

How Plants Talk and Why We Should Listen



Why should we listen?

- Provides the science behind “start clean and stay clean throughout the critical period for weed control.”
- Implications for cover crop management.
- Provides insights into how plants lose yield.
- Breeding crops for greater stress tolerance to weeds.

The problem with plant competition

Plant competition is assumed to be all about resources.

Why do crops such as corn and soybean lose yield potential when growing in the presence of weeds, even when resource availability is not limiting?

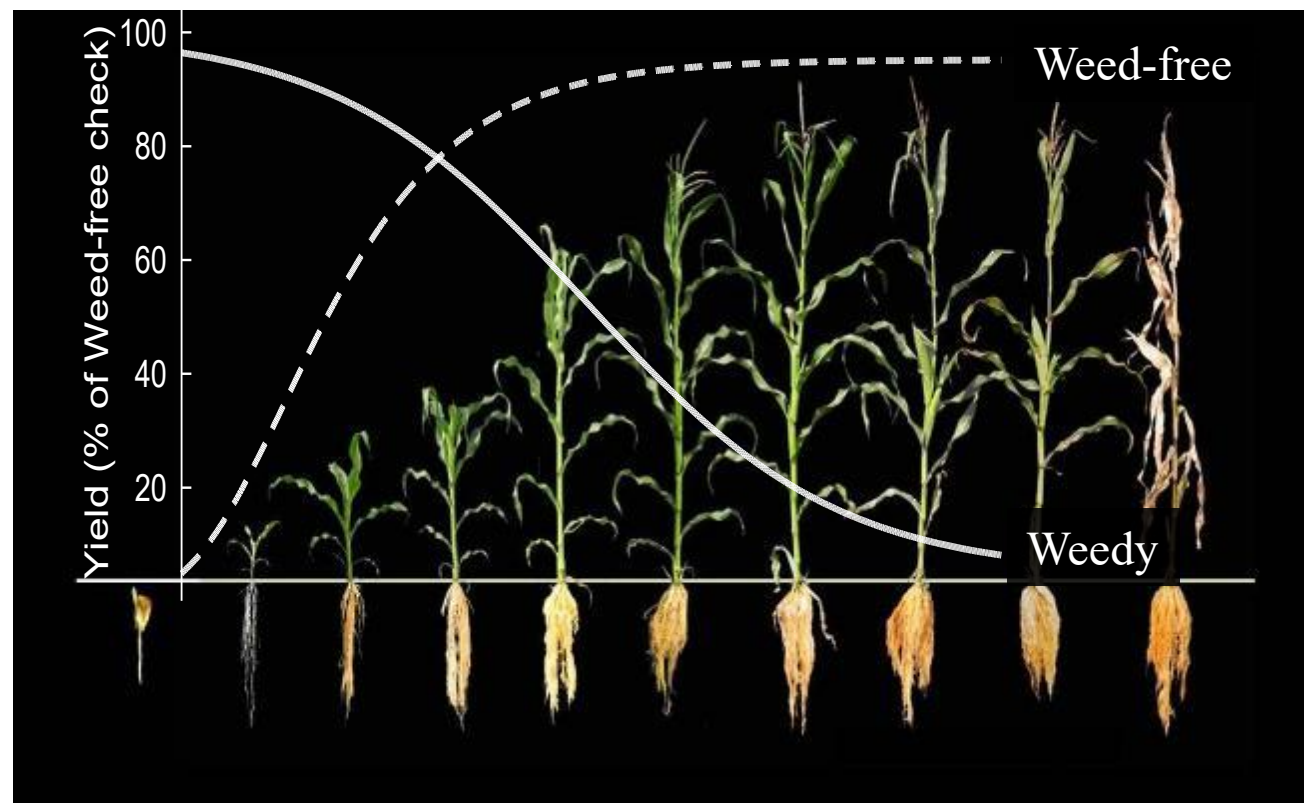
The bulk of published literature on plant competition is descriptive vs. mechanistic.

The problem with plant competition

Are there alternative mechanisms of inter and intra plant competition in play other than resources?

Can understanding how plants talk lead to the discovery of novel mechanisms of plant competition?

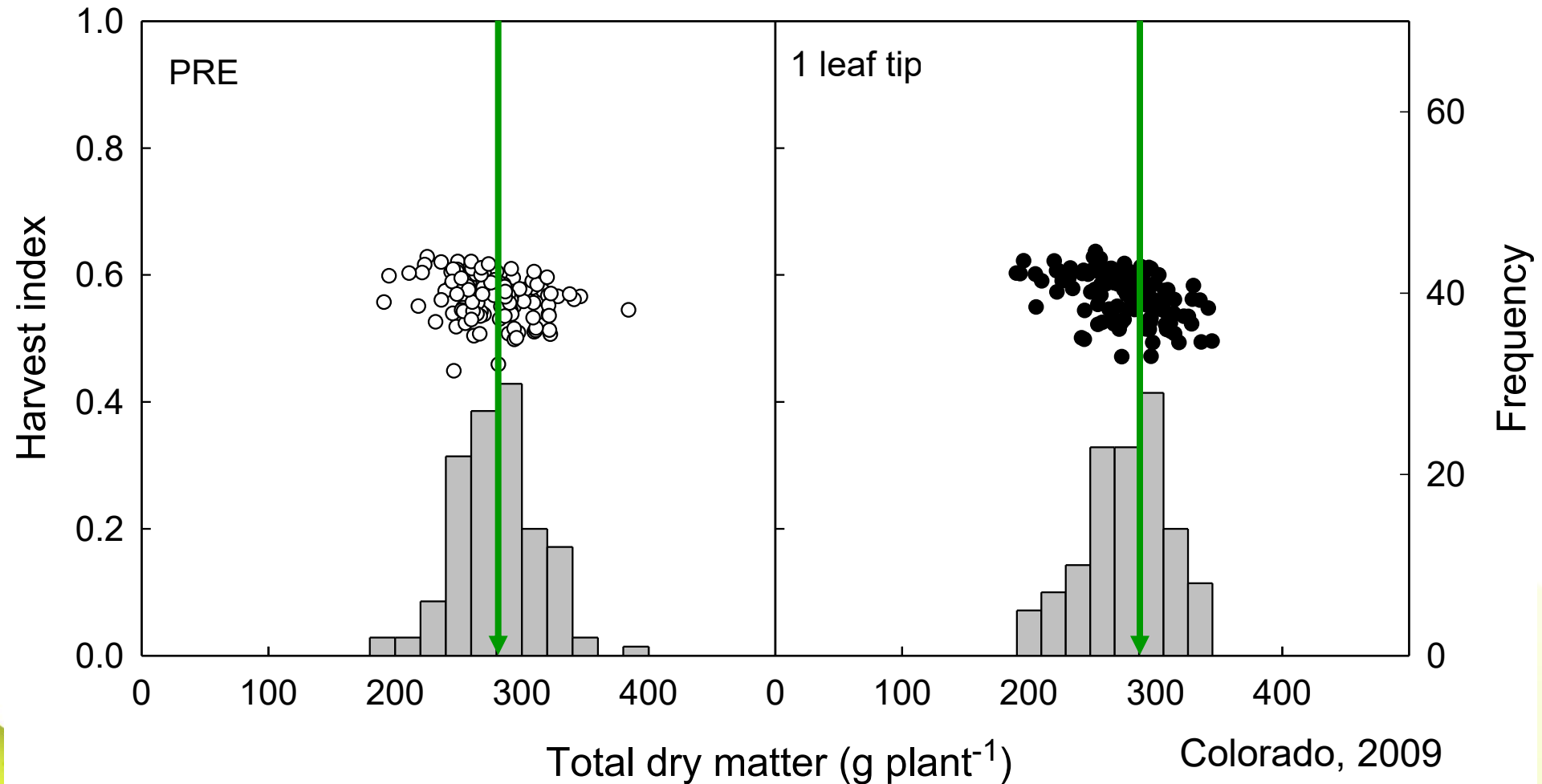




Pre / 1 leaf tip weed control

Yield = 100%

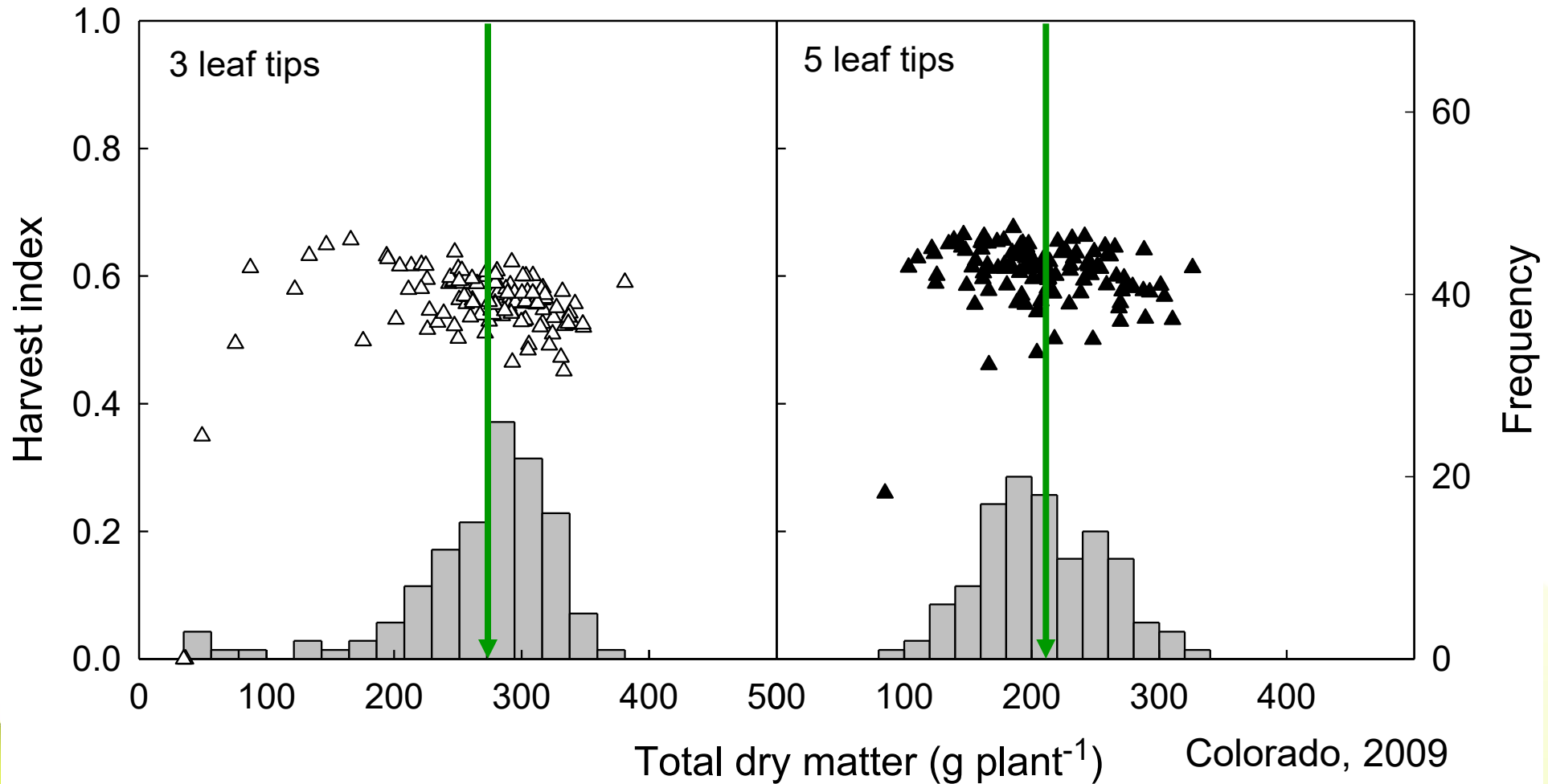
Yield = 99%



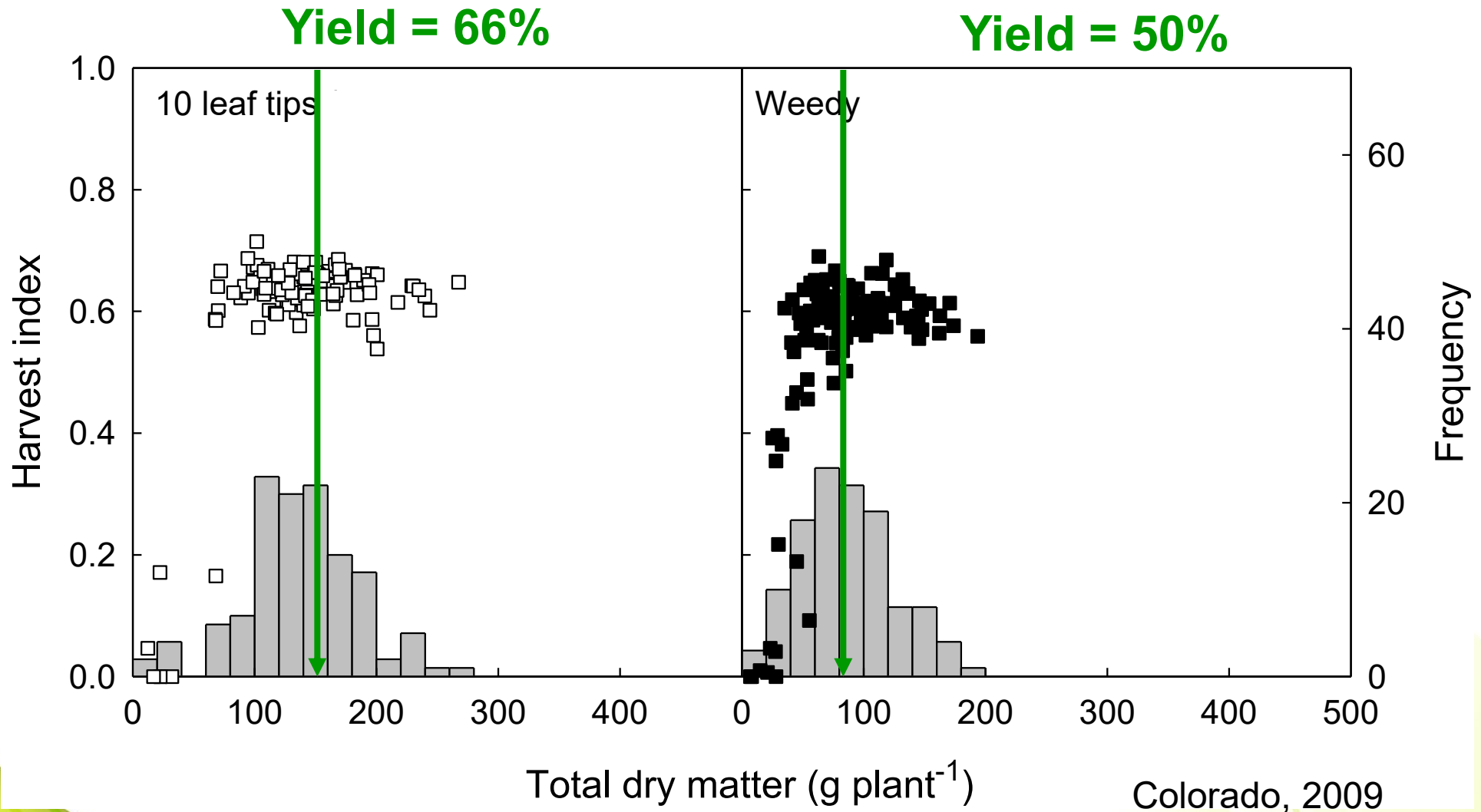
3 / 5 leaf tip weed control

Yield = 97%

Yield = 72%



10 leaf tip / weedy control





1991-2018

1991-2018

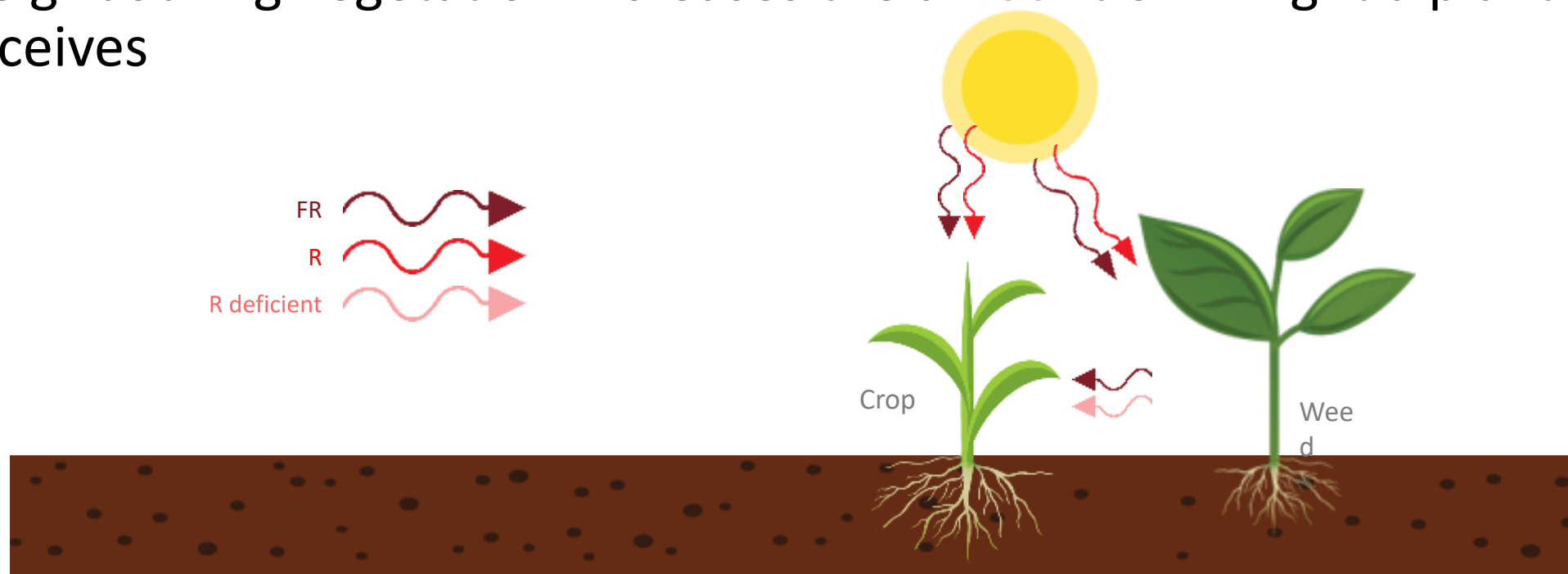
1991

Early presence of neighbouring weed seedlings

- Results in rapid and irreversible changes in corn allometry and harvest index
- Changes in allometry reduces stress tolerance
- Lengthens the anthesis-silking
- Reduces yield

Detection of Far Red light reflected from neighbouring weeds

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



Treatments



Control; R:FR ~ 1.4



Biological; R:FR ~ 0.3



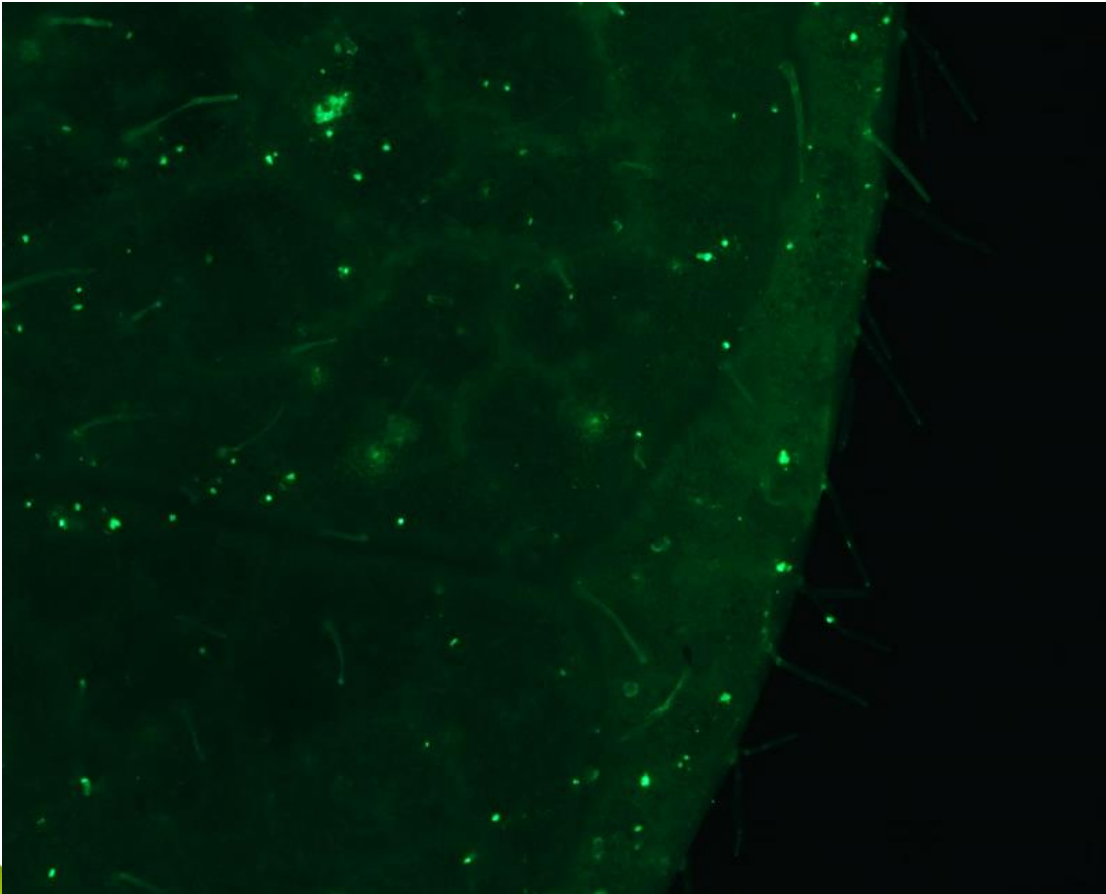
Artificial; R:FR ~ 0.3

No root contact between weed and plant to isolate competition for light quality
RCBD, SAS 9.4 Proc Glimmix

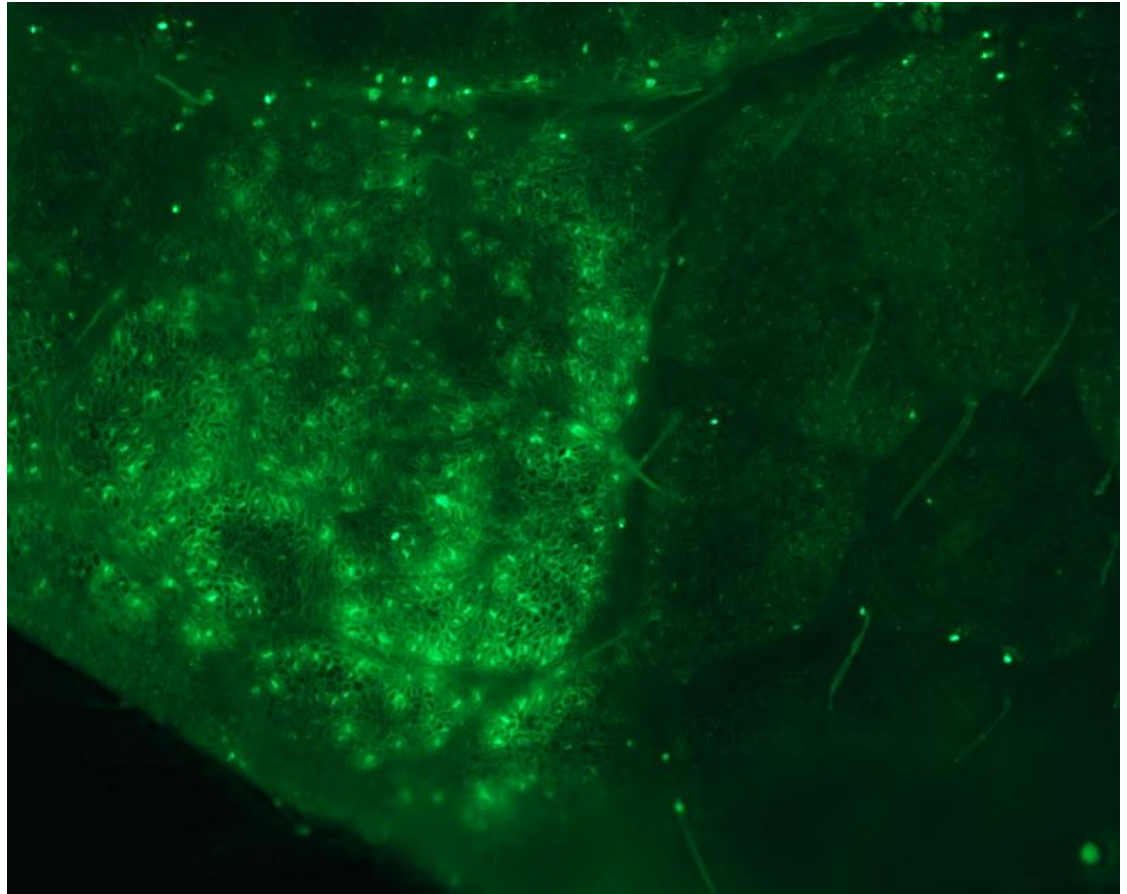
Mechanism 1. Enhanced production of $^1\text{O}_2$

- Singlet oxygen is involved in:
 - Cell signaling
 - Photosynthesis
- Excess levels often associated with abiotic conditions can cause significant cell damage

Far-red light induces $^1\text{O}_2$ production-Soybean



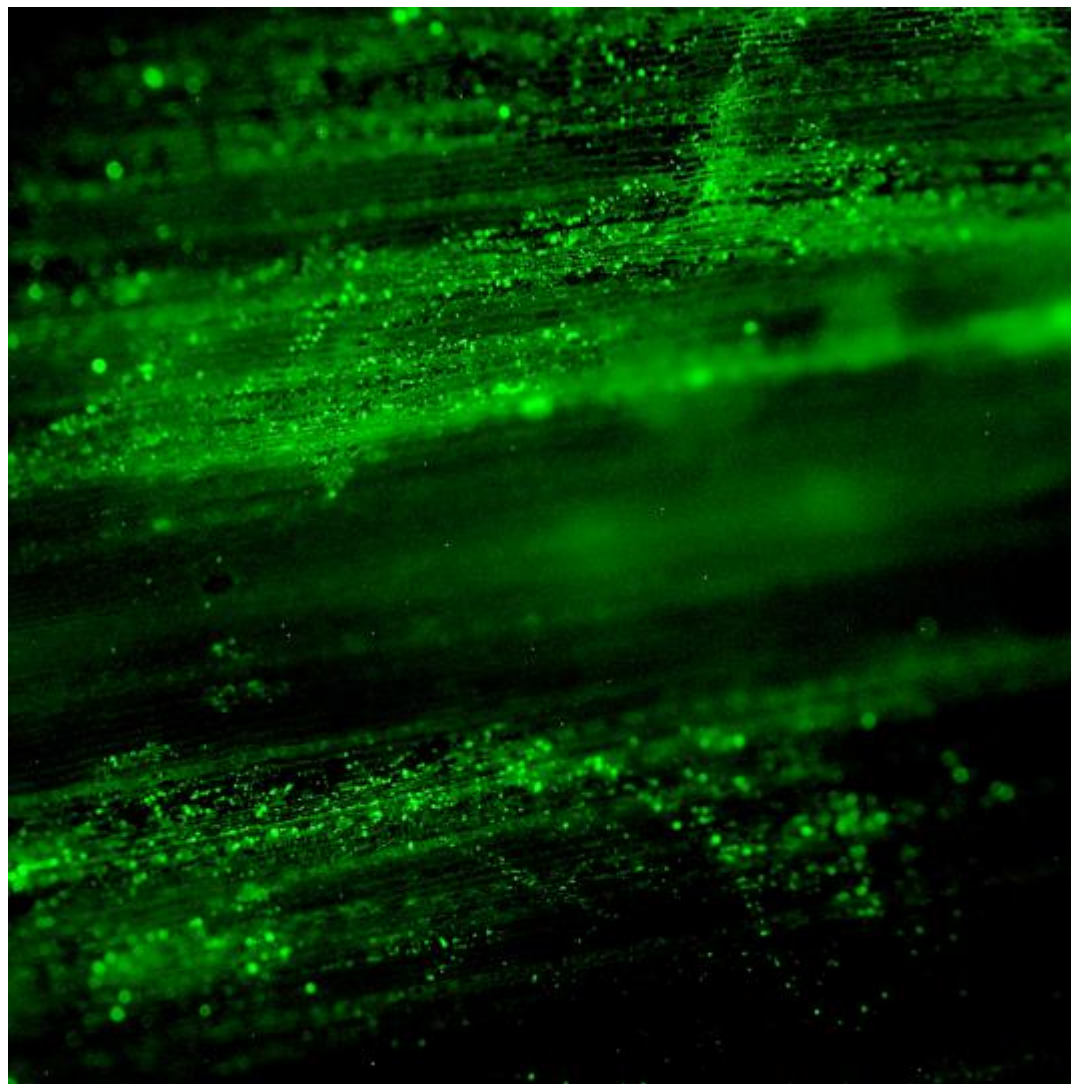
Weed-Free



Weedy

(McKenzie-Gopsill et al., 2019)

$^{18}\text{O}_2$ in Corn



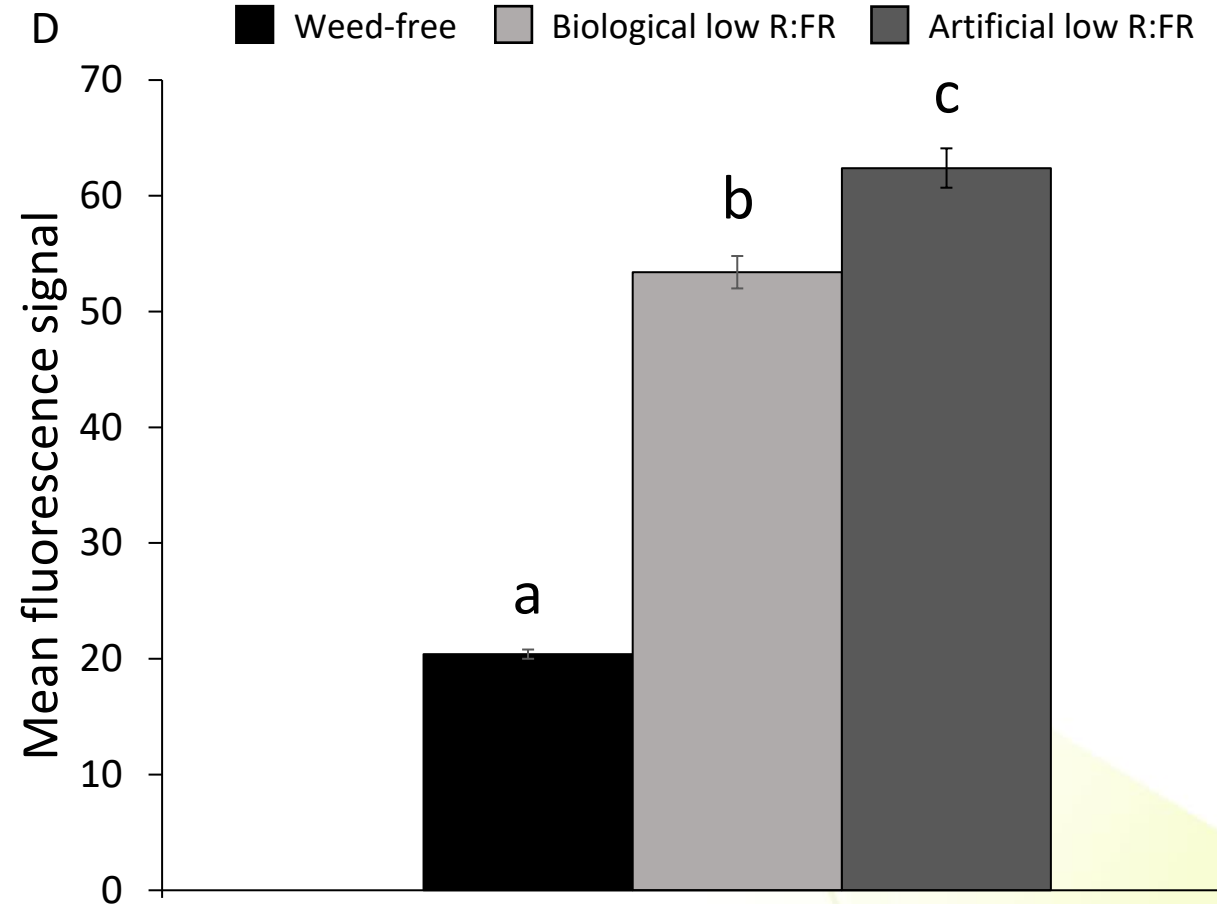
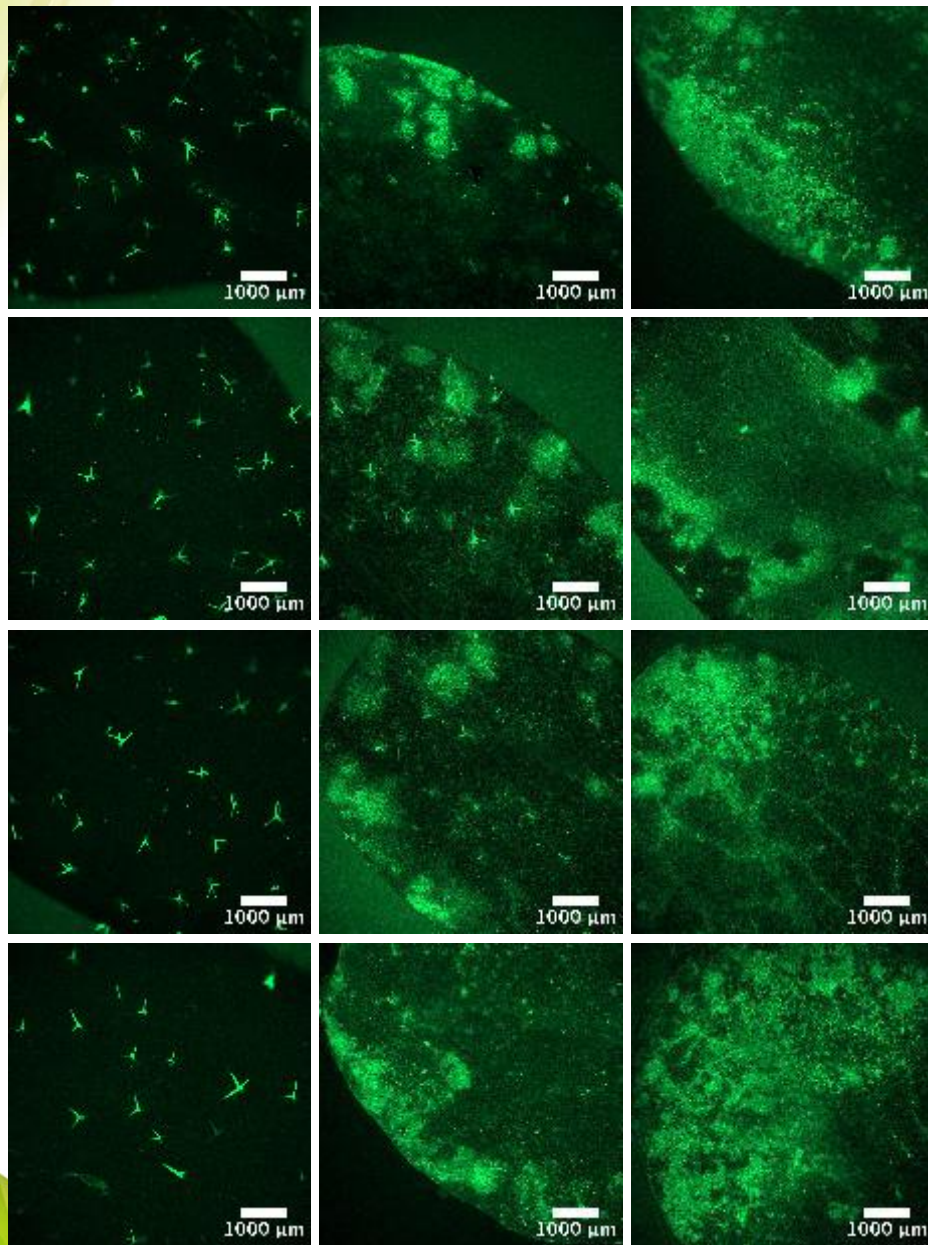
Control

Biological

Artificial

$^1\text{O}_2$ in Arabidopsis

Ministerio Argentino de Molezas-ASACIM
MALFEZAS 2026
Ciencia, producción y sociedad: hacia un manejo sustentable















Follow-up field experiment



24

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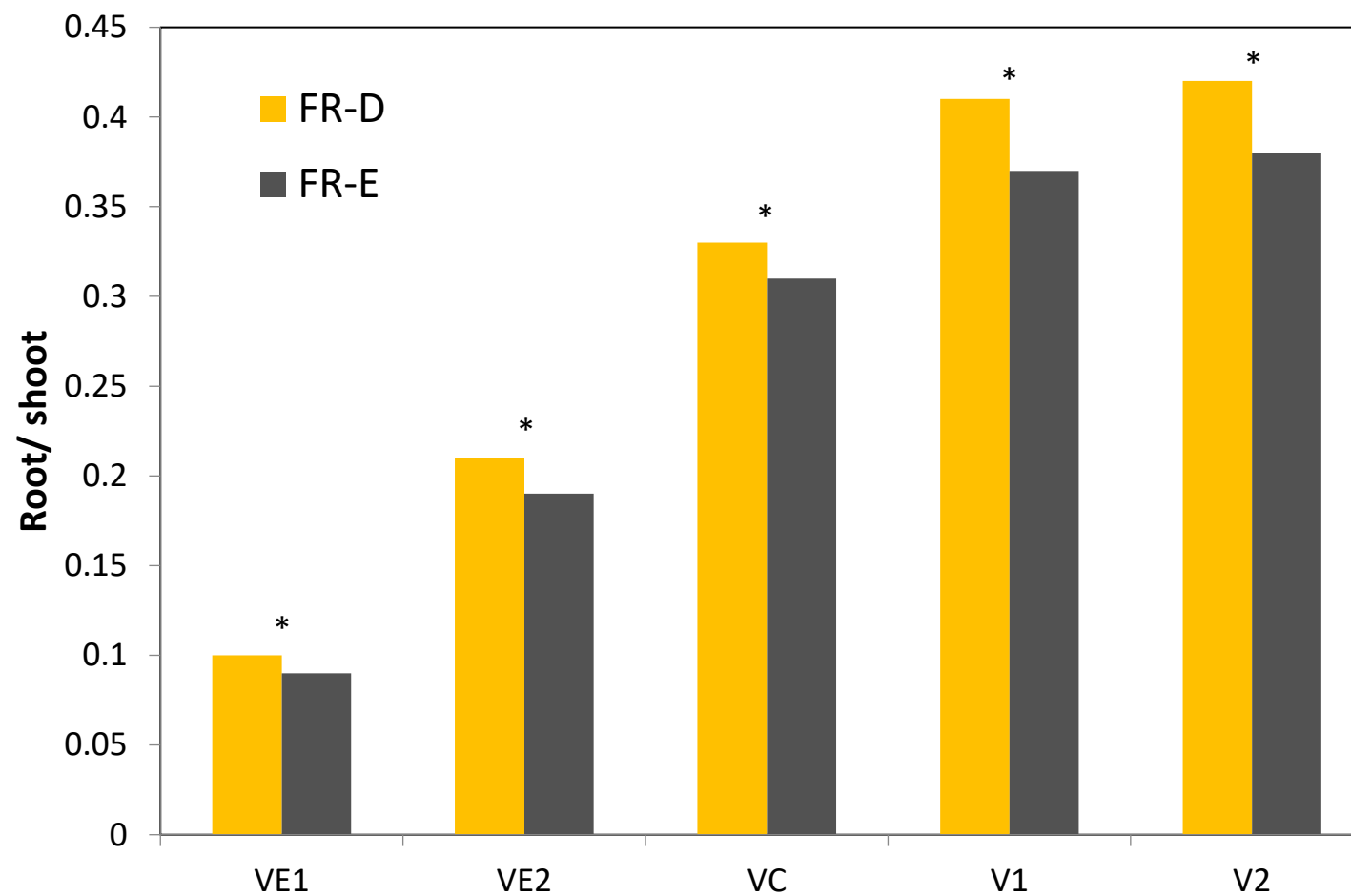


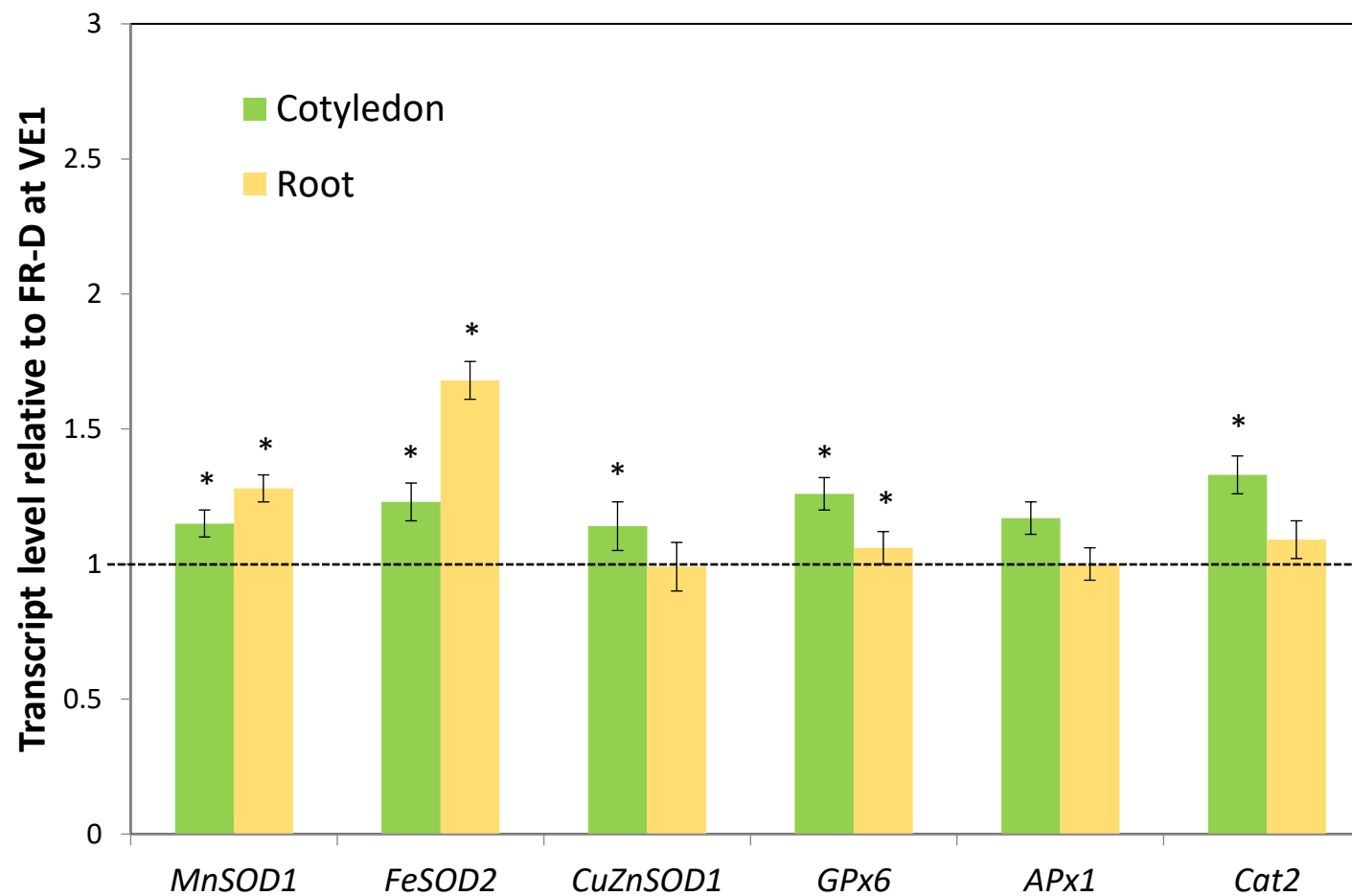








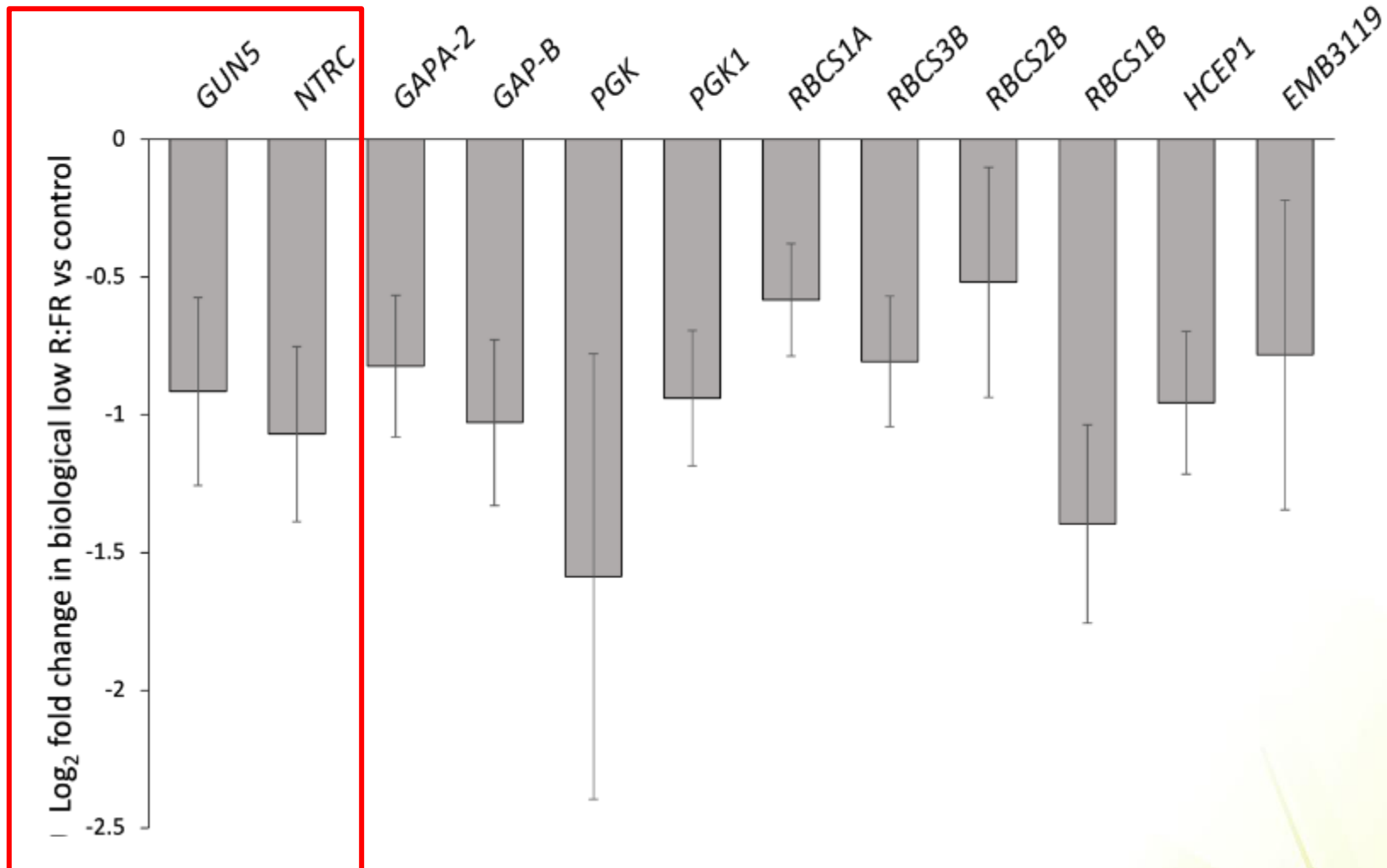




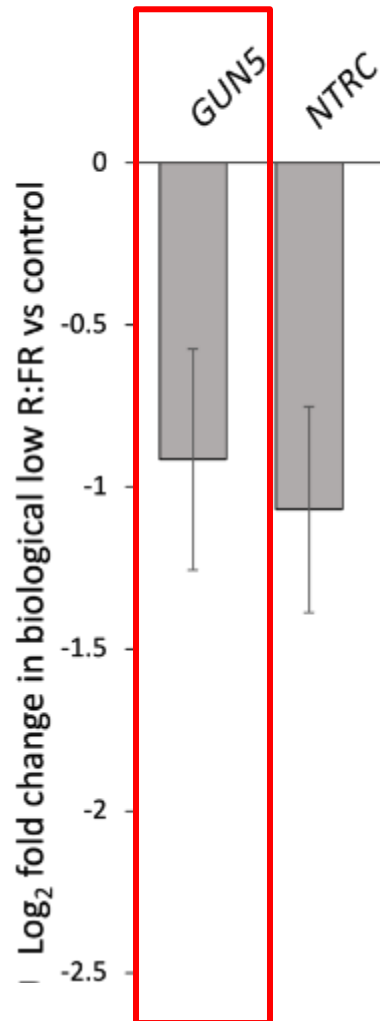
Mechanism 2. Suppression of photosynthesis

- Down regulation of:
 - Photosynthetic genes
 - Chlorophyll biosynthesis genes

Photosynthesis genes are downregulated

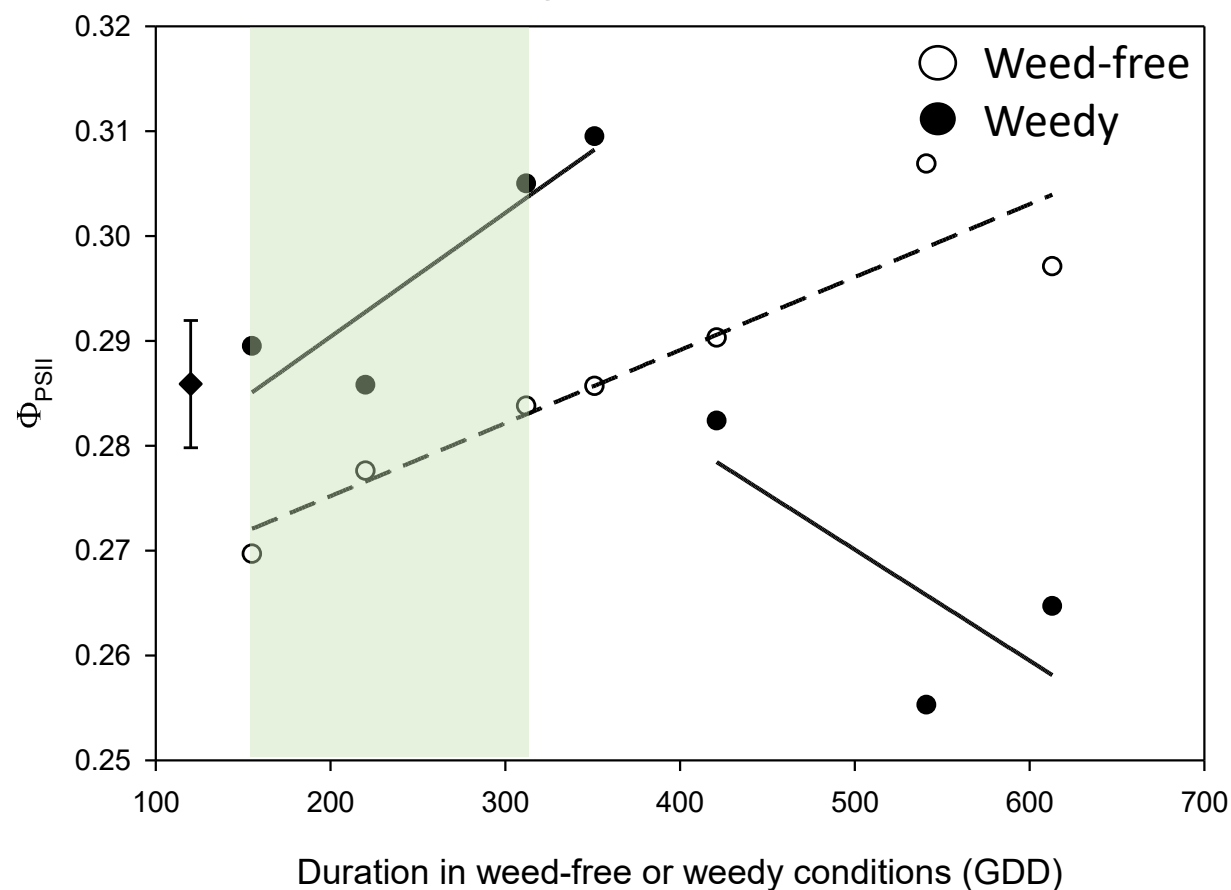
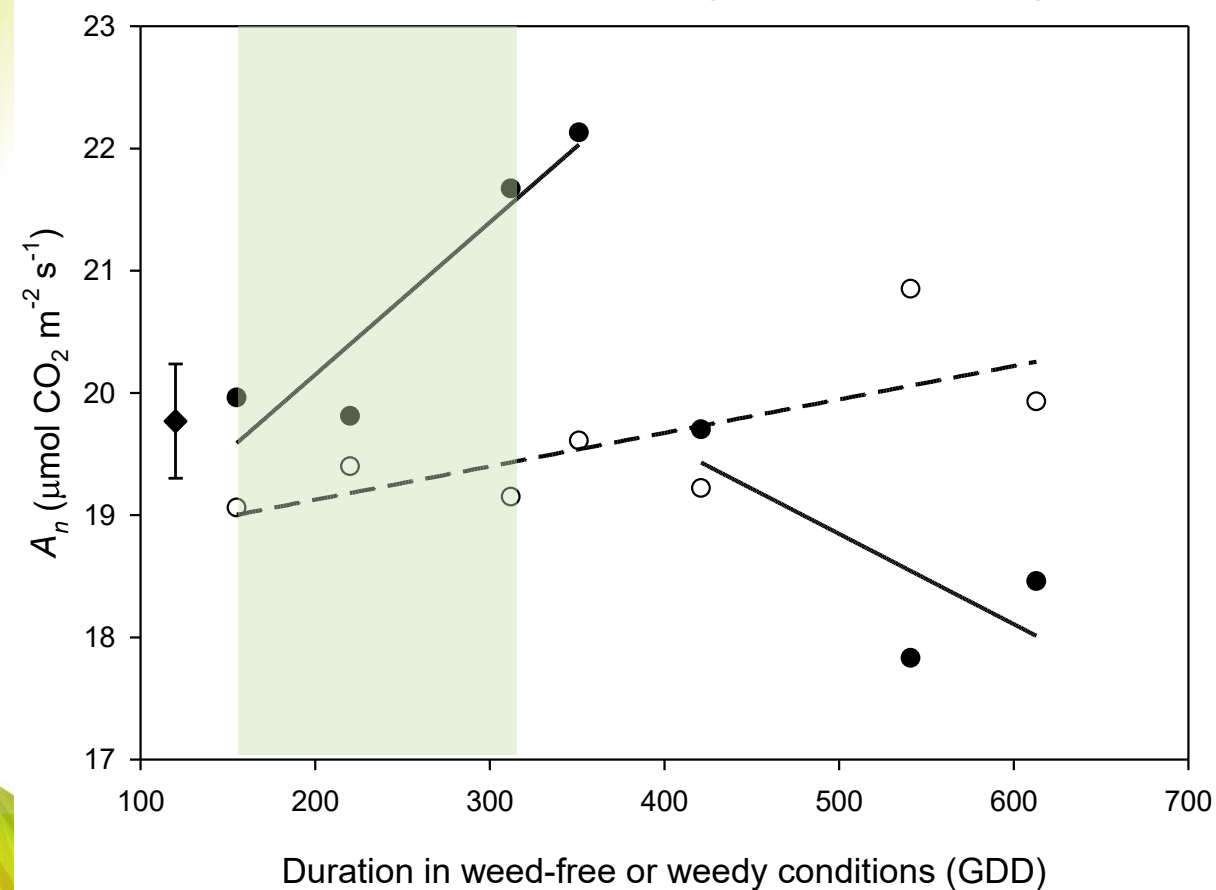


Chlorophyll biosynthesis genes are downregulated



Downregulation may result in accumulation of singlet oxygen molecules

Weed presence impaired CO₂ assimilation and photosynthetic efficiency



Under field conditions common bean exposed to far red light reflected from neighbouring weeds altered:

CO₂ assimilation and stomatal conductance

Water use efficiency

Photosynthetic efficiency and electron transport

Rubisco activity

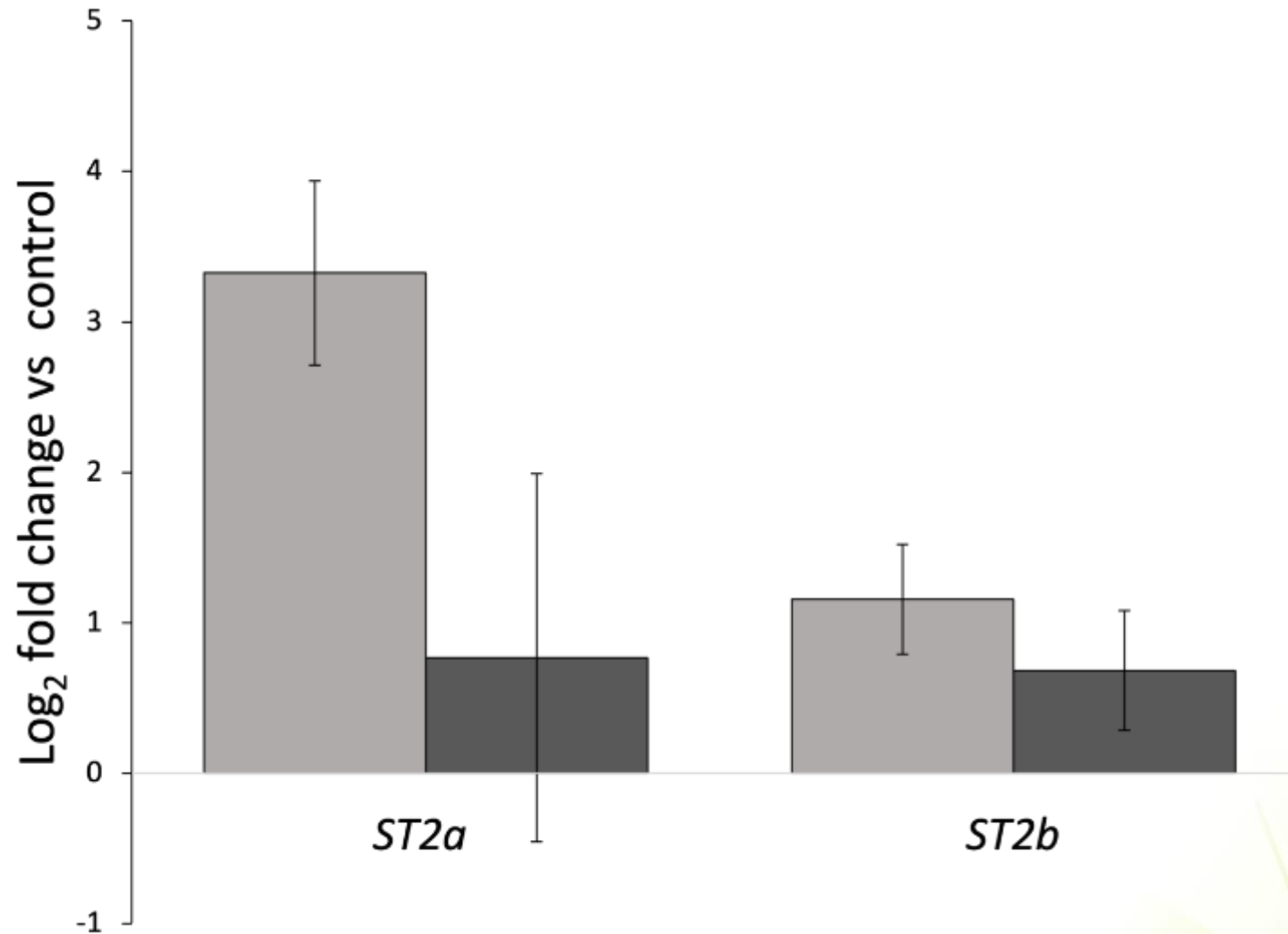
Weed seedlings reduce crop photosynthesis

- Reduction in carbohydrate production
- Increase variability in Harvest Index
- Weight and size of plants decrease
- Yield declines rapidly

Mechanism 3. Enhanced susceptibility to insect and disease damage

- Jasmonic acid (JA) is a plant hormone that plays a crucial role in plant defence mechanisms against herbivores, pathogens and abiotic stresses
- Sulfotransferase (ST2a) - adds a sulfate group to the bioactive JA molecule resulting in a reduction in the pool of bioactive JA

ST2a & ST2b are upregulated under low R:FR



Low R:FR
(biological)

Low R:FR
(artificial)

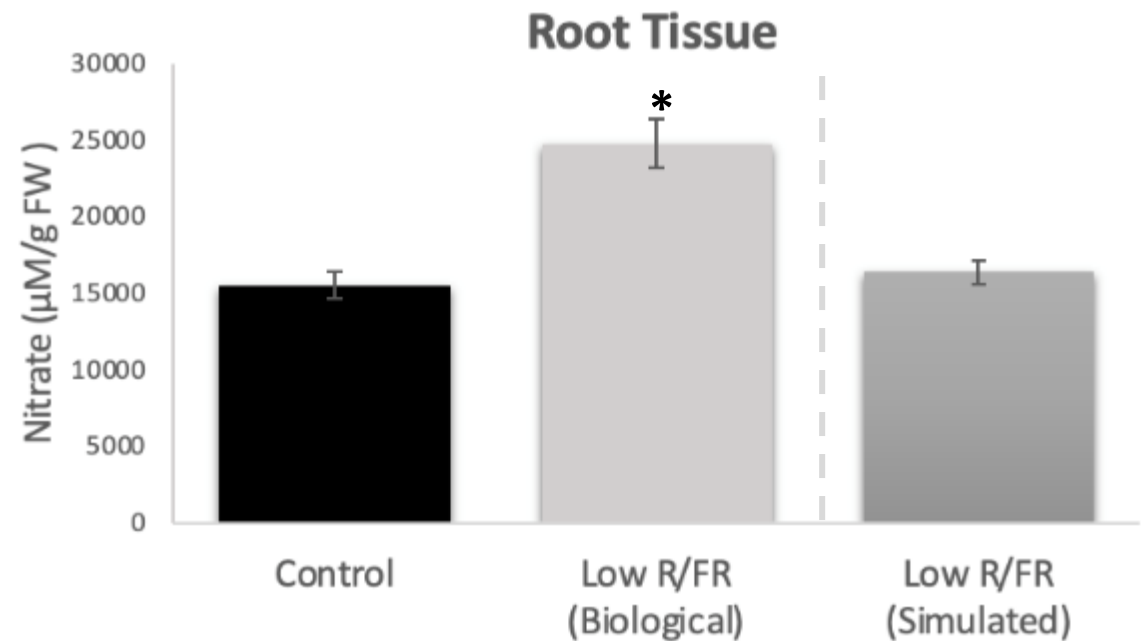
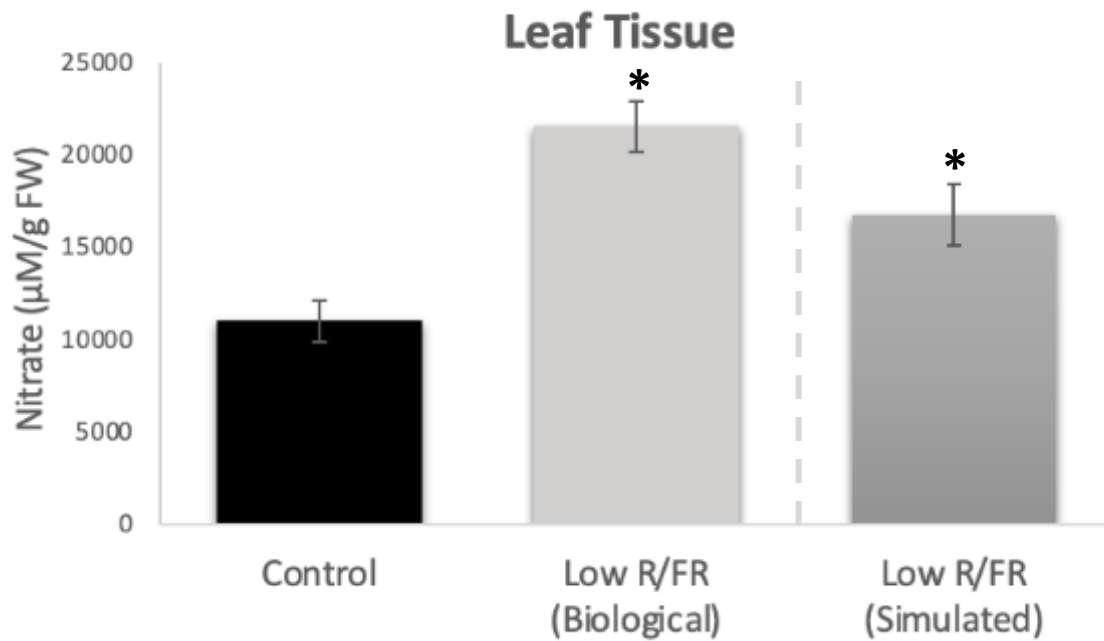
Defence shields are down!

- Upregulation of the gene *ST2a* results in the down regulation of bioactive Jasmonic acid
- This reduces the plants ability to defend against attack by insects and diseases
- Plant growth is promoted over defence response
“Grow or Die Strategy”

Mechanism 4. Low R:FR causes nitrate accumulation

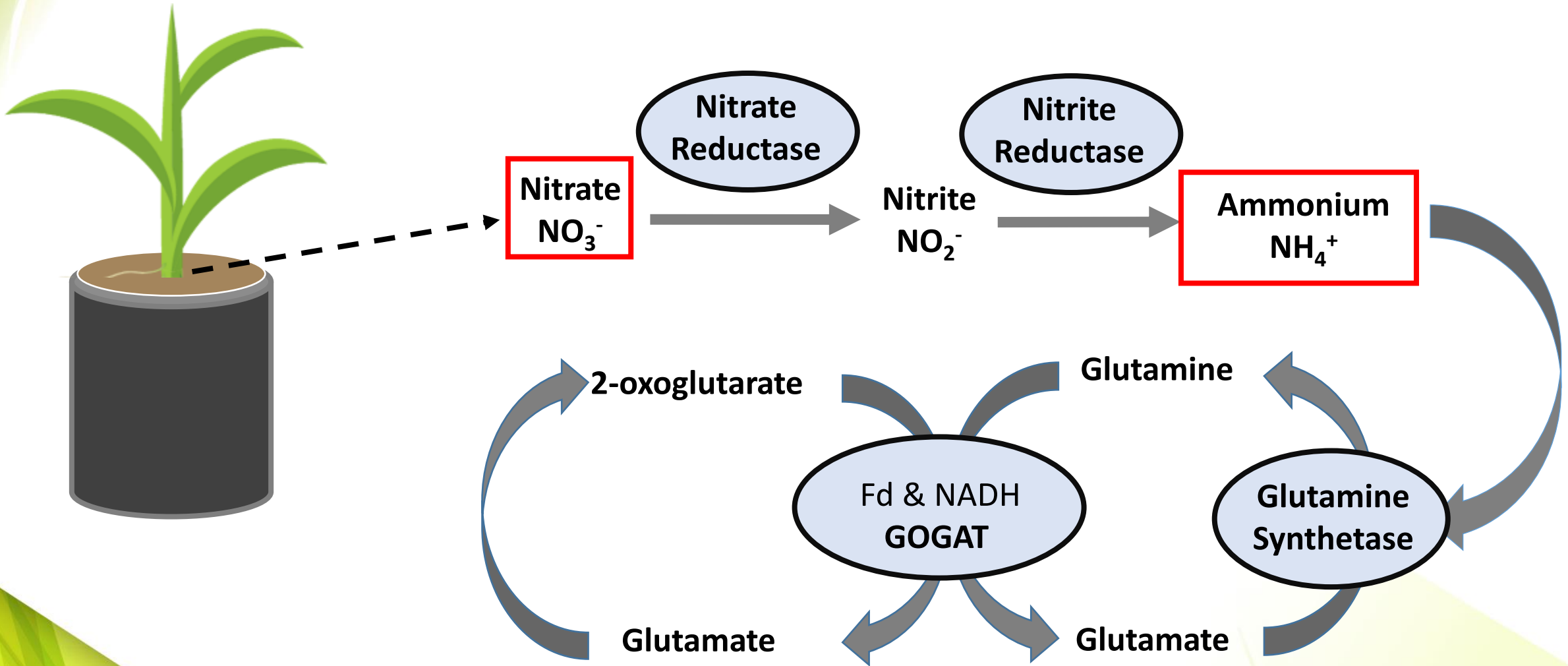
- Exposure to low R:FR causes nitrate accumulation in leaves and roots
- Alteration of nitrogen assimilation

Low R/FR light environments result in nitrate accumulation

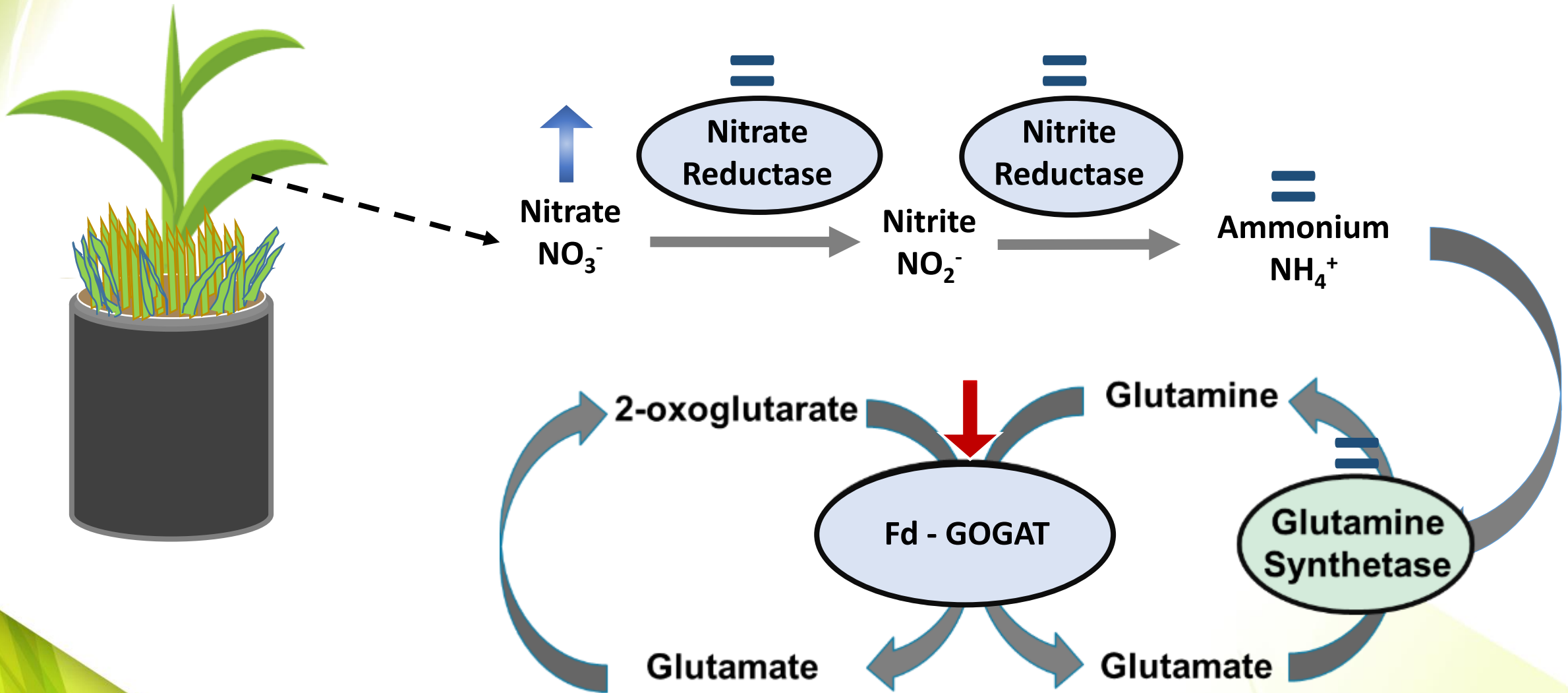


No vacuolar nitrate transporter genes were differentially expressed in corn leaves under biological and artificial low R:FR

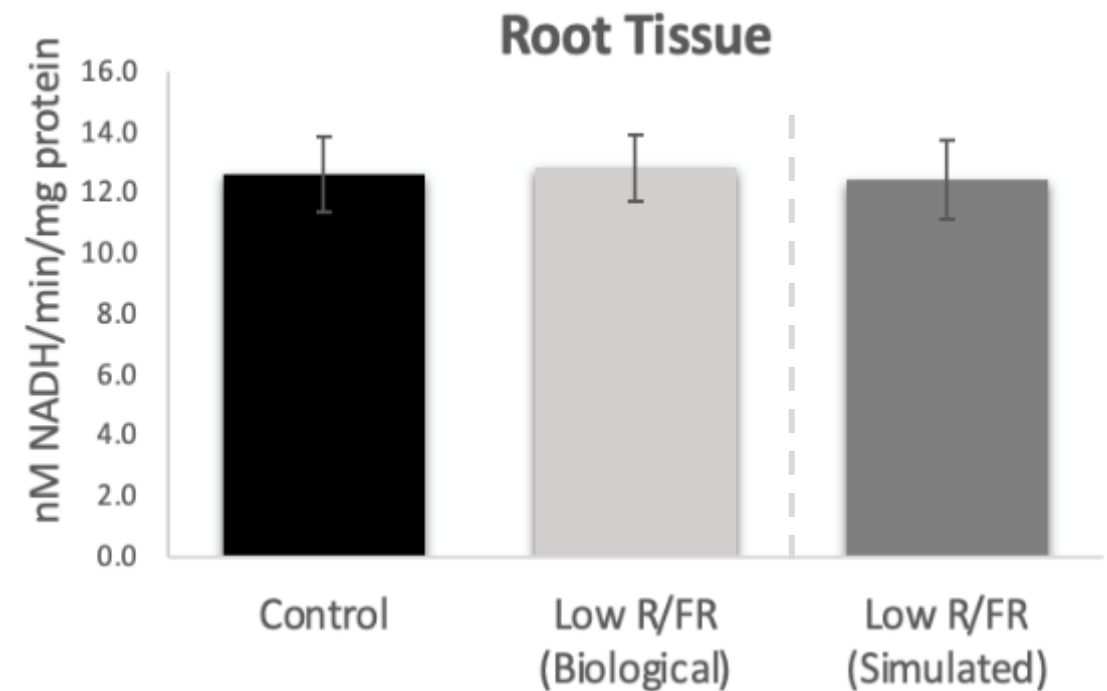
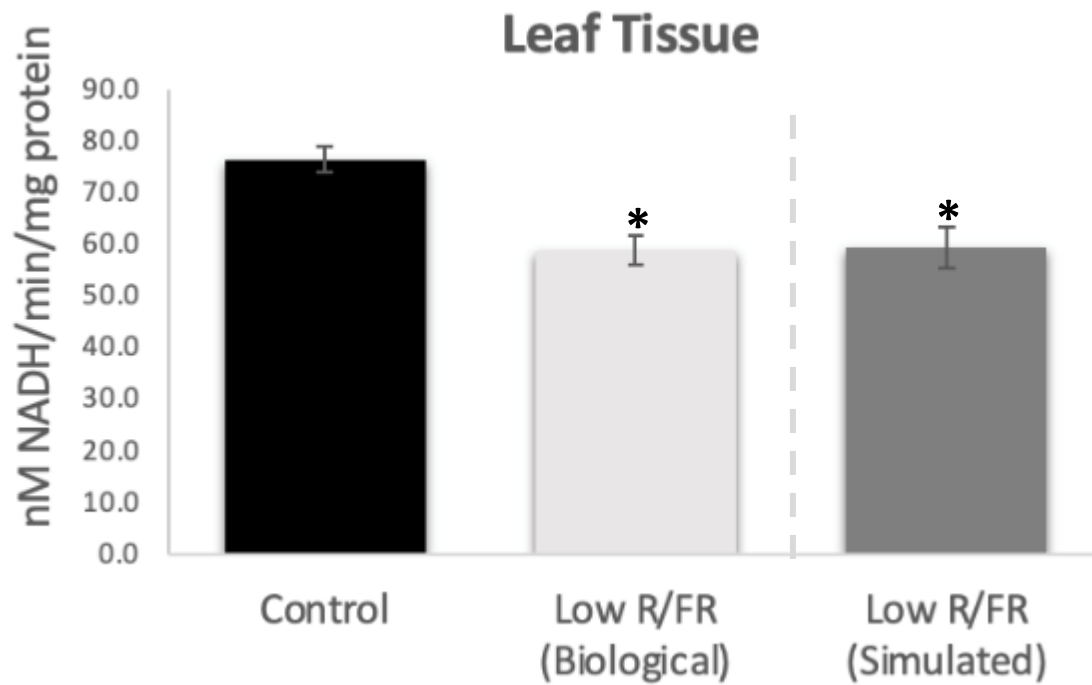
Metabolite and Enzyme Assays



Nitrate is accumulated and Fd-GOGAT activity is reduced



Low R/FR light environments decreased Fd-GOGAT activity in leaves but did not affect NADH-GOGAT activity in roots



When Weeds and Crops Talk

New Mechanisms of Plant Competition

1. Increase in cellular singlet oxygen
2. Reduction in photosynthesis
3. Reduction in defence against insects and diseases
4. Nitrate accumulation and assimilation may be affected
overtime

Key Points for Weed Science

- Inter and intra specific competition begins with plant communication
- Rapid and irreversible physiological and allometric changes (species dependent)
- Yield loss is rapid and irreversible and occurs by the minute

