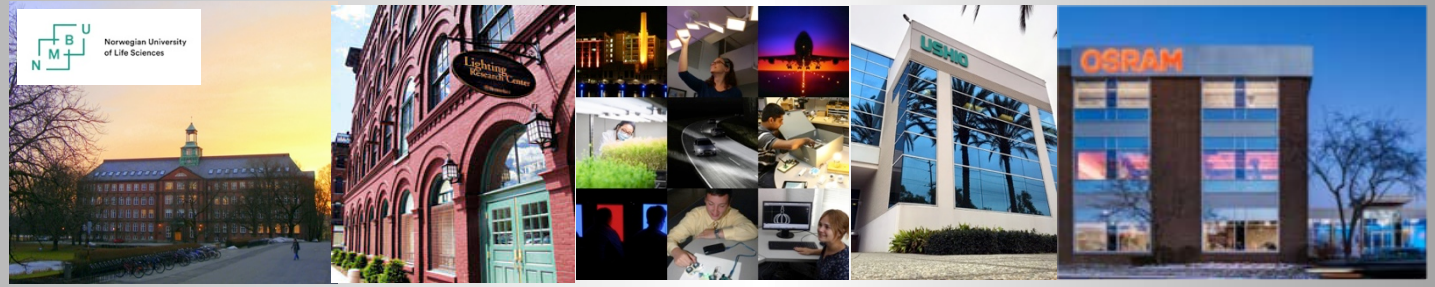
Practical Use of Light for Suppression of Plant Diseases Under Field Conditions



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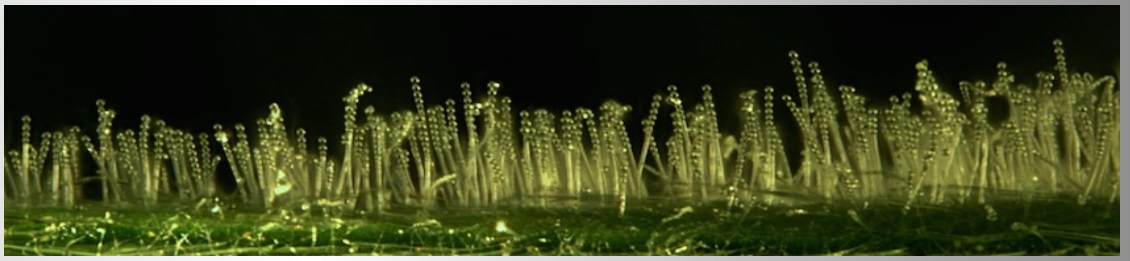
Al Michaloski in 1990 and his invention: a tractor-drawn array of 48 UVC lamps. It suppressed powdery mildew on grapevines, but damage to foliage and fruit was severe.

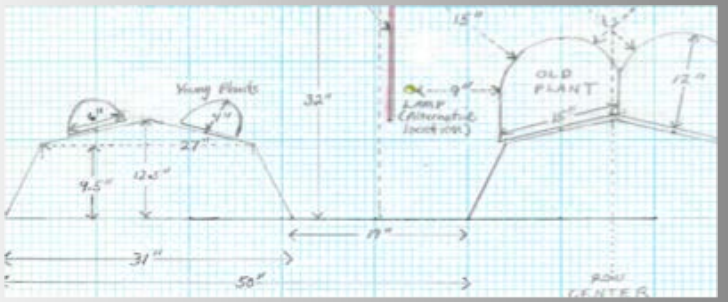
Factors that govern design:



- Timing of treatments in relation to pathogen and host biology.

- Effective dose, ground speed, and reciprocity effects.

- Uniform dosing in a non-uniform environment.

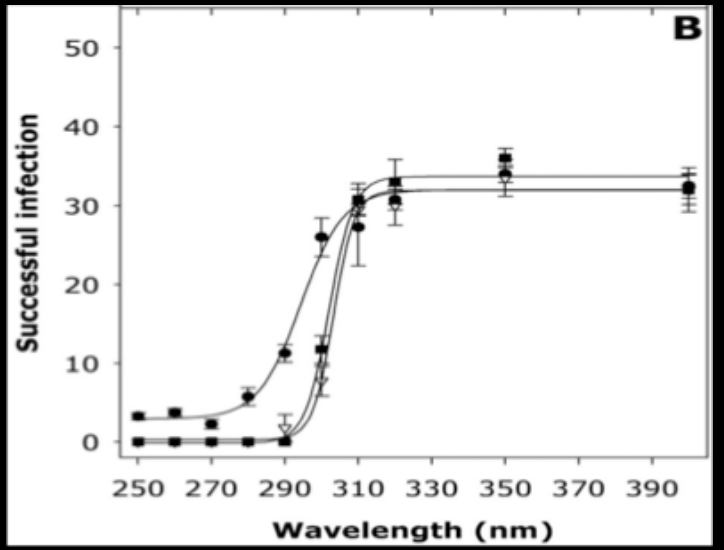


Factor 1: Timing of UV treatments in relation to pathogen and host biology

- Pathogens have been attacking plants for millions of years amidst 24 hr cycles of light and darkness.
- Many pathogens have evolved systems that repair DNA.
- Repair systems are upregulated by blue and UVA, and downregulated by red light or darkness.
- UV treatments applied at night can use a relatively low dose to achieve a significant suppressive effect on the pathogen.

Effective dose, ground speed, and reciprocity effects

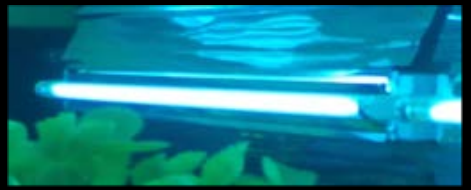
- *Mode of action of UV from 250 to 280 nm is the same: damage to pathogen DNA.*
- *Efficacy of UV wavelengths from 250 to 280 nm is similar.*
- *Effective dose is near 100 Joules/m2.*



Suthaparan et al, J. 2016. Phytochem. & Photobiol.

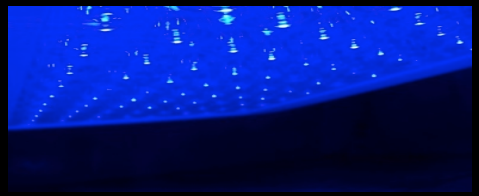
Effective dose, ground speed, and reciprocity effects

- *Available sources of UV*
  - *Fluorescent UVC lamps*



  - *Fluorescent UVB lamps.*

  - *UV LEDs*



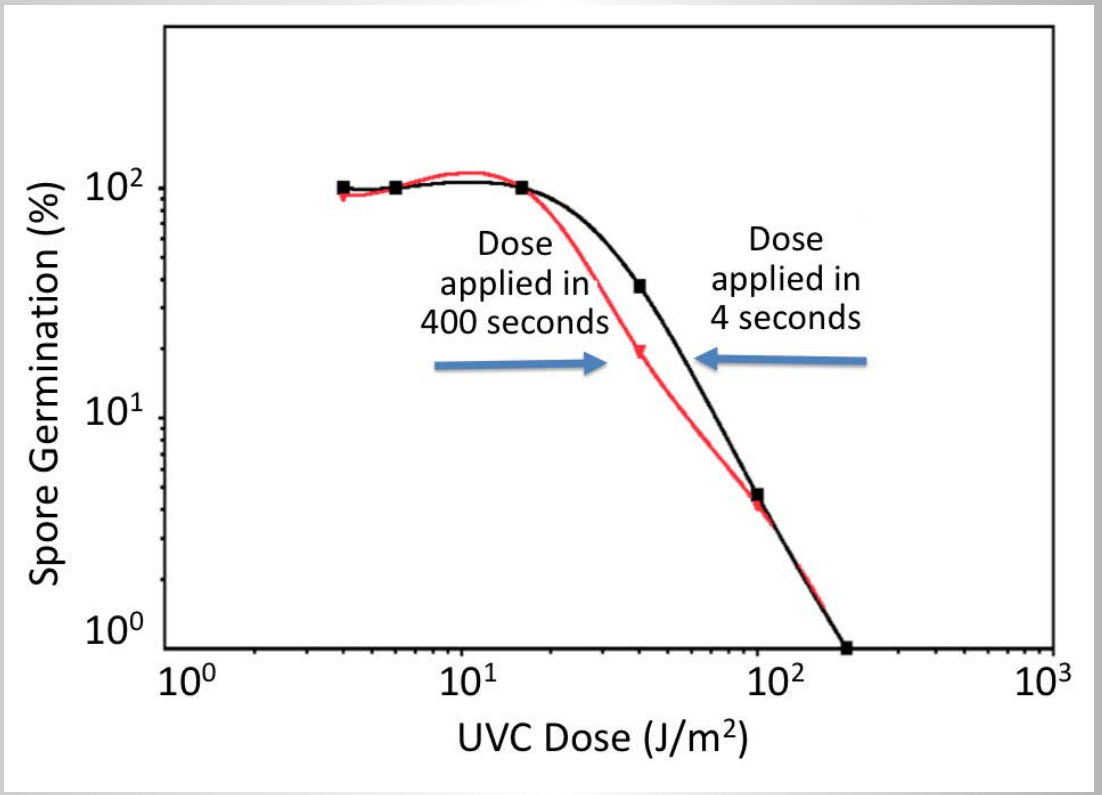
The need for speed

- 175X increase in speed requires increased radiant energy
  - Increase number of lamps and move them closer to plants?
    - Physical limits to size and density of arrays
  - Same dose at higher speed assumes perfect *reciprocity*
    - Does 1X2=2X1? This must be confirmed experimentally

Does reciprocity hold within range used in trials?

Yes.

Germinated spore



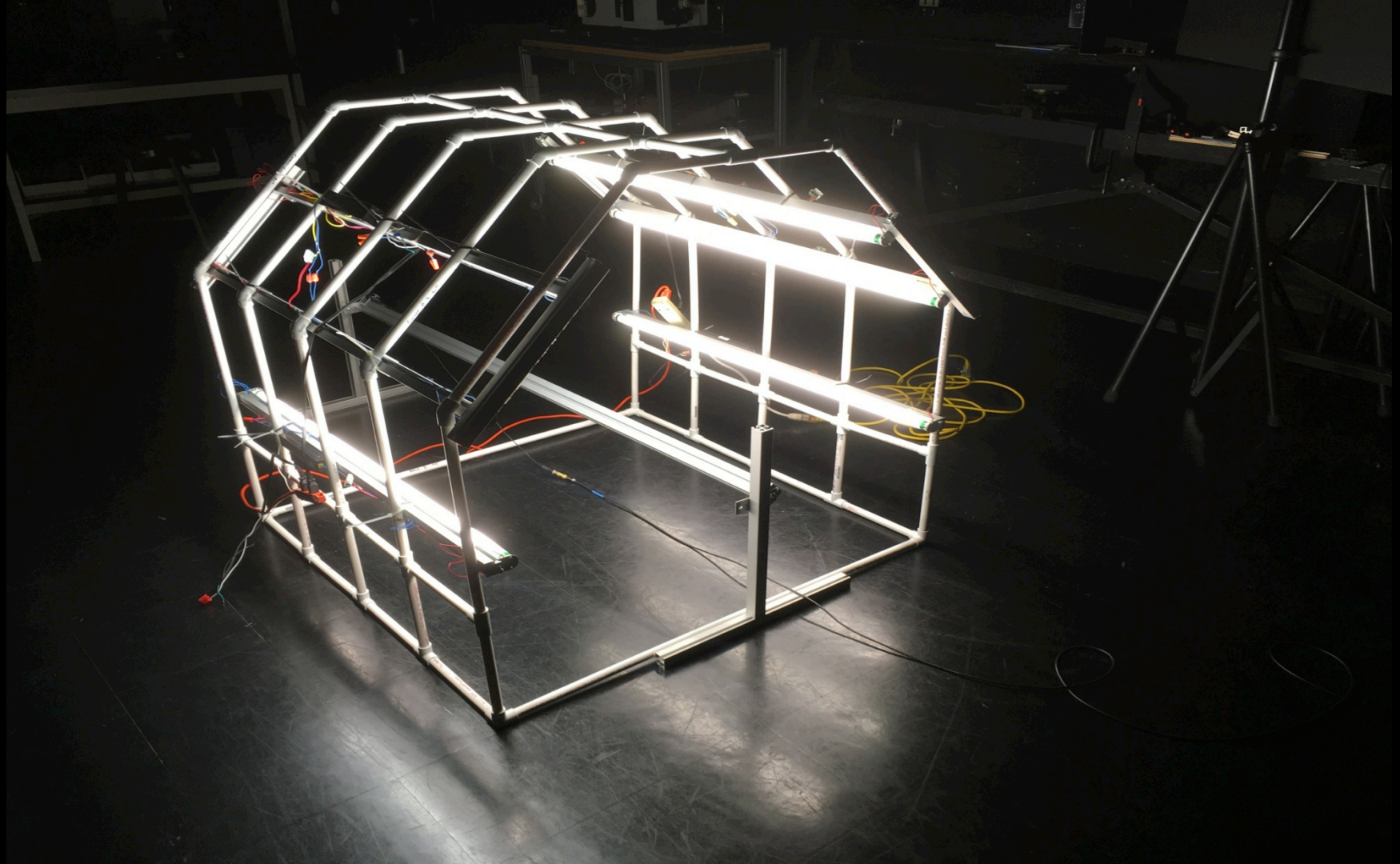
Ungerminated spore

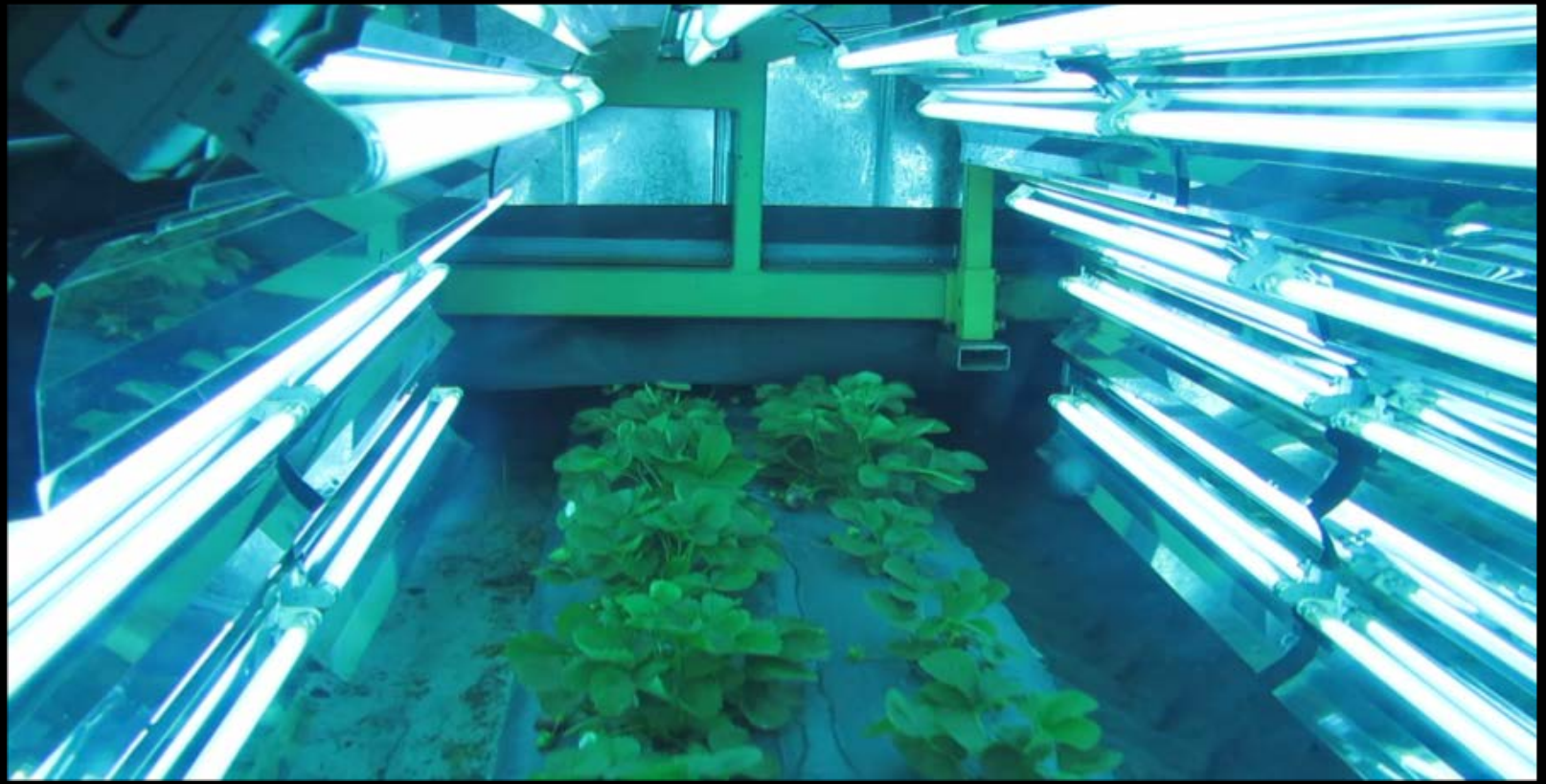
How can UV treatments be adapted to field use?

- Lamps over plants for 2-4 sec. rather than 2-4 min.
- UV must reach inner canopy and undersides of leaves
- Lamps are numerous and close to plants
- Reflector design is critical

2017 trials at Wish Farm

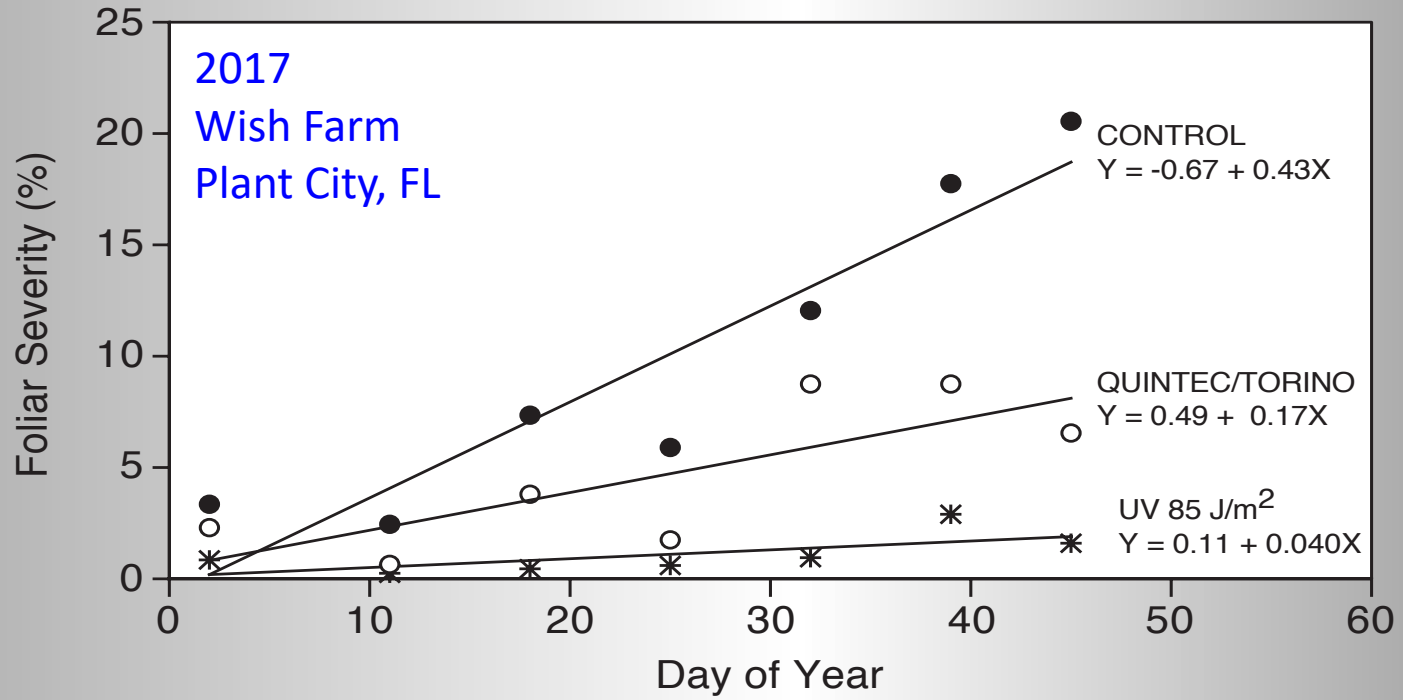
- Dose = 85 joules/M^2
- Applied 2X per week
- Speed = 2.8 mph (4.5 kph)





How does UV efficacy compare to that of a standard fungicide program?

- UV treatments were significantly more effective than alternated sprays of Quintec and Torino.
- No significant effects on plant size or yield of fruit.



A second towable unit similar in design is being tested in a commercial high tunnel site in South Carolina

Summary

- Application speed is an overriding design consideration.
- Presently, fluorescent UVC lamps are the best technology for field apparatus moving at practical speeds (e.g., 3 mph).
- Reciprocity appears to hold across the range of intensity, dose, and duration used in our trials to date.
- Lamp array density and reflector design are critical to uniform dosing in an non-uniform environment.