Talking Plants
The Science Behind Good Weed Management

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Plants are in a state of constant conversation

Crop seedlings are not passive organisms

“Can’t run but sure can respond rapidly”

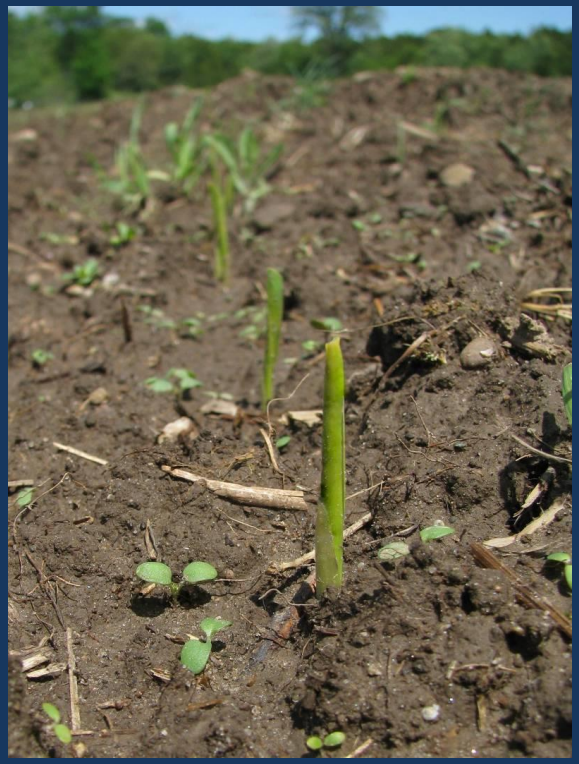


Photo: P. Smith

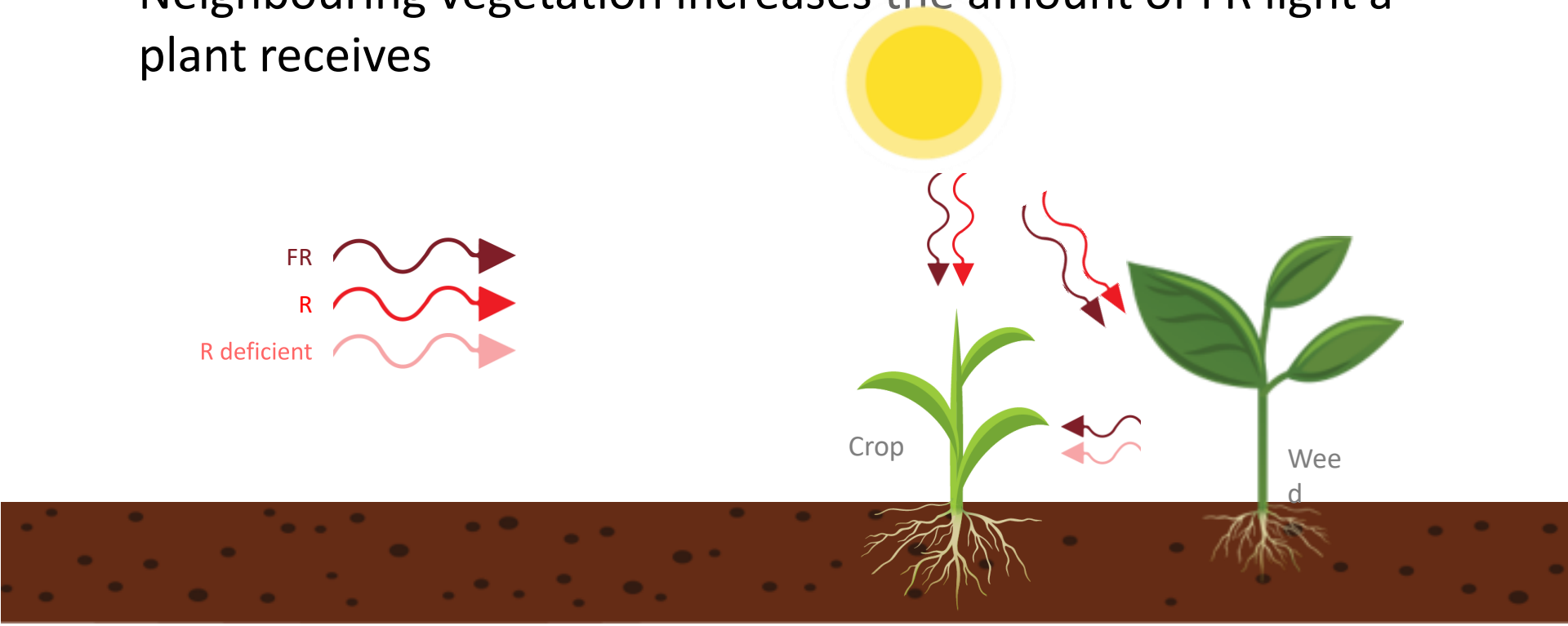
Talking Plants Exchange Information

A conversation between weed and crop seedlings changes everything!

These changes impact crop yield potential

Detection of Far Red light reflected from neighbouring weeds

- Neighbouring vegetation increases the amount of FR light a plant receives



System for Indirect Competition

R/FR ≈ 1.4

FR-D

R/FR ≈ 0.4

FR-E

Two Fundamental Concepts of Good Weed Management

1. Timing is everything

2. Speed at which a crop loses yield caused by weeds

Number 1 Variable Driving Crop Yield Loss

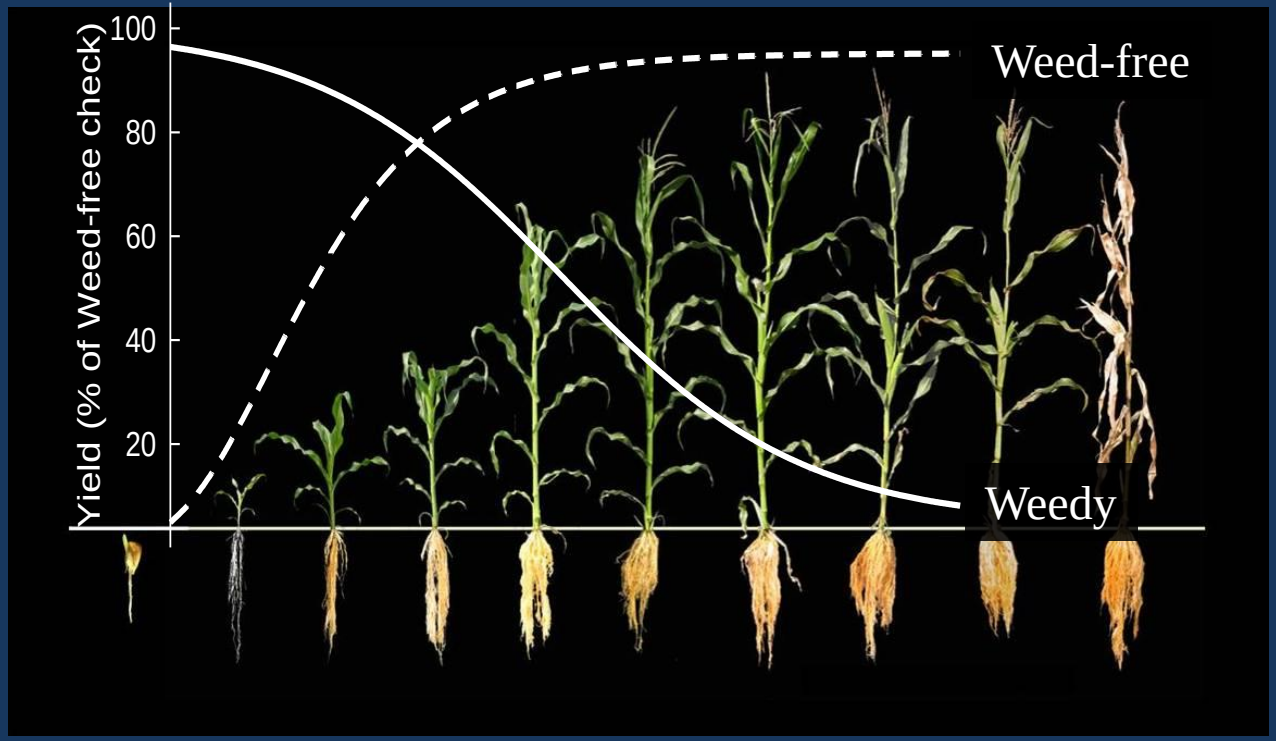
Timing of weed emergence relative to the crop is the fundamental driver of yield loss

Earliest emerging weeds are the most competitive…….why?

Key Points #1

- Timing of weed management is everything
- Yield loss caused by emerging weed seedlings varies with crop leaf stage
- Yield loss can be calculated by the day
- Yield loss is rapid and irreversible

Critical period for weed control

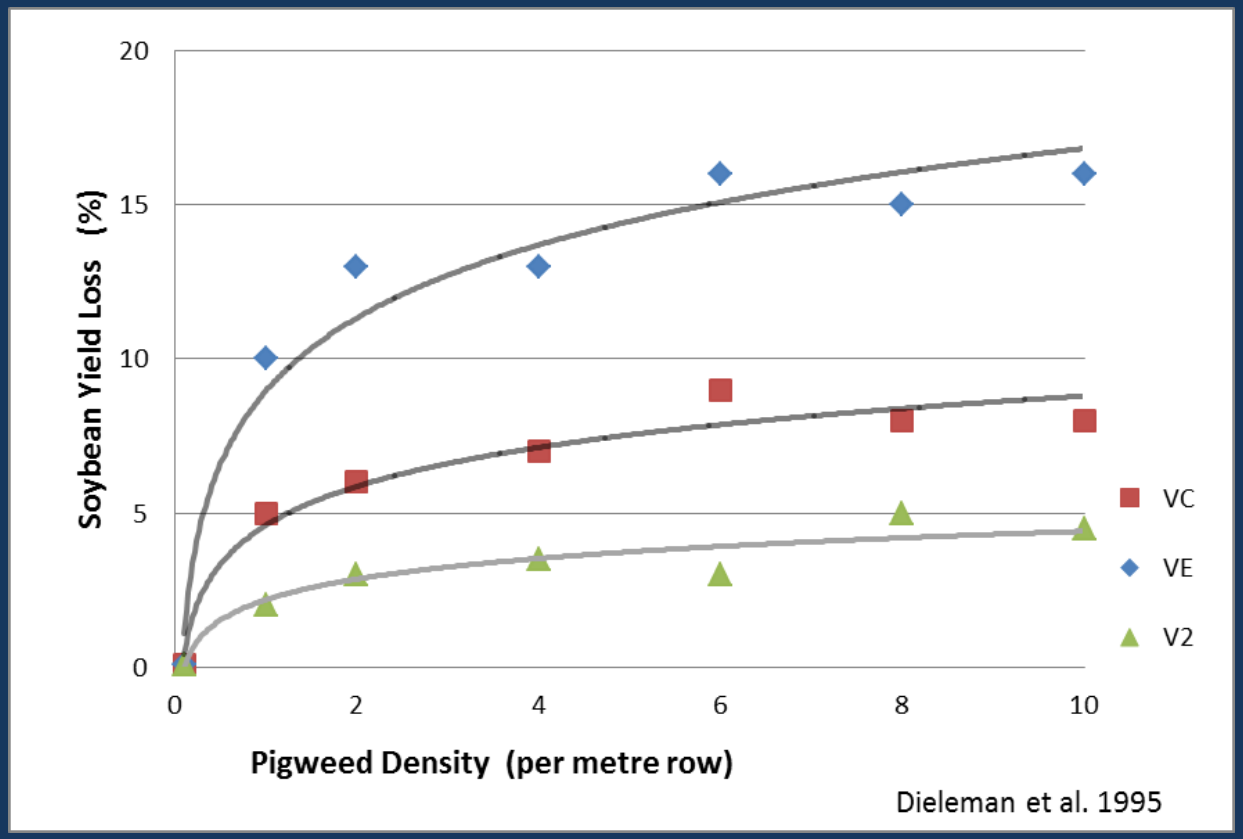


Time of weed control and corn yield loss

Year	Location	Yield loss period		Yield loss		
		Start	Duration	Total	Daily	
		days[1]	days	(%)	(%)	(bu/ac[2])
1988	Kemptville	50	20	30	1.5	2.3
	Elora	20	40	70	1.8	2.6
	Woodstock	20	60	20	0.3	0.5
	Ridgetown	20	60	60	1.0	1.5
1989	Kemptville	20	60	50	0.8	1.2
	Elora	40	30	65	2.2	3.3
	Woodstock	0	70	90	1.3	1.9

[1] Days after planting, [2] Weed-free yield of 150 bu/ac

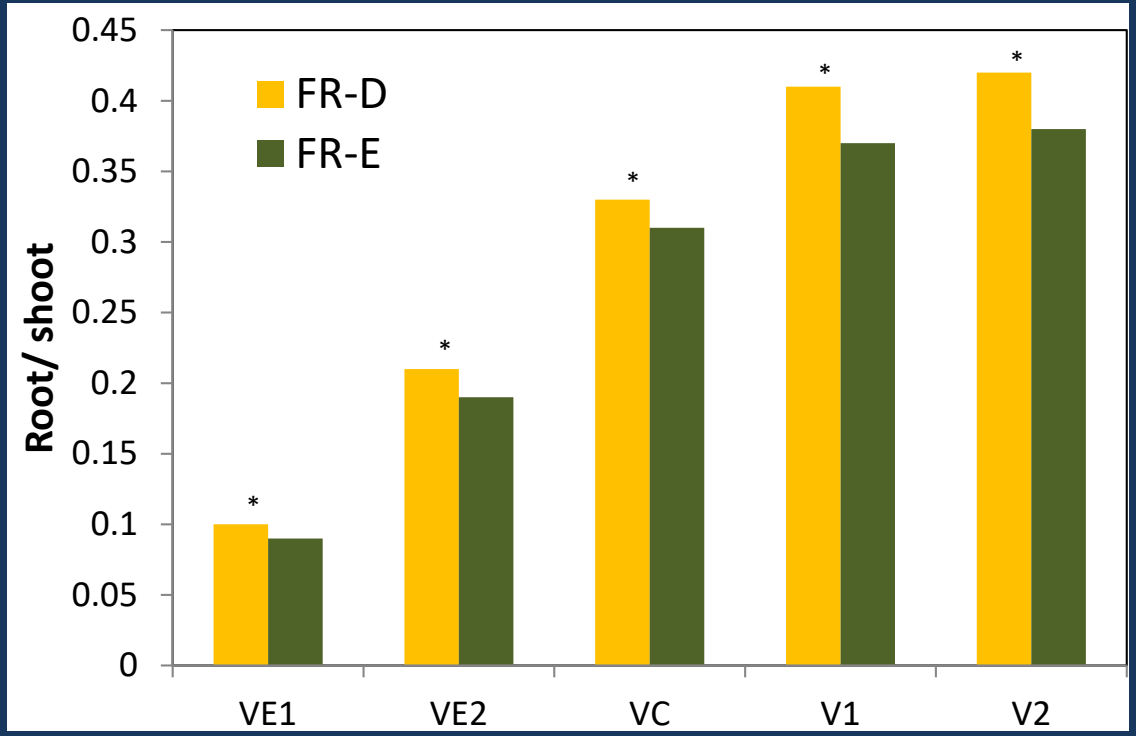
Threshold studies with *Pigweed species*



Key Point #2

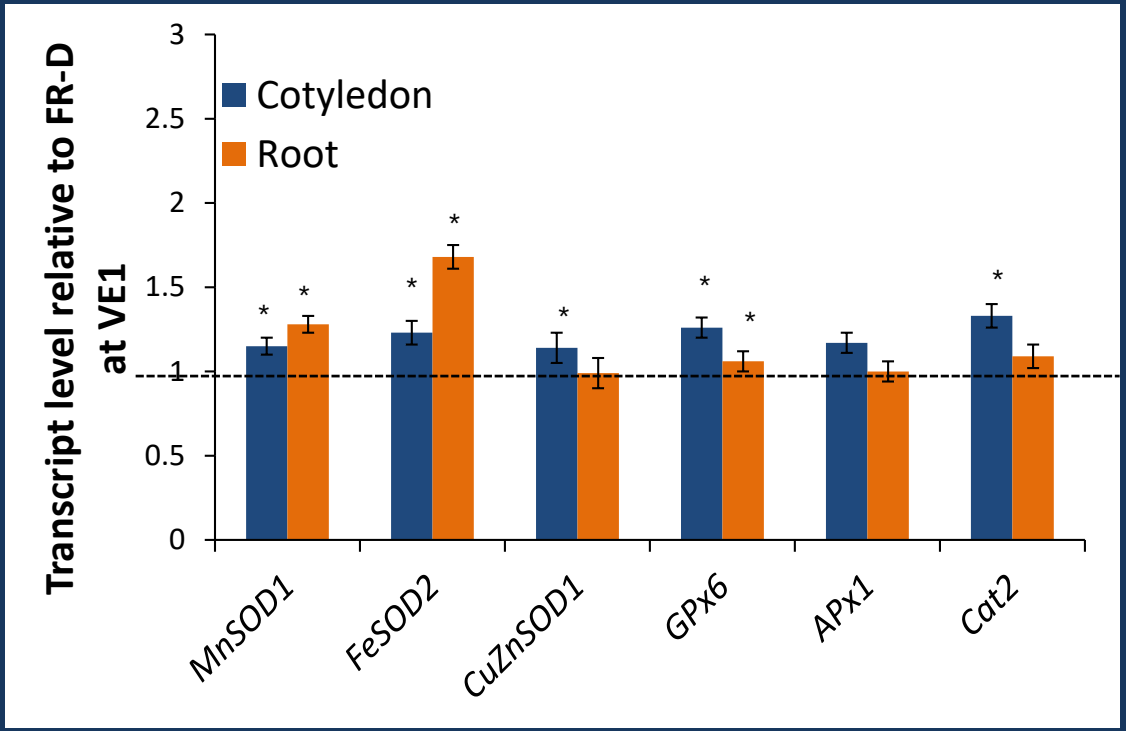
- Prior to emergence crop seedlings can detect above ground weeds
- Weeds rapidly alter crop seedling morphology

Soybean responds to weeds at emergence



McKenzie-Gopsill *et al.,* (2016) Weed Research

Antioxidant gene expression at VE1

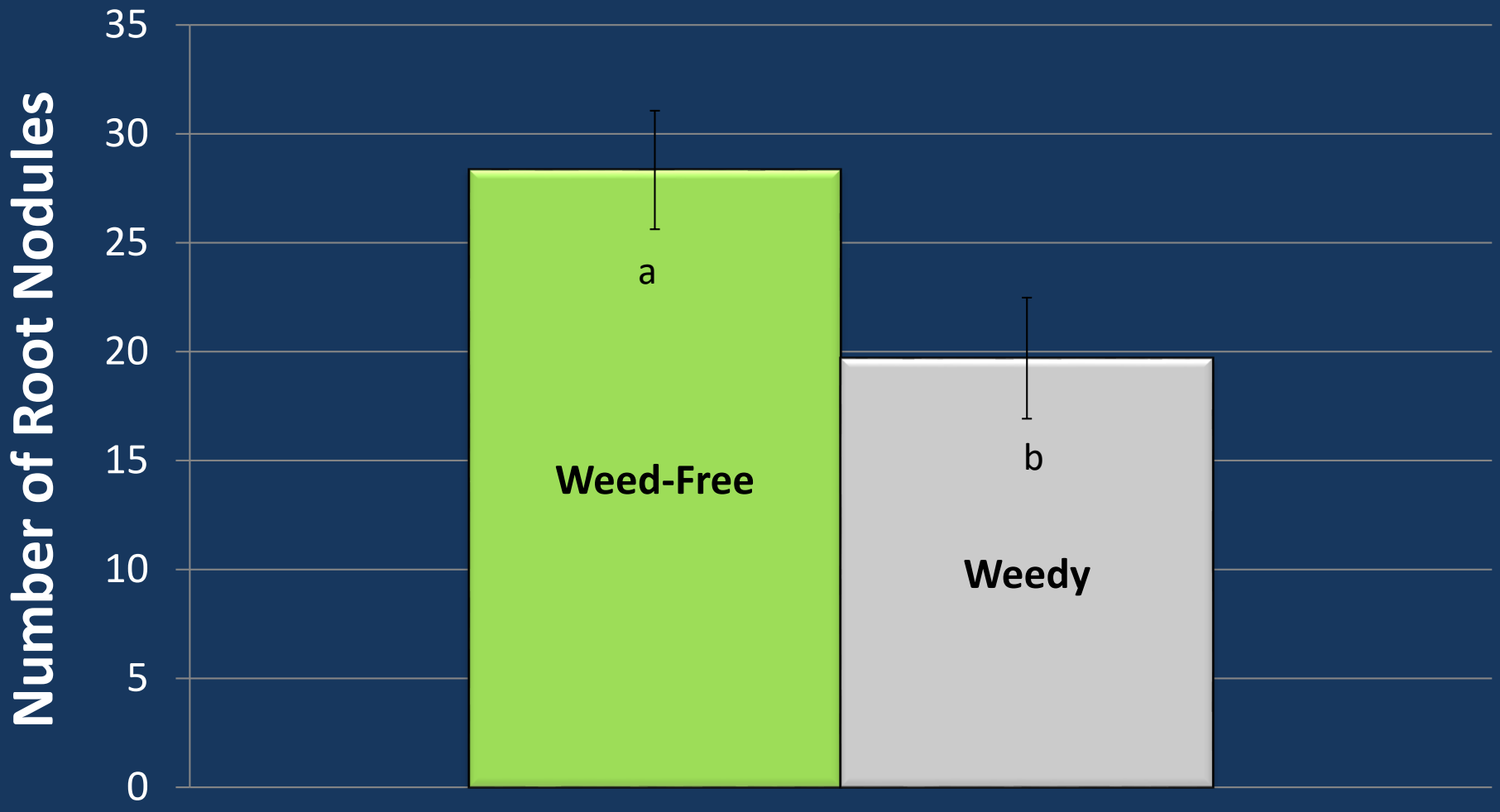


McKenzie-Gopsill *et al.*, (2016)
Weed Research

Soybean morphology was affected by neighbouring weeds!

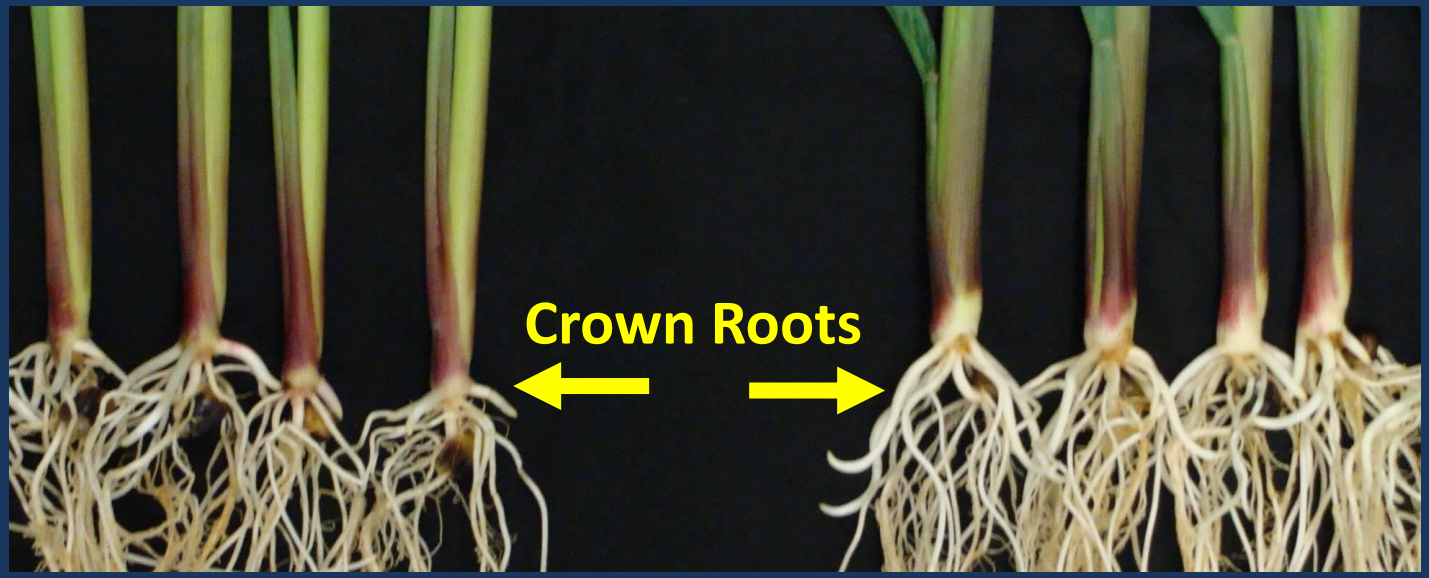
- Reduced root:
  - Total length
  - Surface area
  - Volume
  - Dry weight

Weeds reduced number of root nodules on unifoliate soybean seedlings



Weed Free Weedy Far Red Filter

Corn Root Response to Weeds



Weedy **Weed-free**

	Weedy	Weed-free
Crown root number :	7.0 b	11.6 a
Total root volume (cm^3):	1.25 b	1.58 a

In the Field……

Weedy

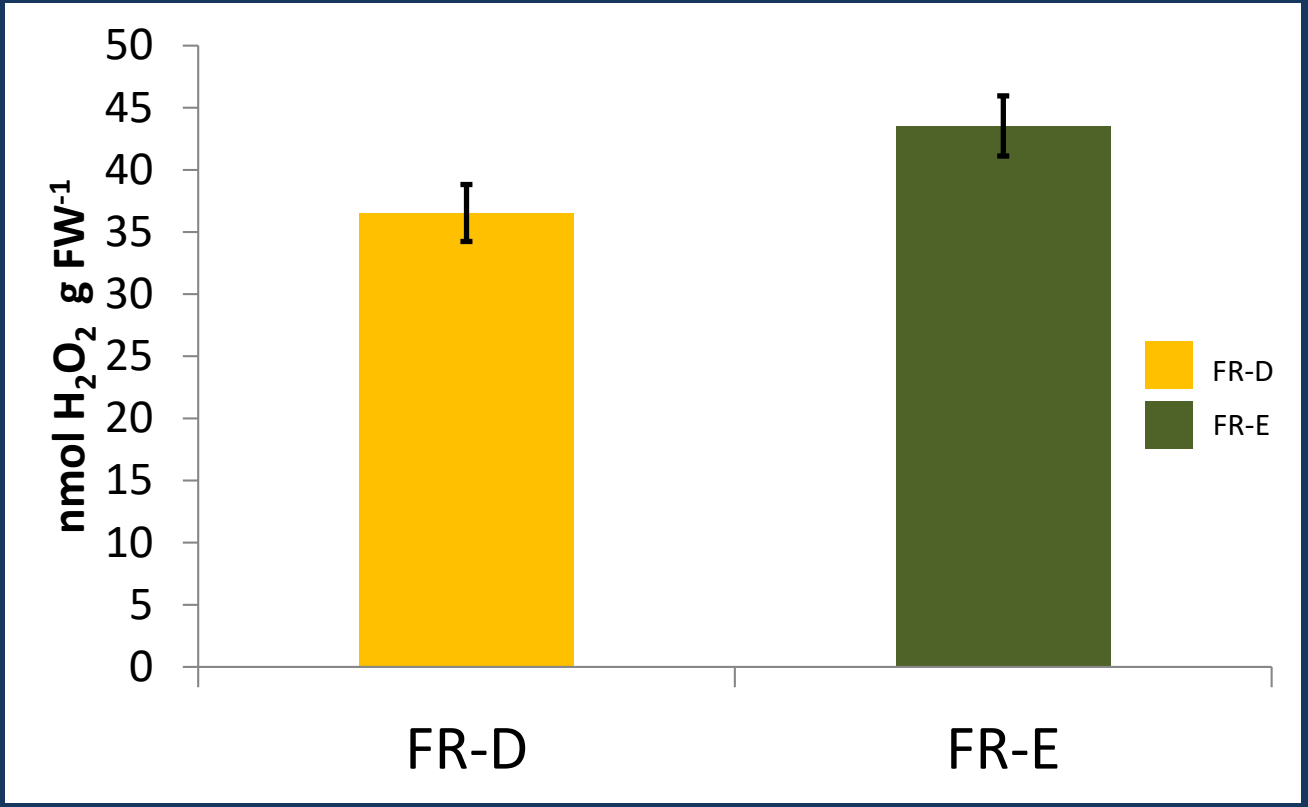
Weed-free

Key Point #3

- Neighbouring weeds rapidly change the physiology of the crop seedling.

- Altering the physiology of the crop seedling will have a significant effect on the ability of a crop seedling to recover from stress

FR-E light Increases Leaf H_2O_2

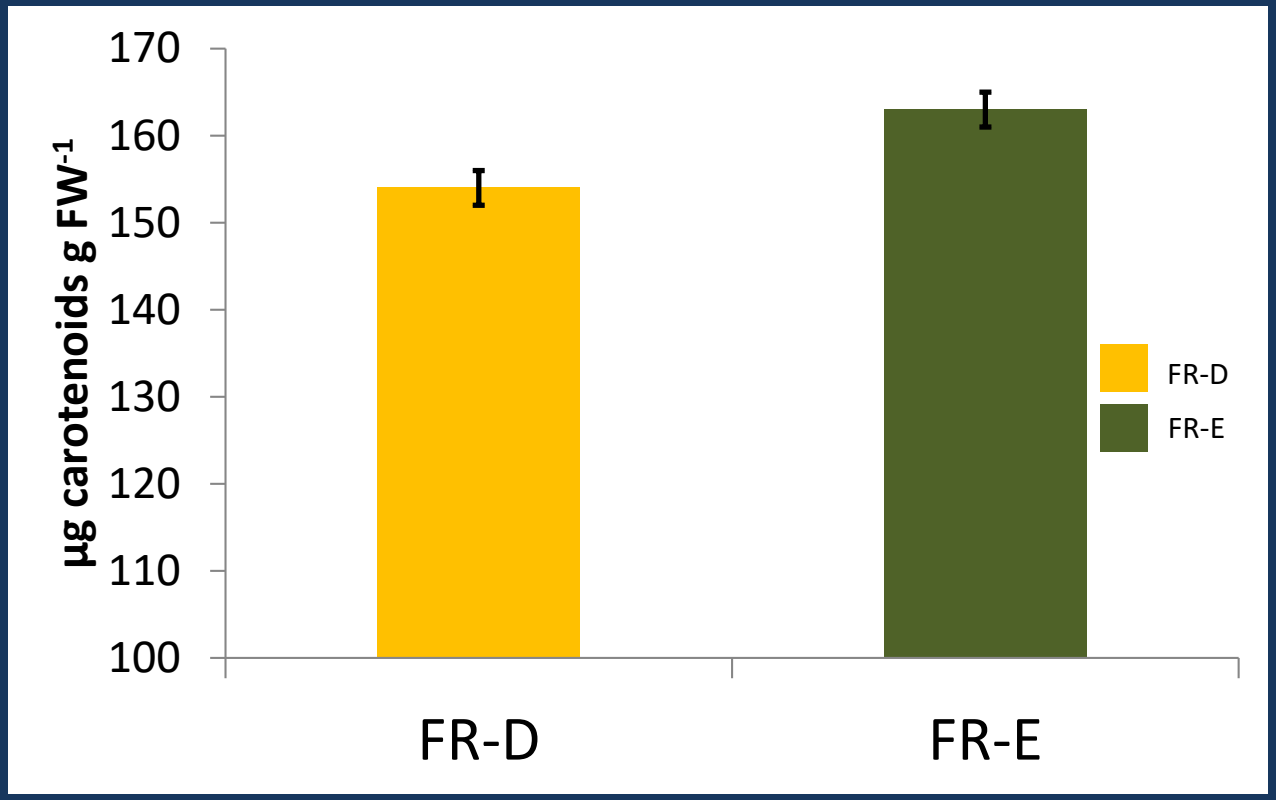


Aboveground weeds and far red filter increased H_2O_2 in the first leaf

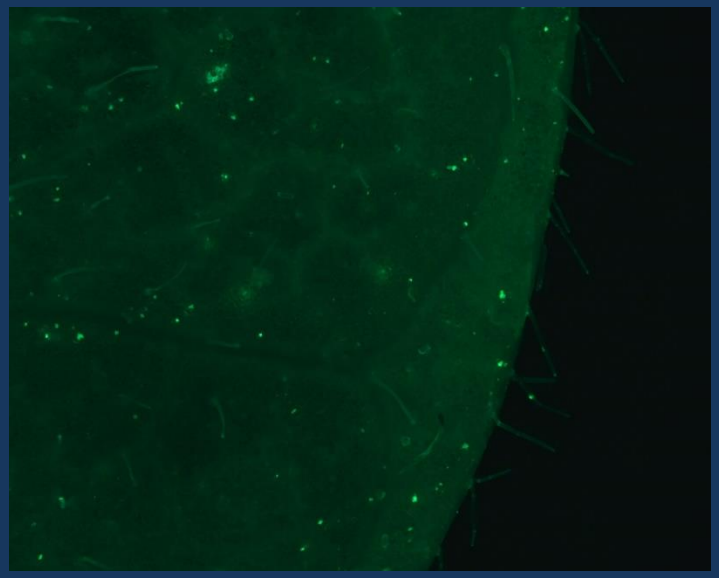
WF W FRF

- **Sampled at the 4th leaf tip**

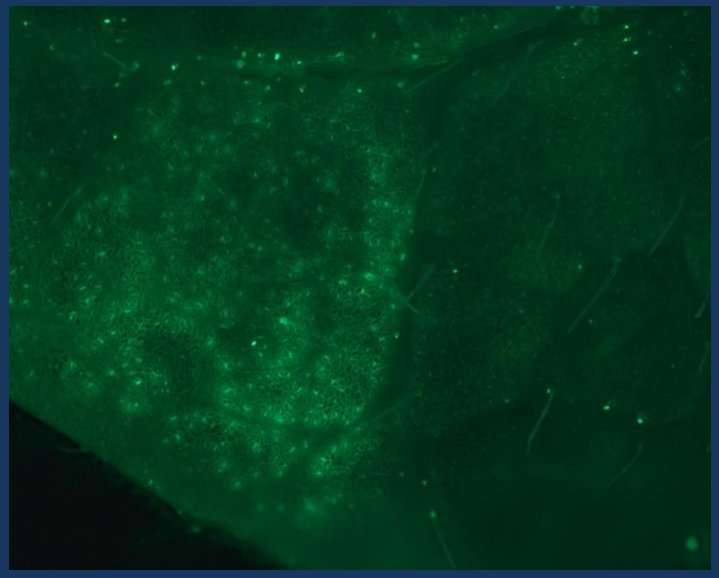
FR-E light Increases Leaf Carotenoids



Weeds Increase $^1O_2$ Level



Weed-Free



Weedy

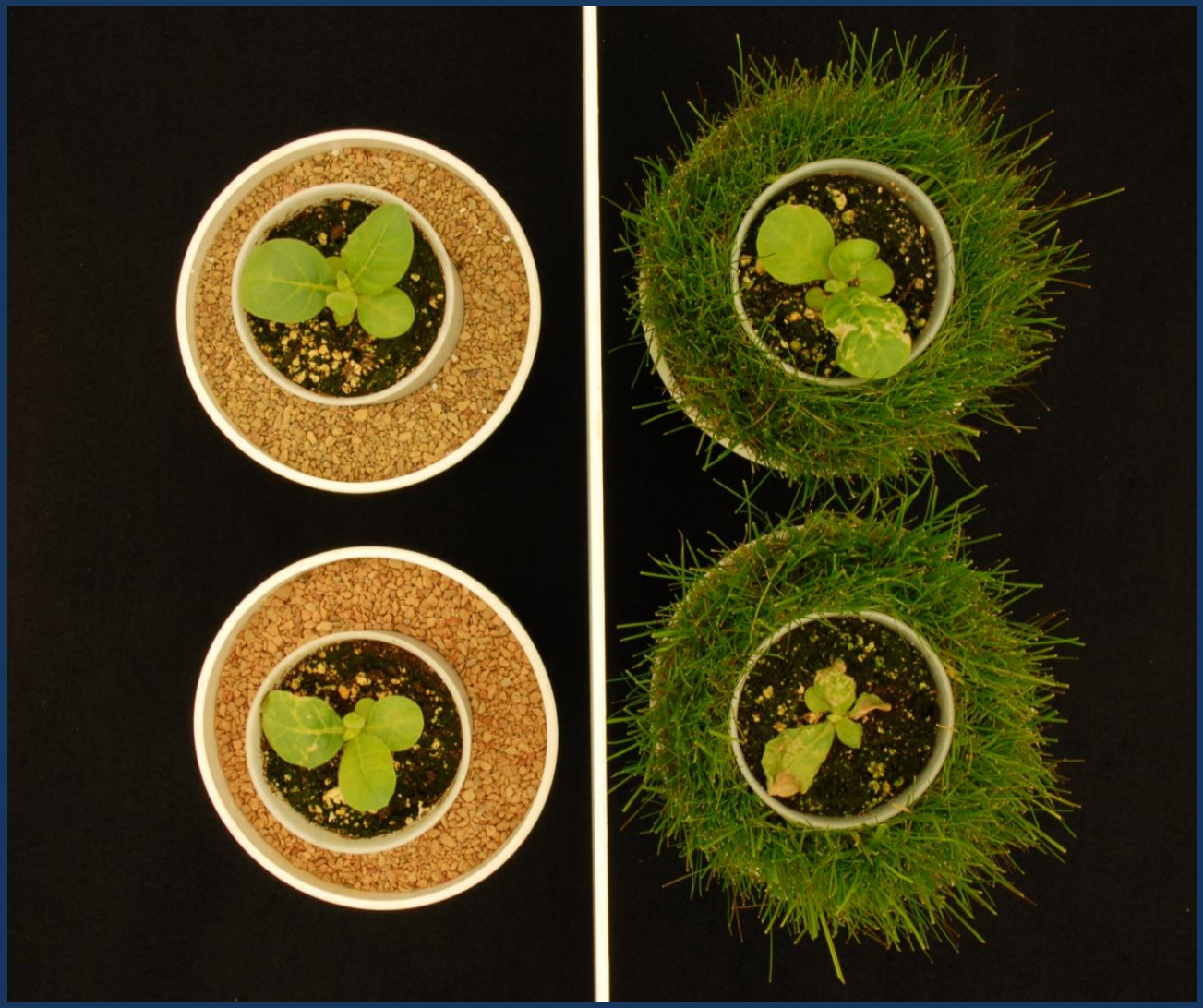
In Response to Neighbouring Weeds

Decreased

- SOD activity

Increased

- Leaf H_2O_2
- Oxidised ascorbate
- Carotenoids
- Susceptibility to $^1O_2$-generating compound

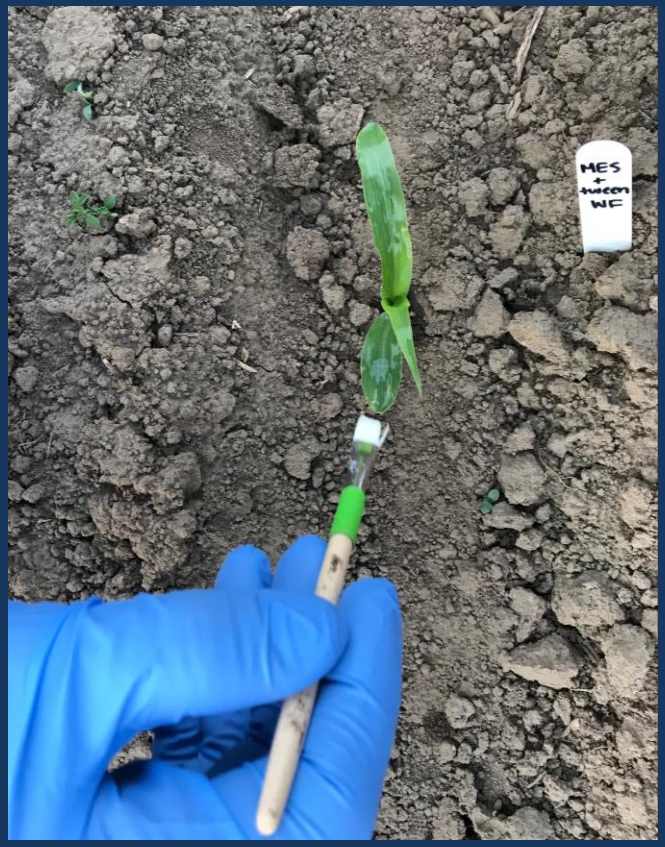


Follow-up field experiment

Materials & methods

Treatments:

- 2mL of buffer (MES) with:
  - Tween 20 (control)
  - Tween 20 + 40 mM of ALA



Results- Weedy Plots

48 hours after 40 mM ALA application

3 weeks after 40 mM ALA application

Results – Weed Free Plots

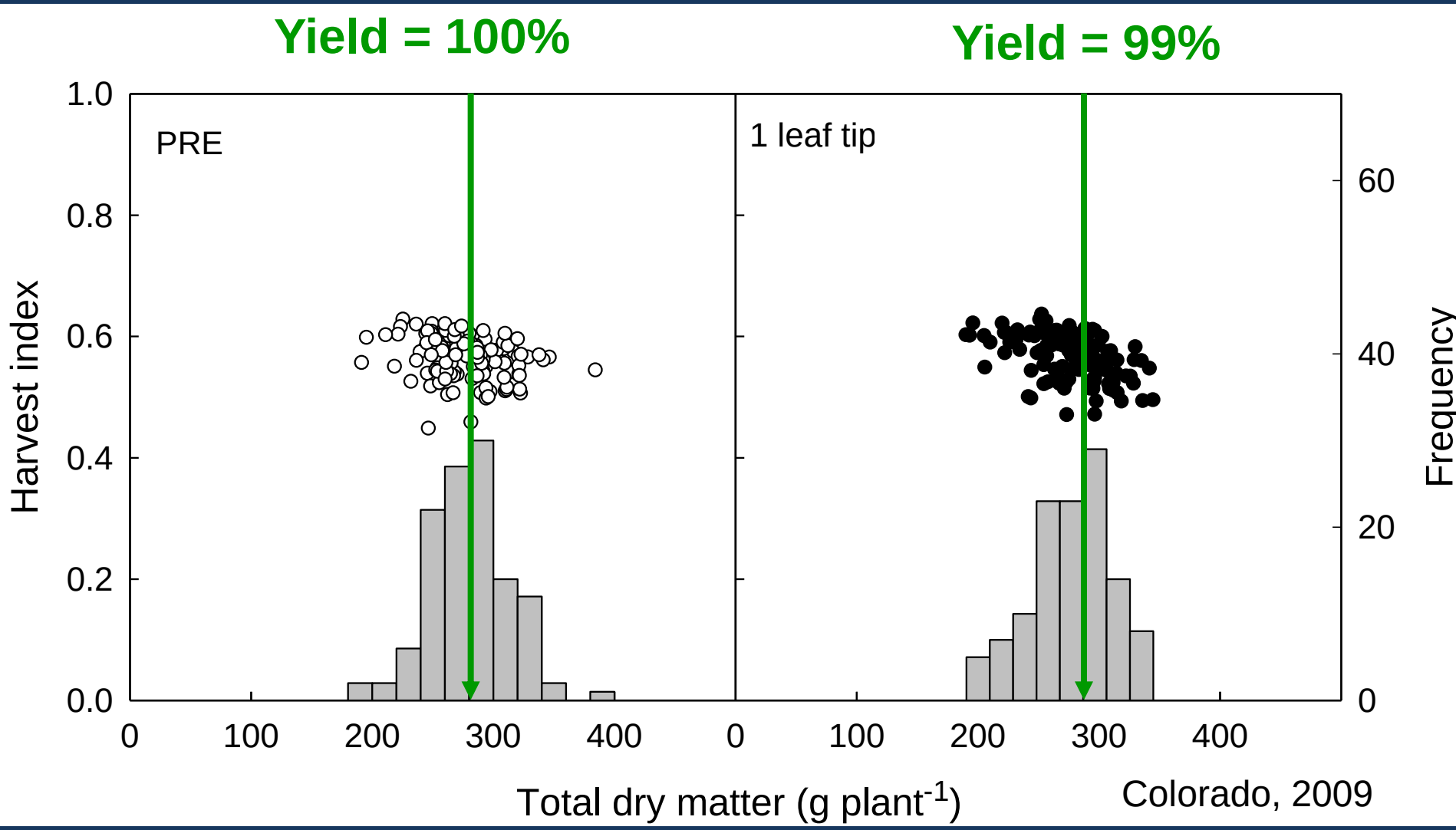
48 hours after 40 mM ALA application

3 weeks after 40 mM ALA application

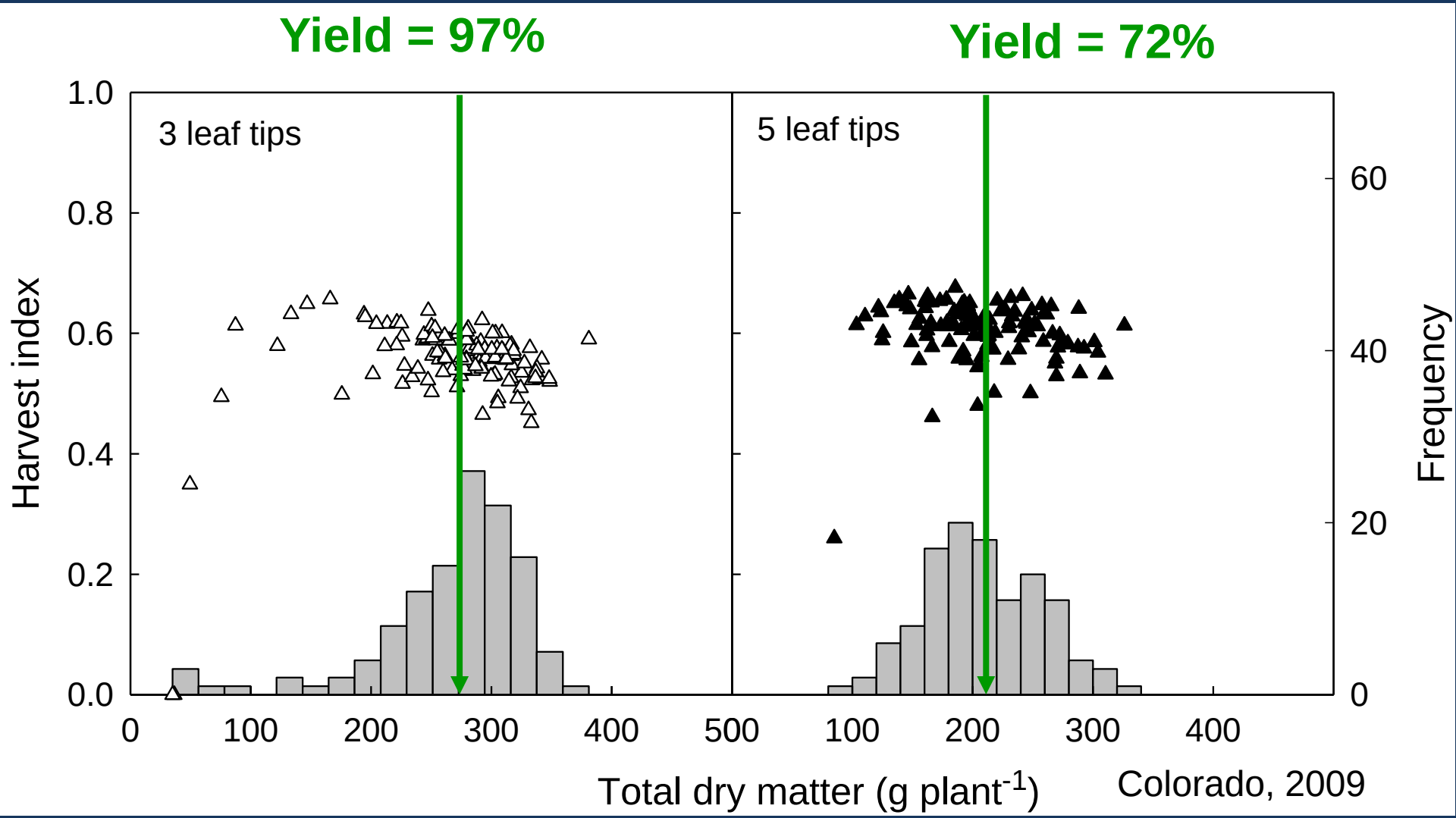
Key Point #4

- Weeds will rapidly reduce rate of growth and subsequent accumulation of total dry matter per plant
- Reduction in growth rate at silking will affect yield of corn

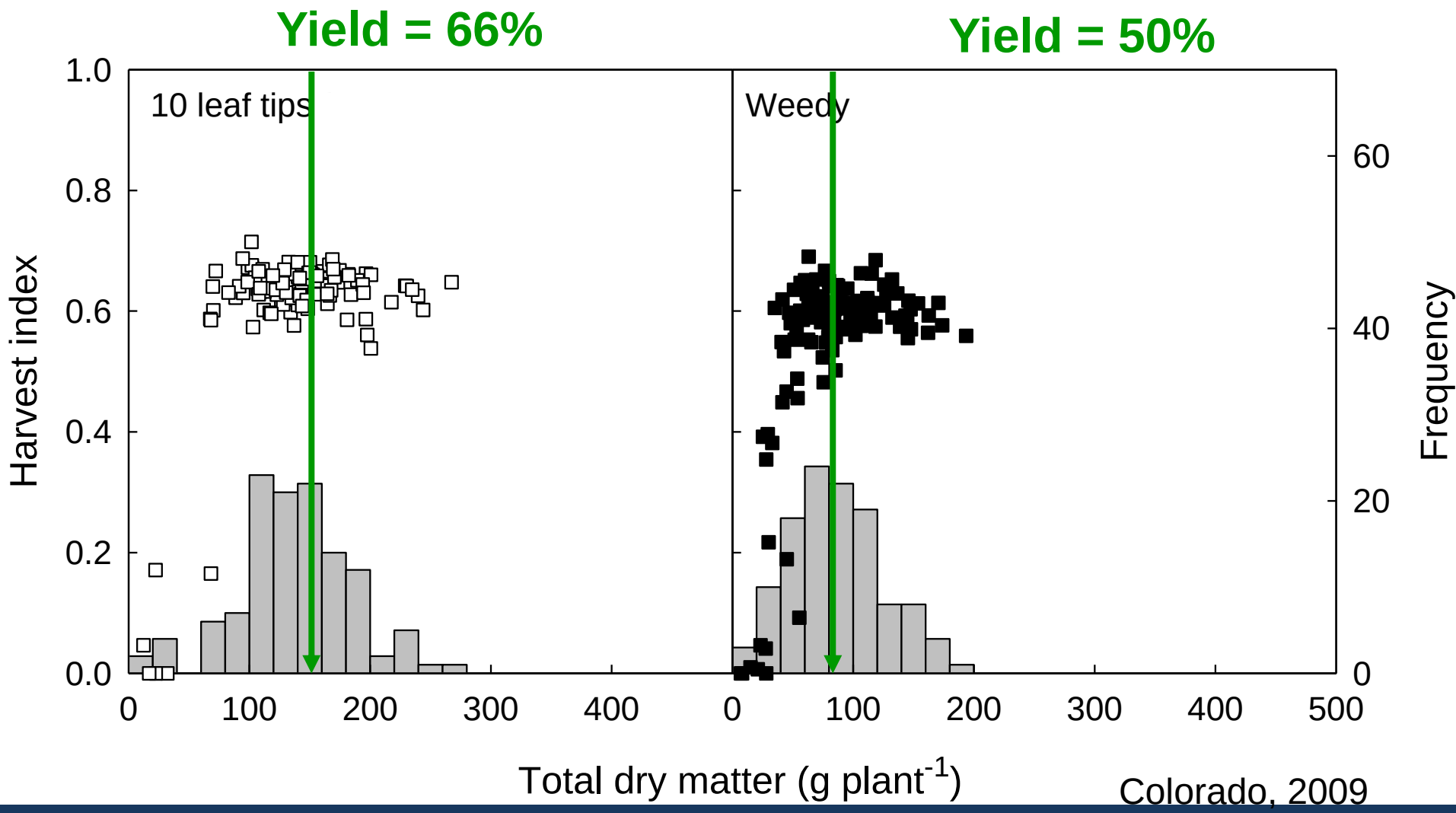
Pre / 1 leaf tip weed control



3 / 5 leaf tip weed control



10 leaf tip / weedy control



Anthesis:

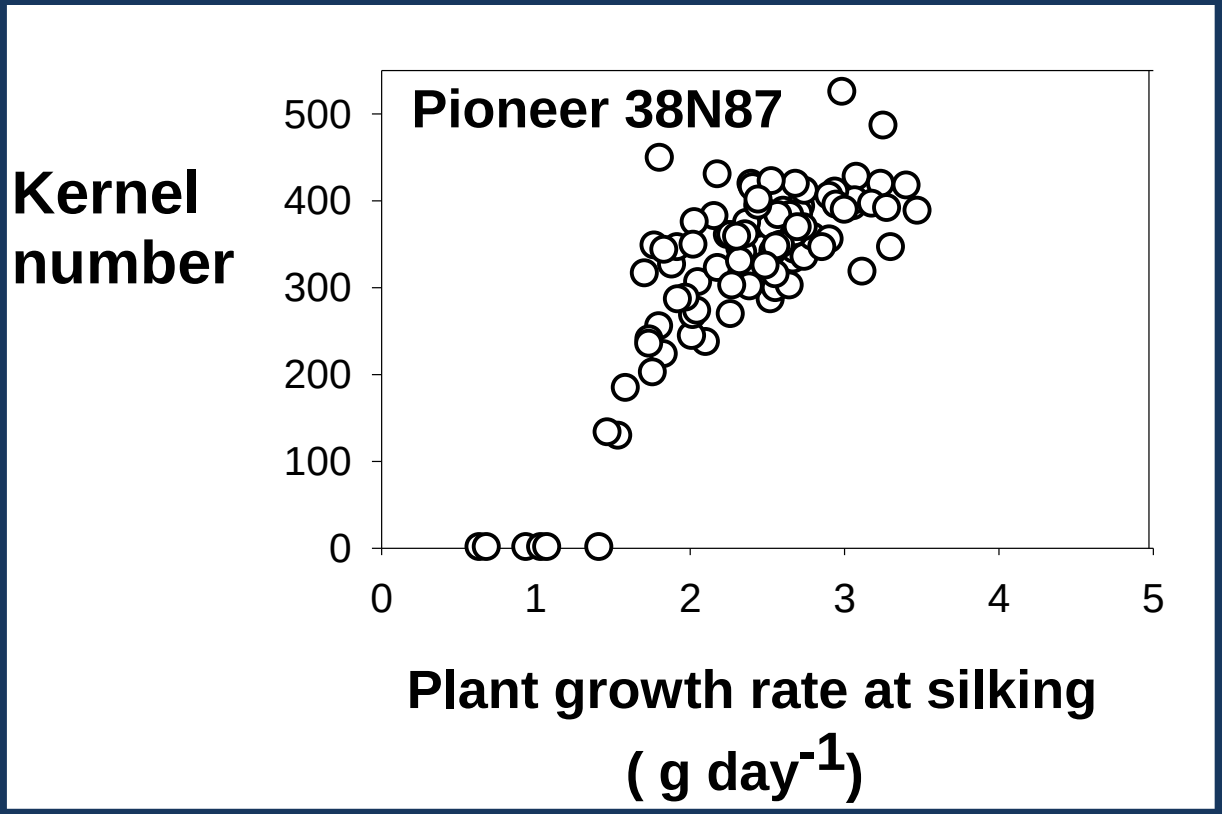
Pollen shed

Source: ipm.missouri.edu

Silking

Source:
www.mississippi-crops.com

Kernel number per plant



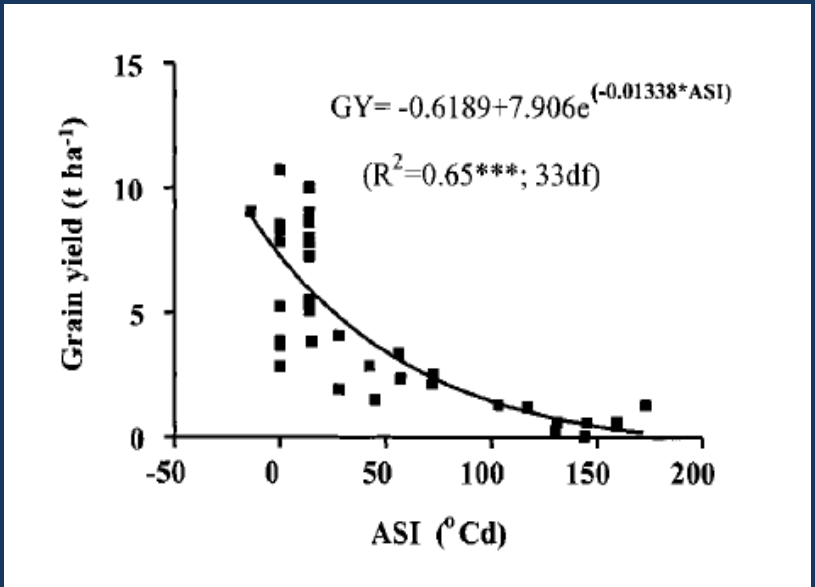
One gram can make a difference!

- Example: if 100% of corn plants grow at an avg. rate of 4.5 g/day, corn yield = 12,300 kg/ha (197)

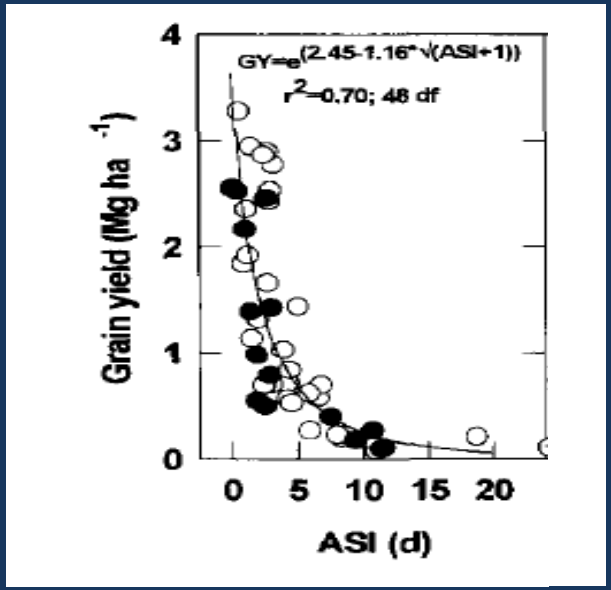
- If 20% of corn plants grow at a rate of
  3.5 g/day, corn yield = 10,000 kg/ha (160)

- A reduction in growth rate of 1 g/day in 20% of corn = yield loss of 2300 kg/ha = 37 bushels/acre

Grain yield and ASI

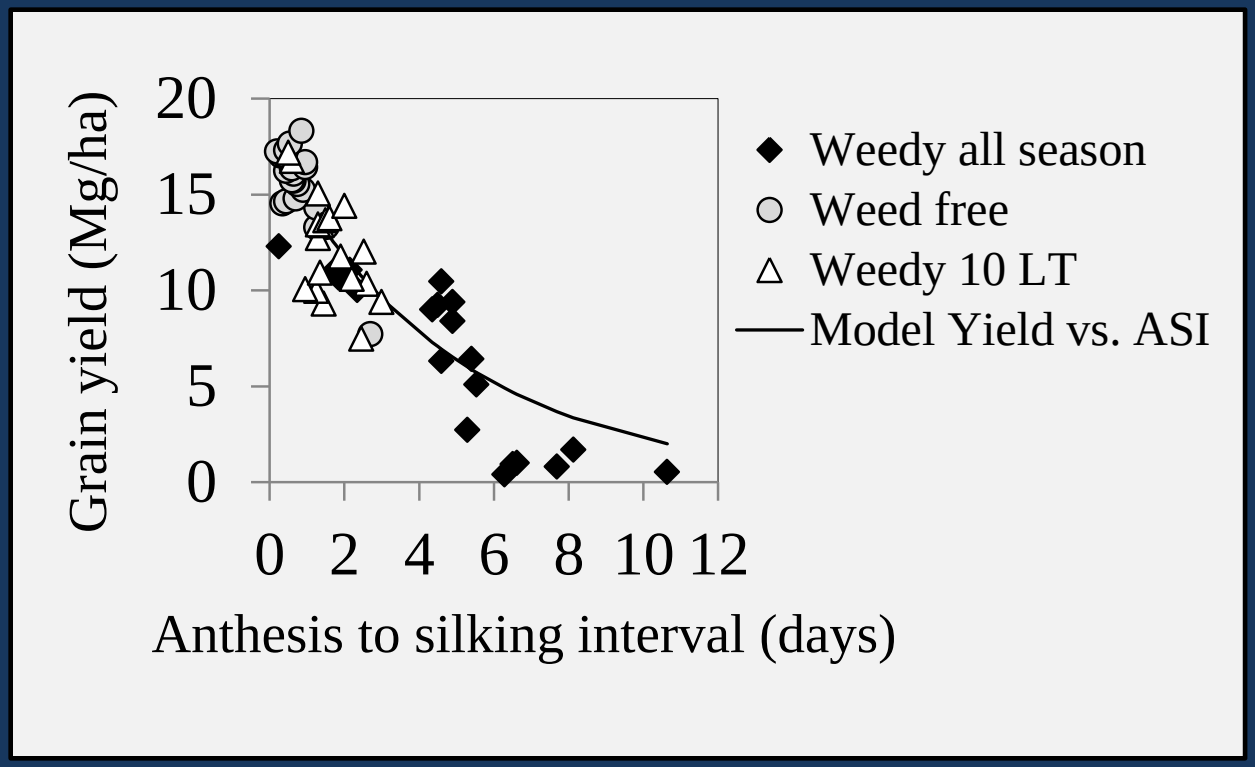


Bruce et al., 2002



Bolaños and Edmeades, 1996

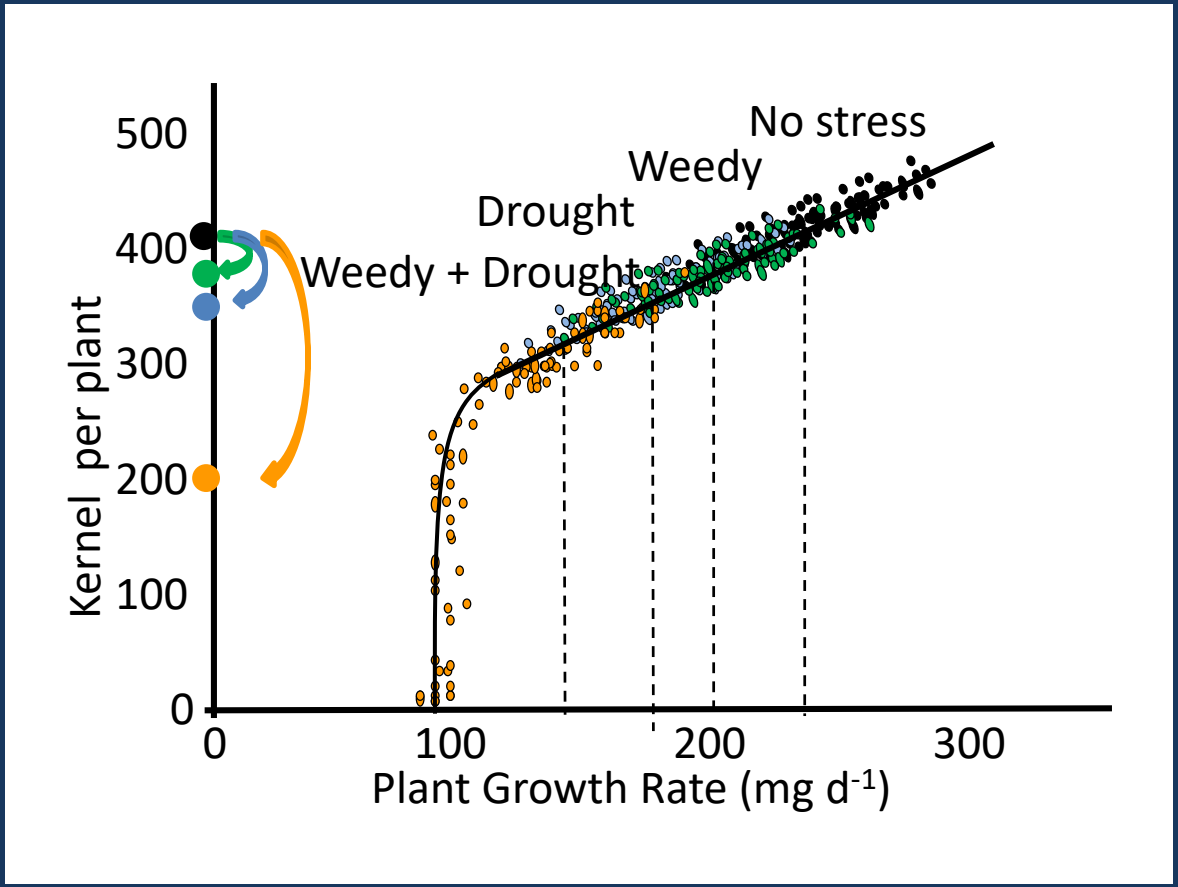
ASI is influenced by weed controls



Reid *et al.,* (2014) Weed Sci 62: 326-337

Reference:	Estimated Yield Loss (%)		
	ASI		
	7 hrs	14 hrs	21 hrs
	3.5 GDD	6.9 GDD	10.4 GDD
Bolaños and Edmeades (1996)	15	26	36
Bruce *et al.,* (2002)	5	10	14
Reid *et al.,* (2014)	6	12	18

Effect of stress on plant dry matter and kernel number



Weed-free

Yield = 10.7 Mg/ha

Kernel no. = 563

Removal @ 4 tips

Yield = 10.3 Mg/ha

-4%

Kernel no.= 531

-6%

Removal @ 8 tips

Yield = 8.5 Mg/ha

-20%

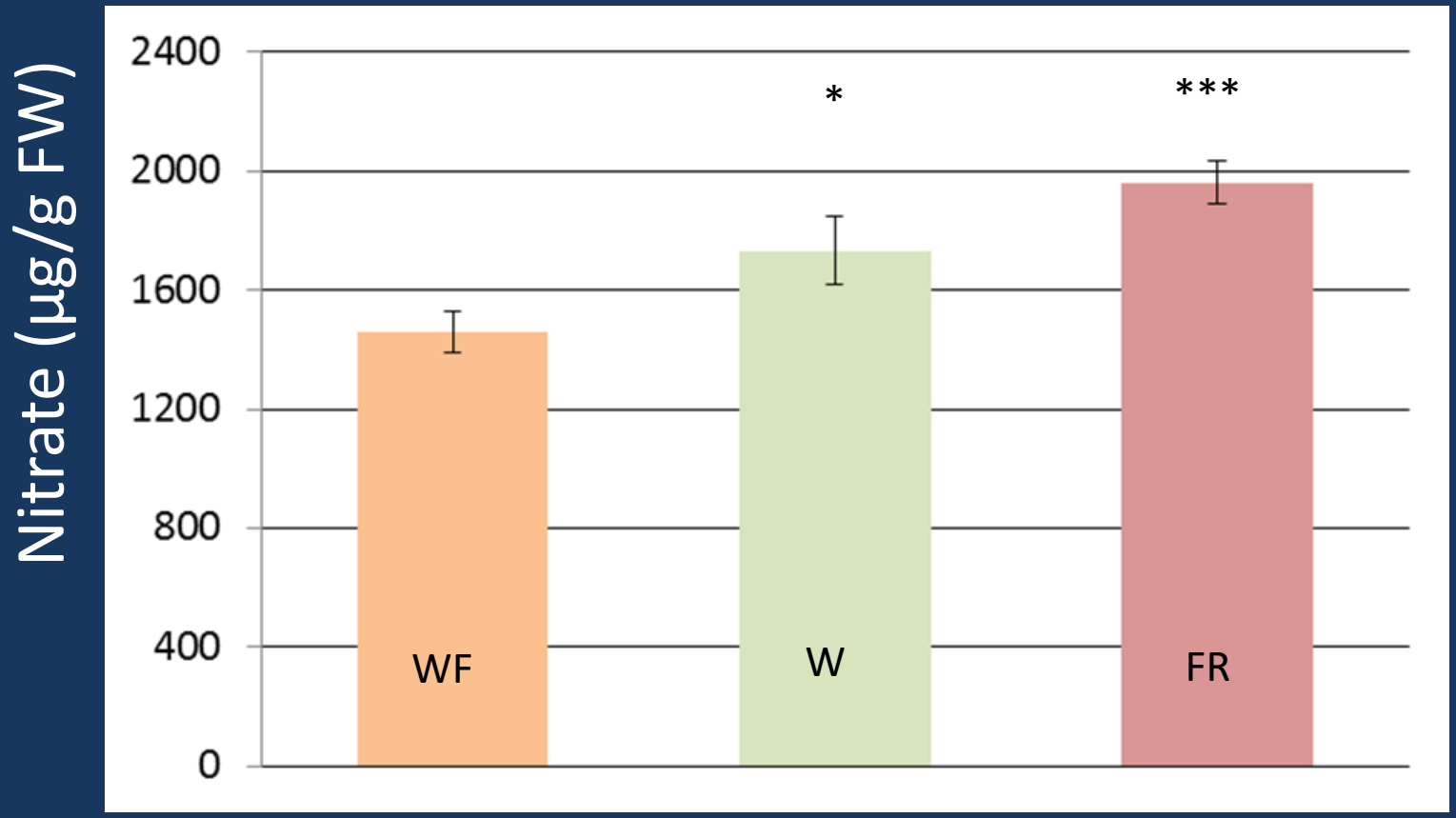
Kernel no.= 491

-13%

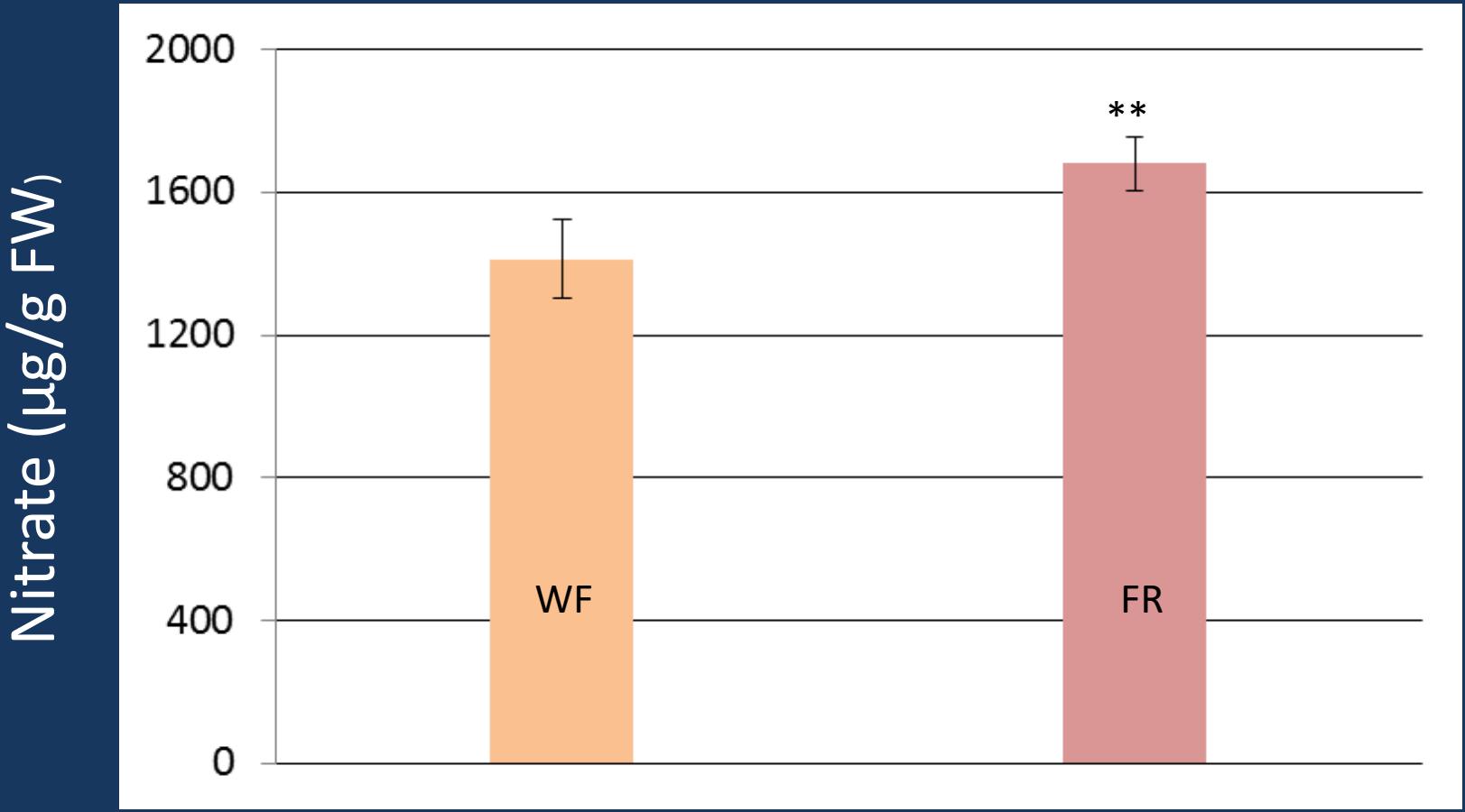
New Research - Key Point #5

- The presence of neighbouring weeds at the unifoliate growth stage results in nitrate accumulation in roots of soybean and corn
- Far red light increases singlet oxygen in corn

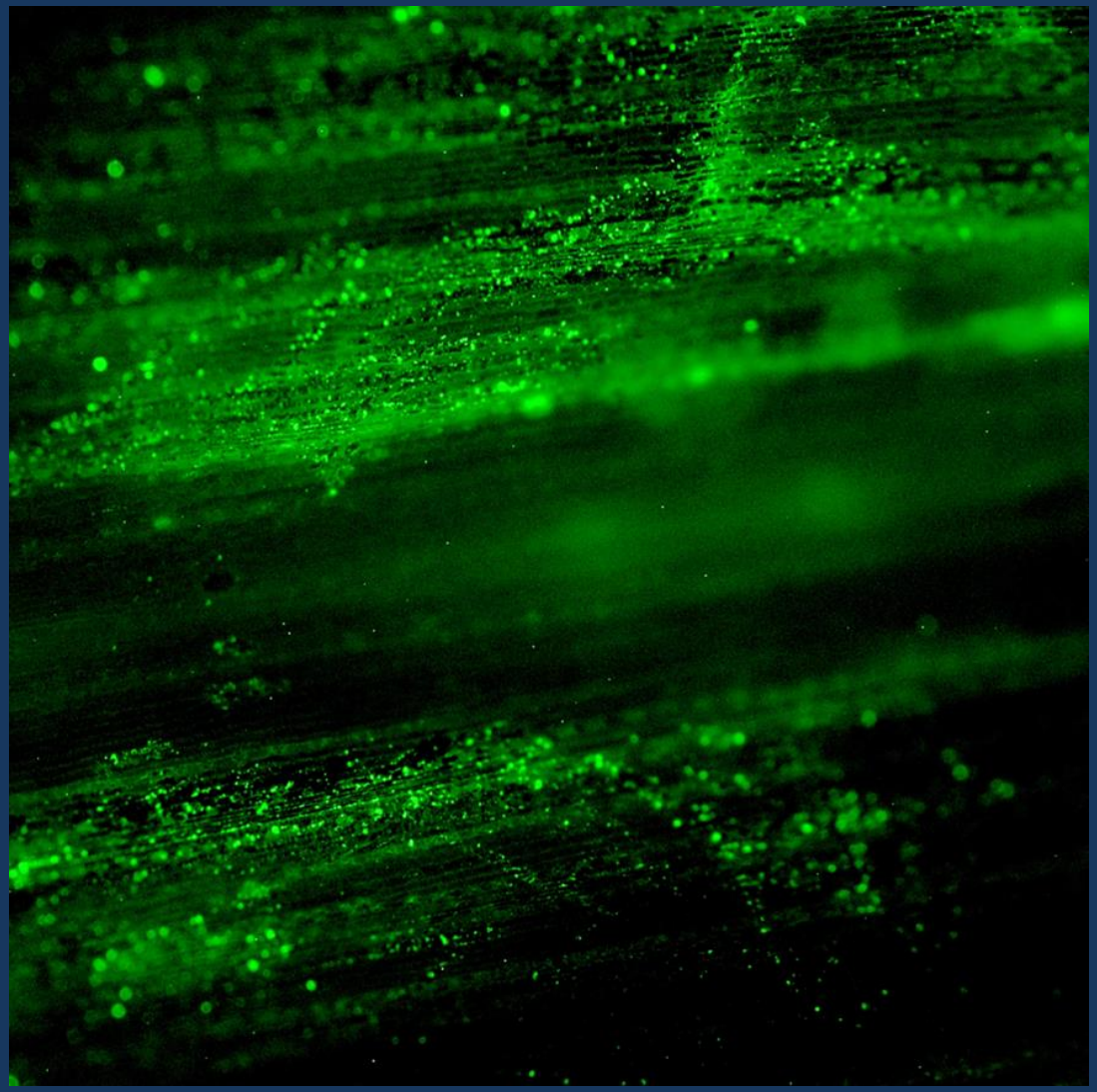
Soybean roots at unifoliate stage (11-day-old)



Maize roots at 4th leaf tip stage (9-day-old)



Far Red Light Increases $^1O_2$ Level in Corn



Talking Plants and the Science of Weed Control

- This research helps to explain:
  - "why" early season weed control is so important
  - the concepts of critical periods and weed thresholds
  - the speed and irreversibility of yield loss

Plants Talk
Timing and Speed

Thank you!