different light settings.

Financial balance estimation

To be finalised for operating costs: electricity & cold and heat production for temperature regulation



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Thank you for your attention

Many thanks to Pierre and Gaëtane, the germination laboratory staff and Cindy Aubin

Questions ?



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