Ecological Interactions

Lessons from temperate alley cropping systems

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Competitive

Synergistic

Competitive Interactions

Competition for

Light
Water
Nutrients
Phytotoxicity

Synergistic Interactions

Microclimatic modifications
Insect/pest control
Soil improvement
Nutrient capture

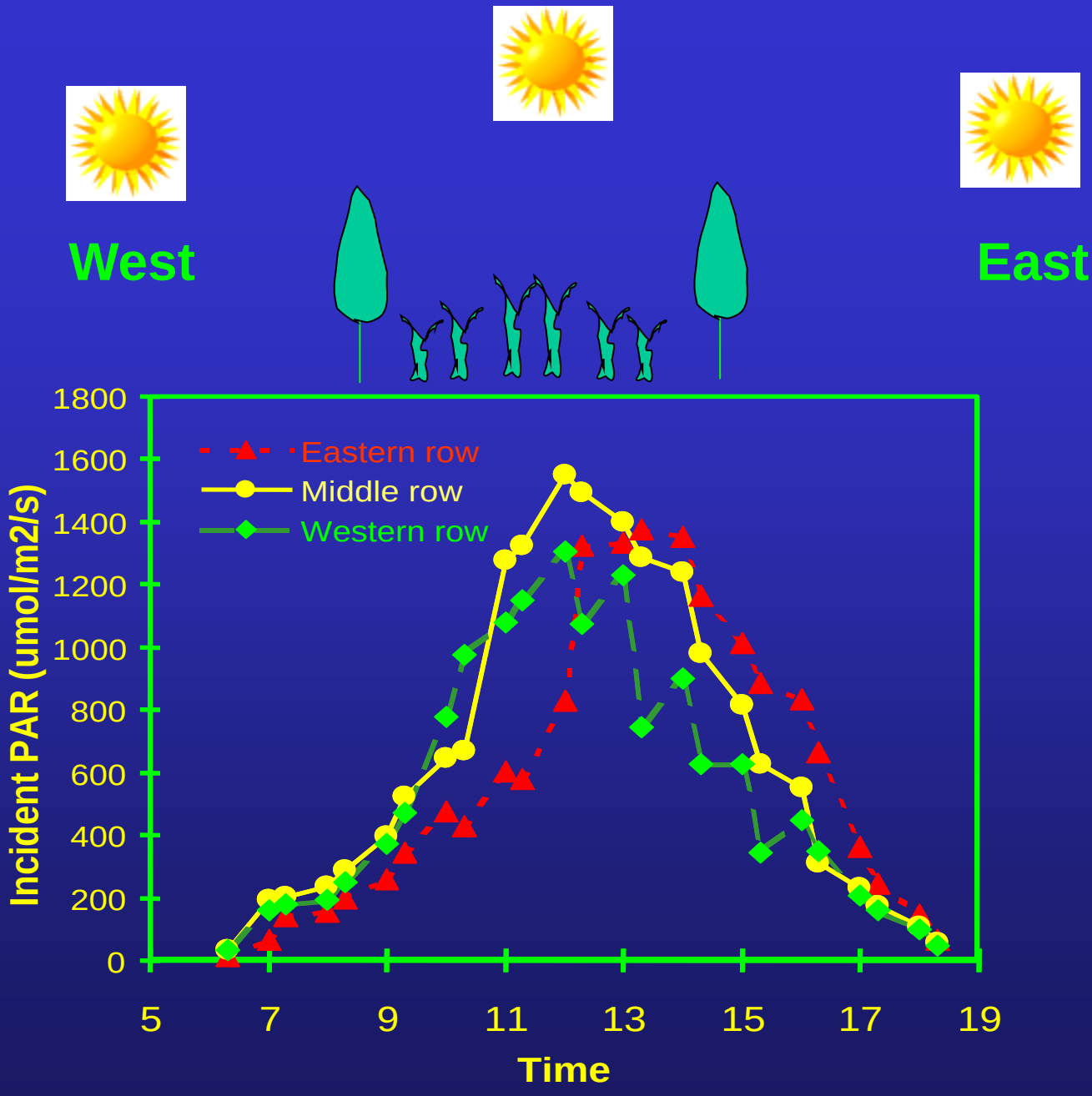

Black walnut-corn alley cropping


Pecan-Cotton alley cropping


Competition for light

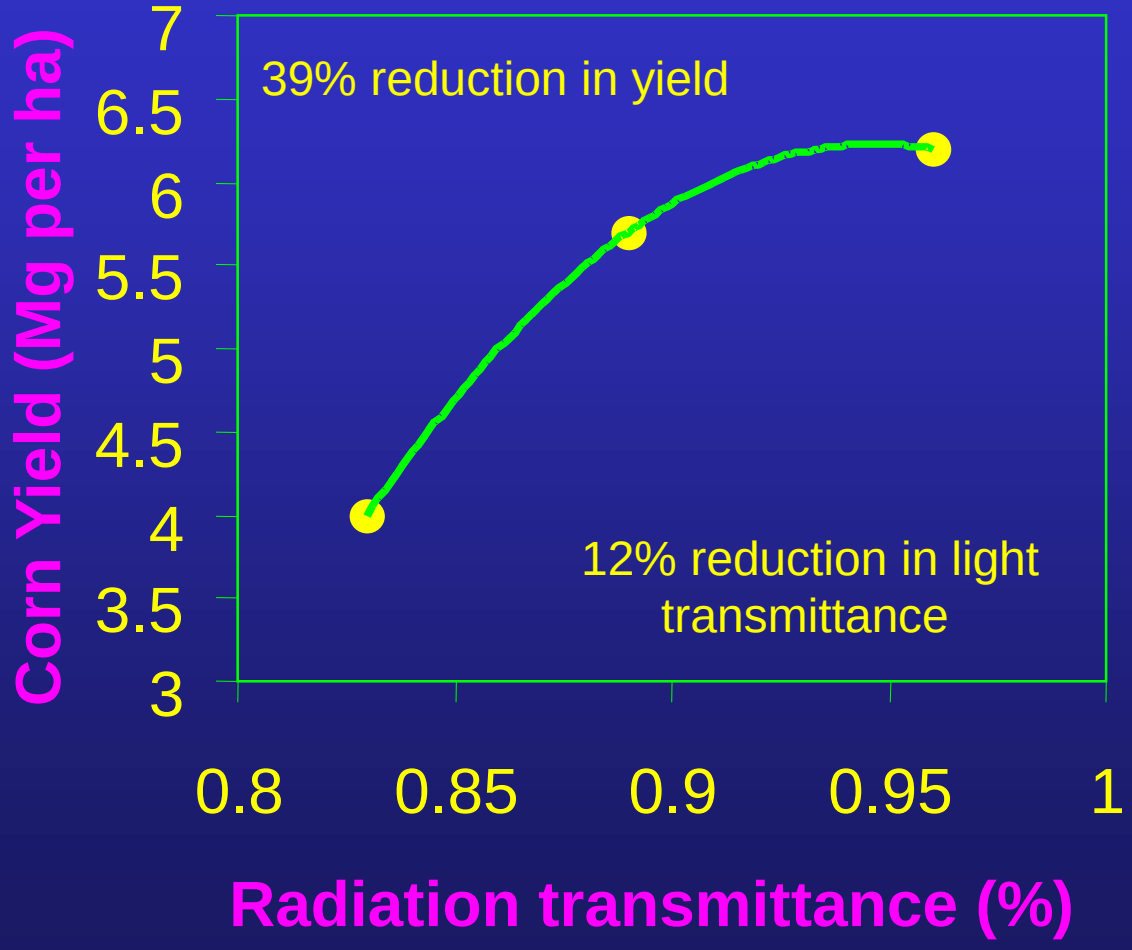
← 9-year-old

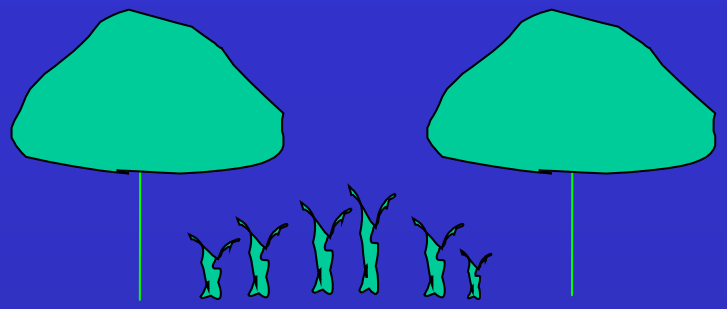
12-year-old →

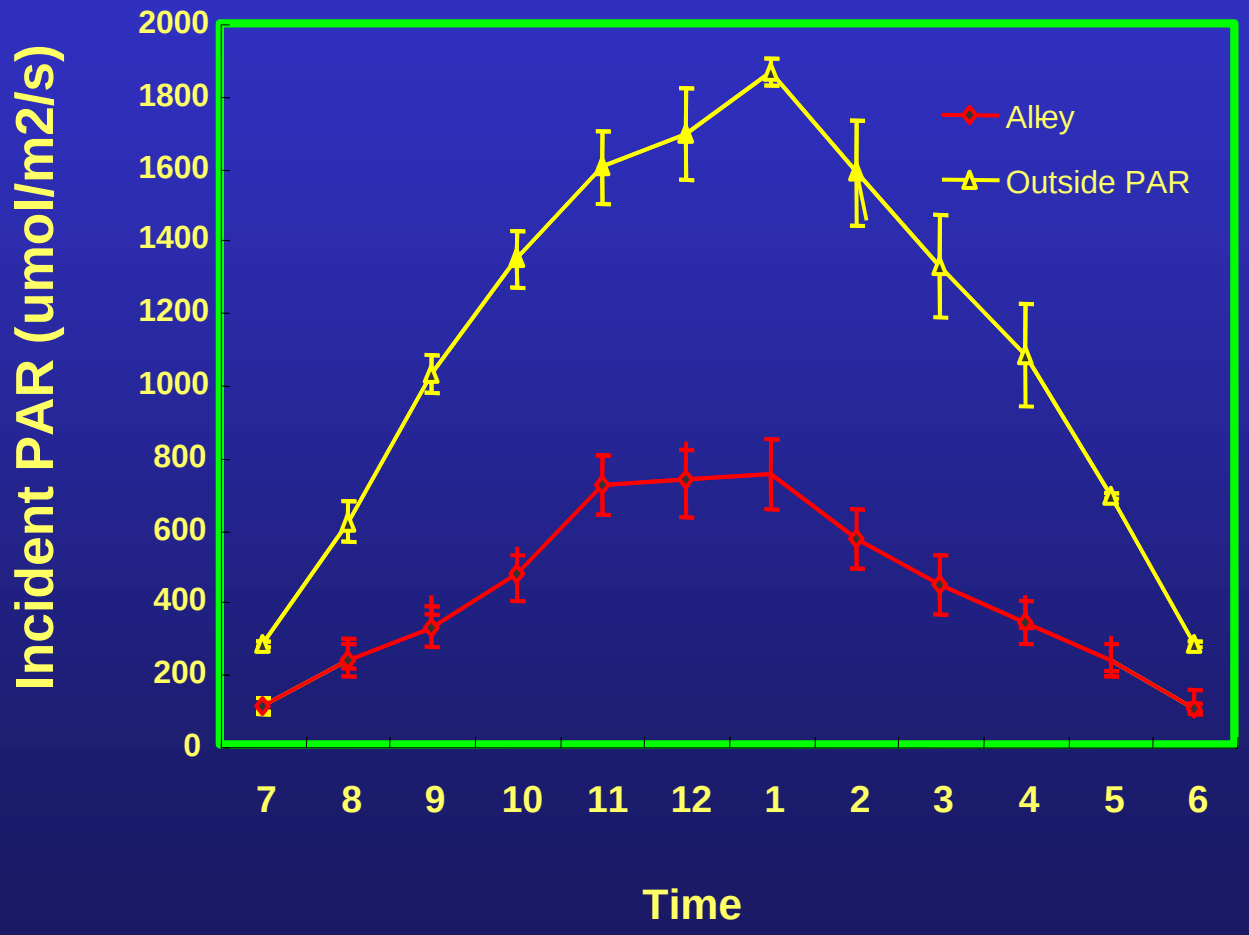


12-yr-old trees + corn

Corn yield as a function of radiation transmittance

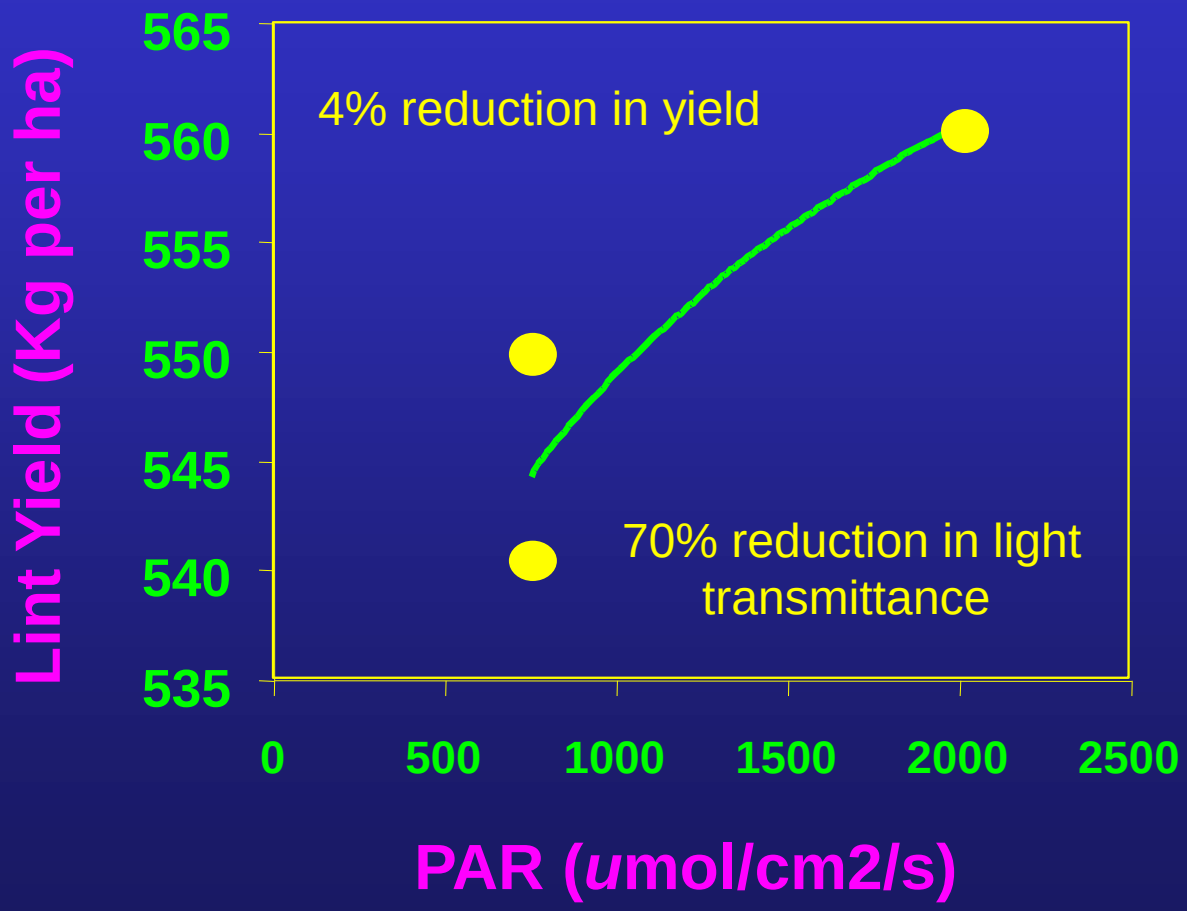




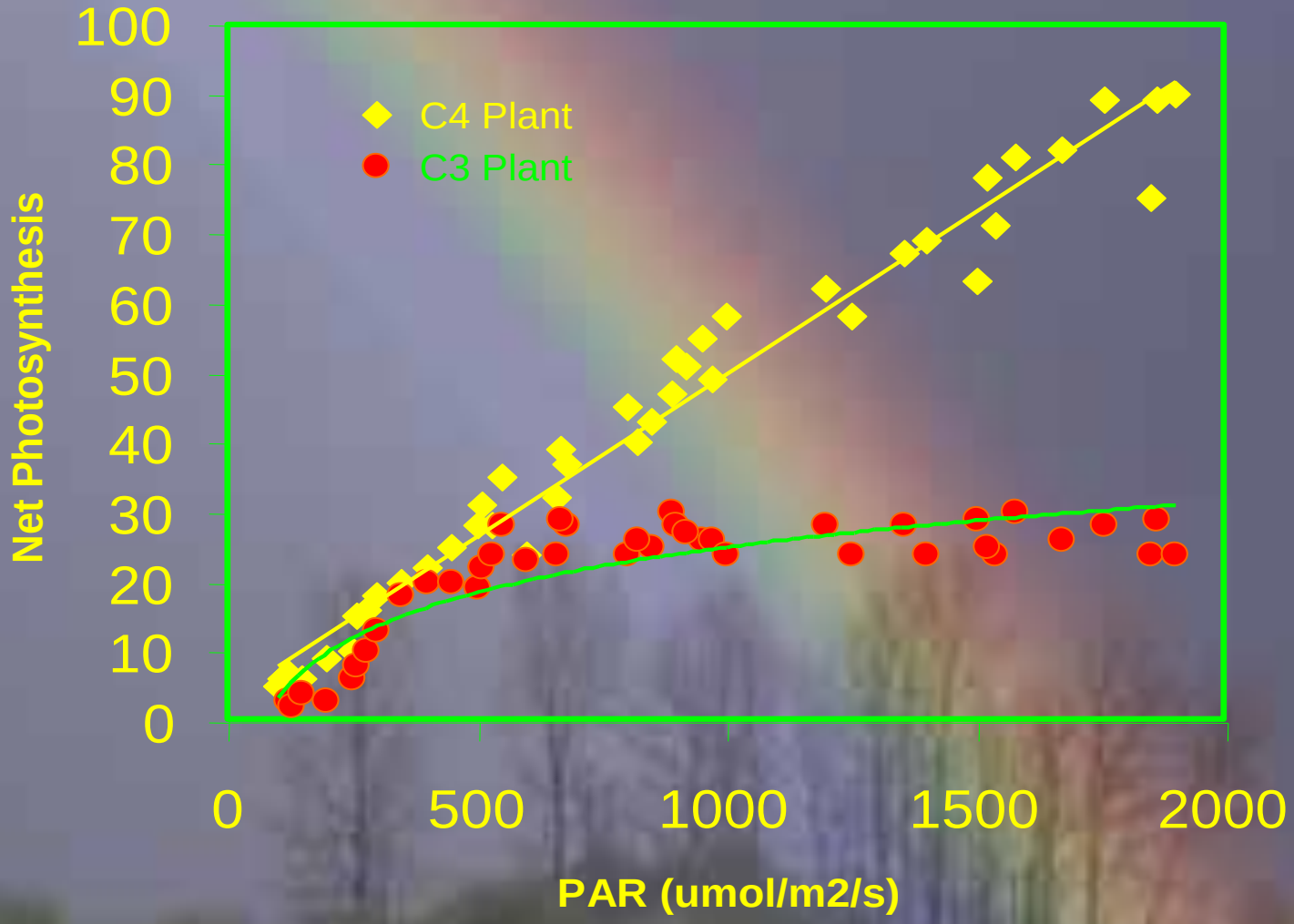


47-yr-old trees + cotton

Cotton yield as a function of radiation transmittance



PAR vs. P_{net}


C4 Plant
C3 Plant
Net Photosynthesis
100
90
80
70
60
50
40
30
20
10
0
0
500
1000
1500
2000
PAR (umol/m2/s)

As you know…….

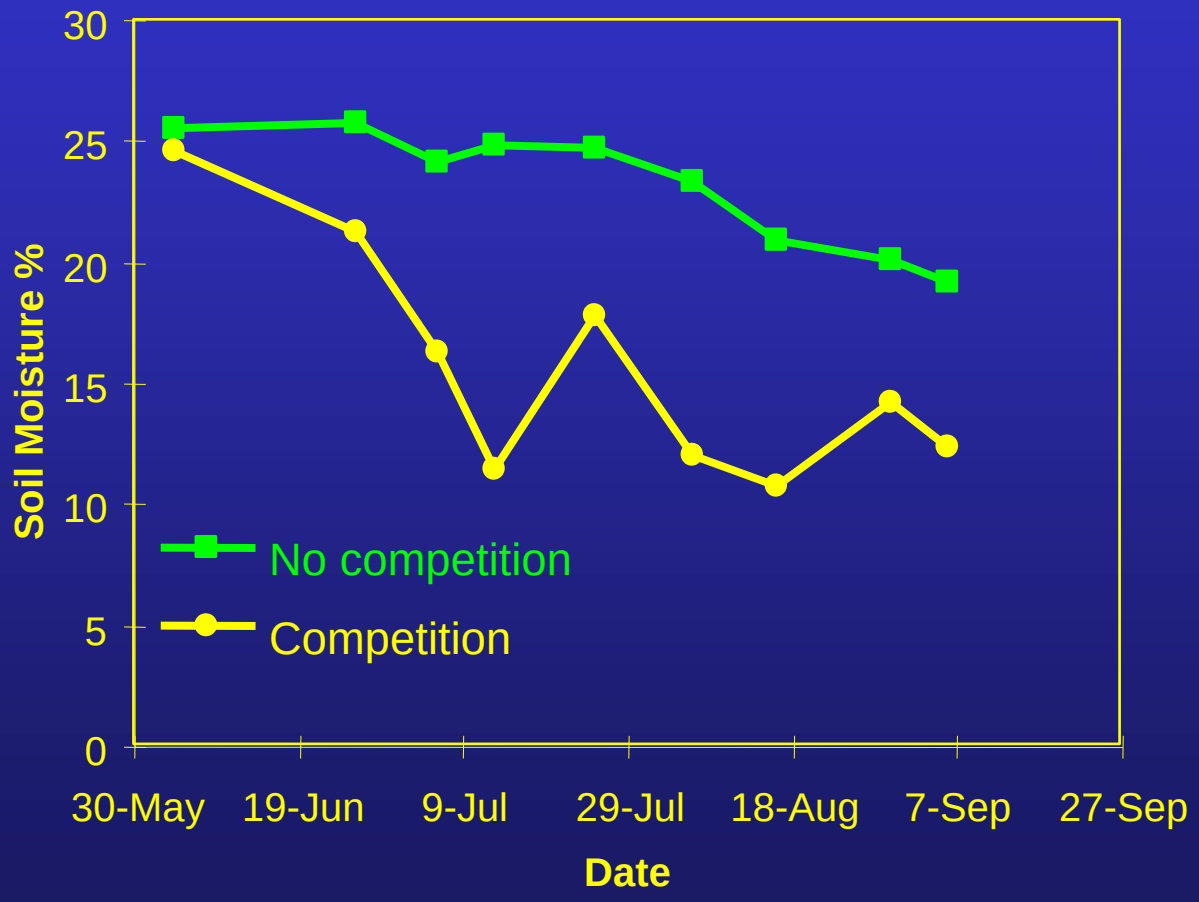
P_{net} per unit leaf area is important

But, overall canopy P_{net} drives productivity

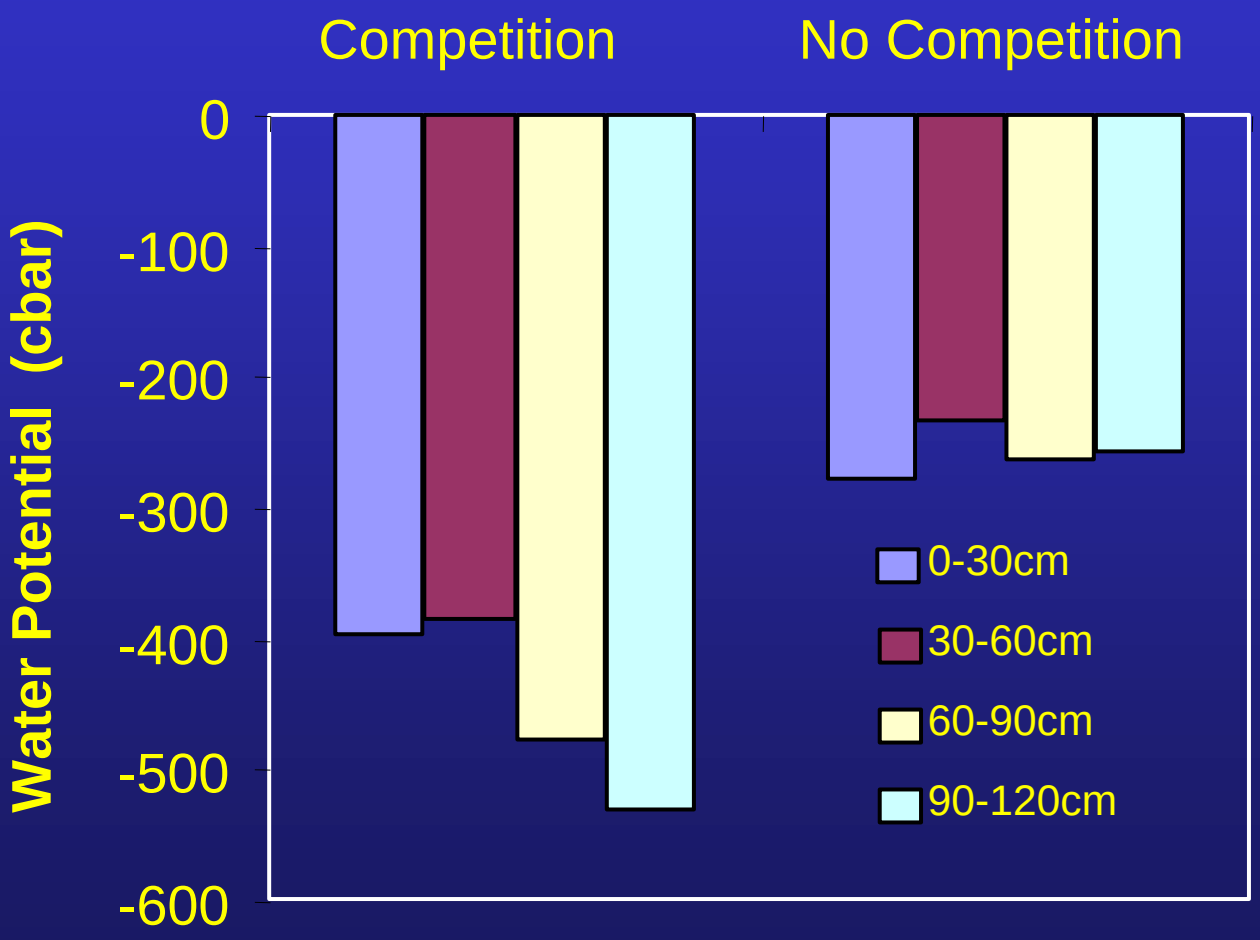
Competition for water

Leaf expansion is the first process inhibited by Water stress in plants

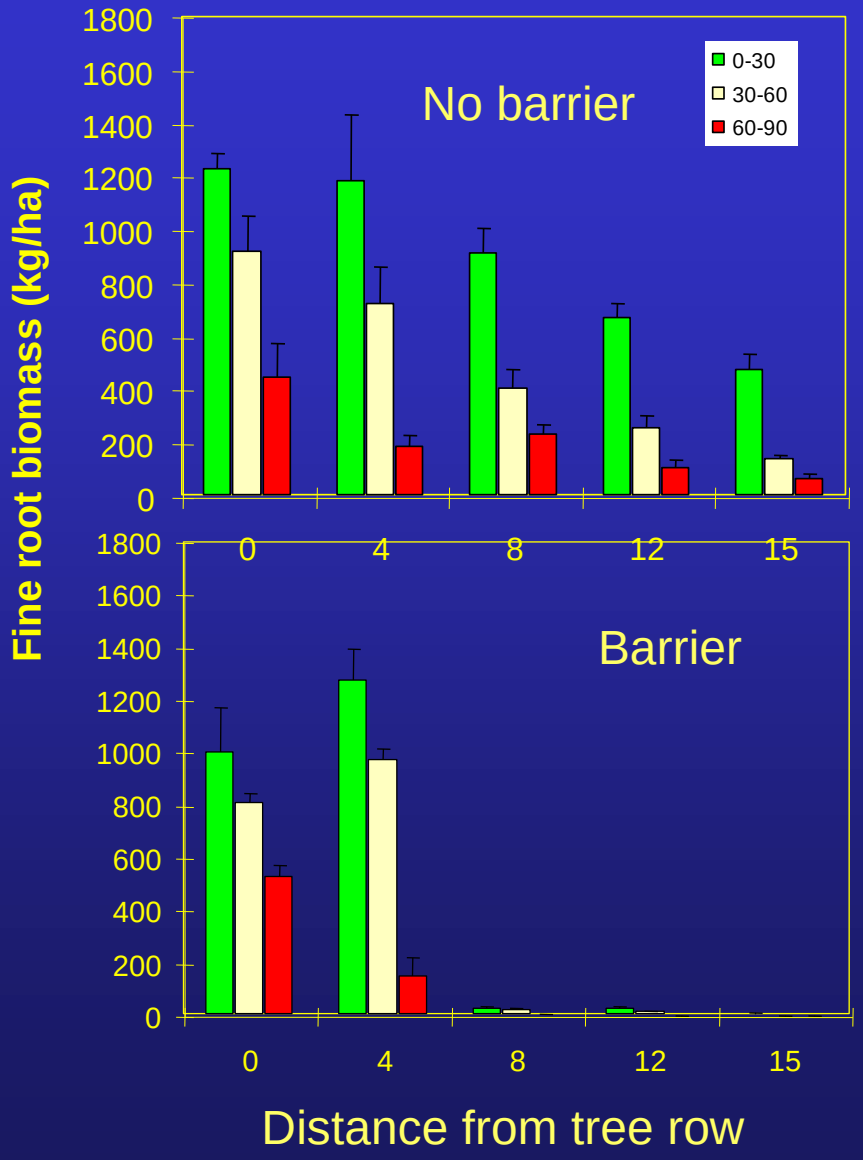
Alley soil water as influenced by tree competition (Black walnut-corn)



Alley soil water as influenced by tree competition (Pecan-cotton)

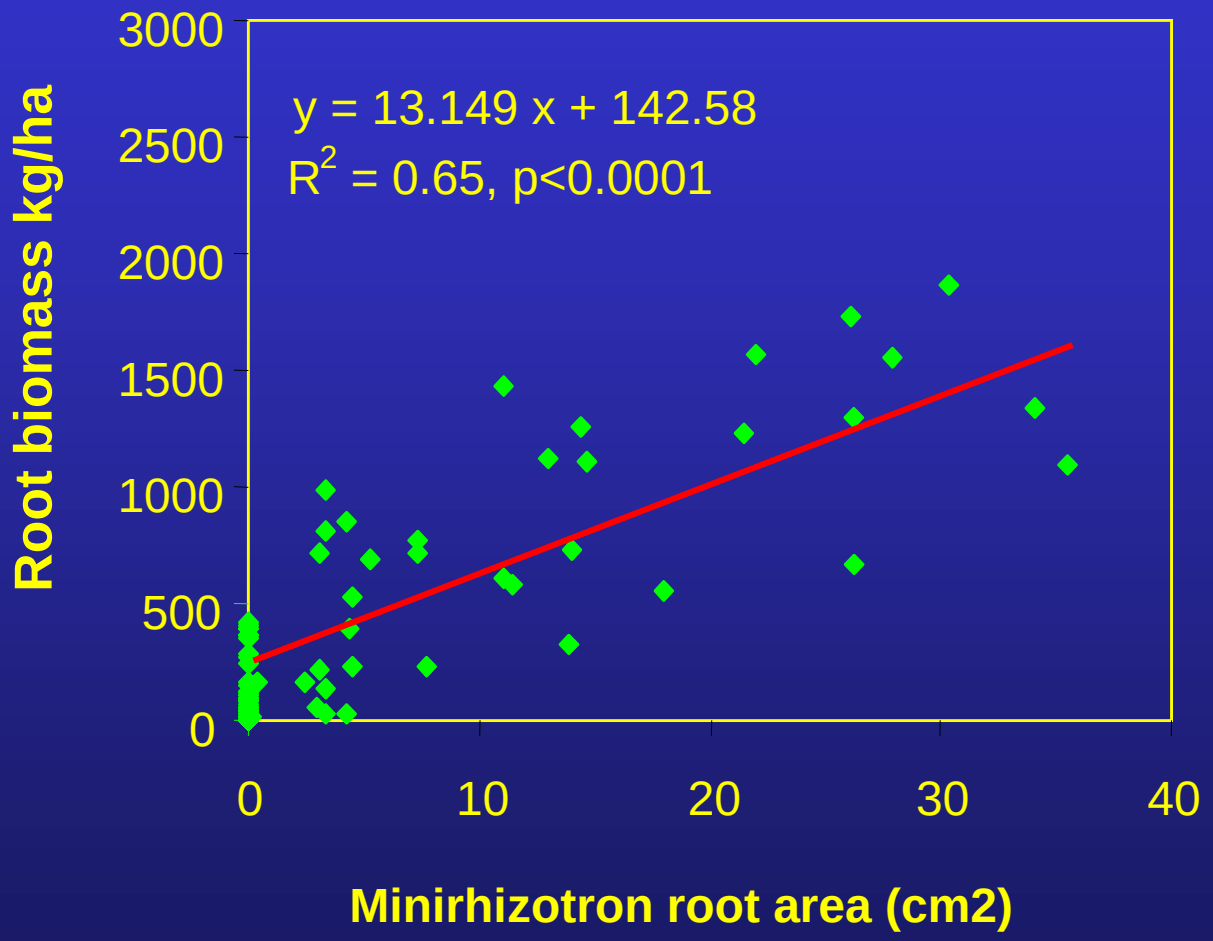


Rooting density is the key

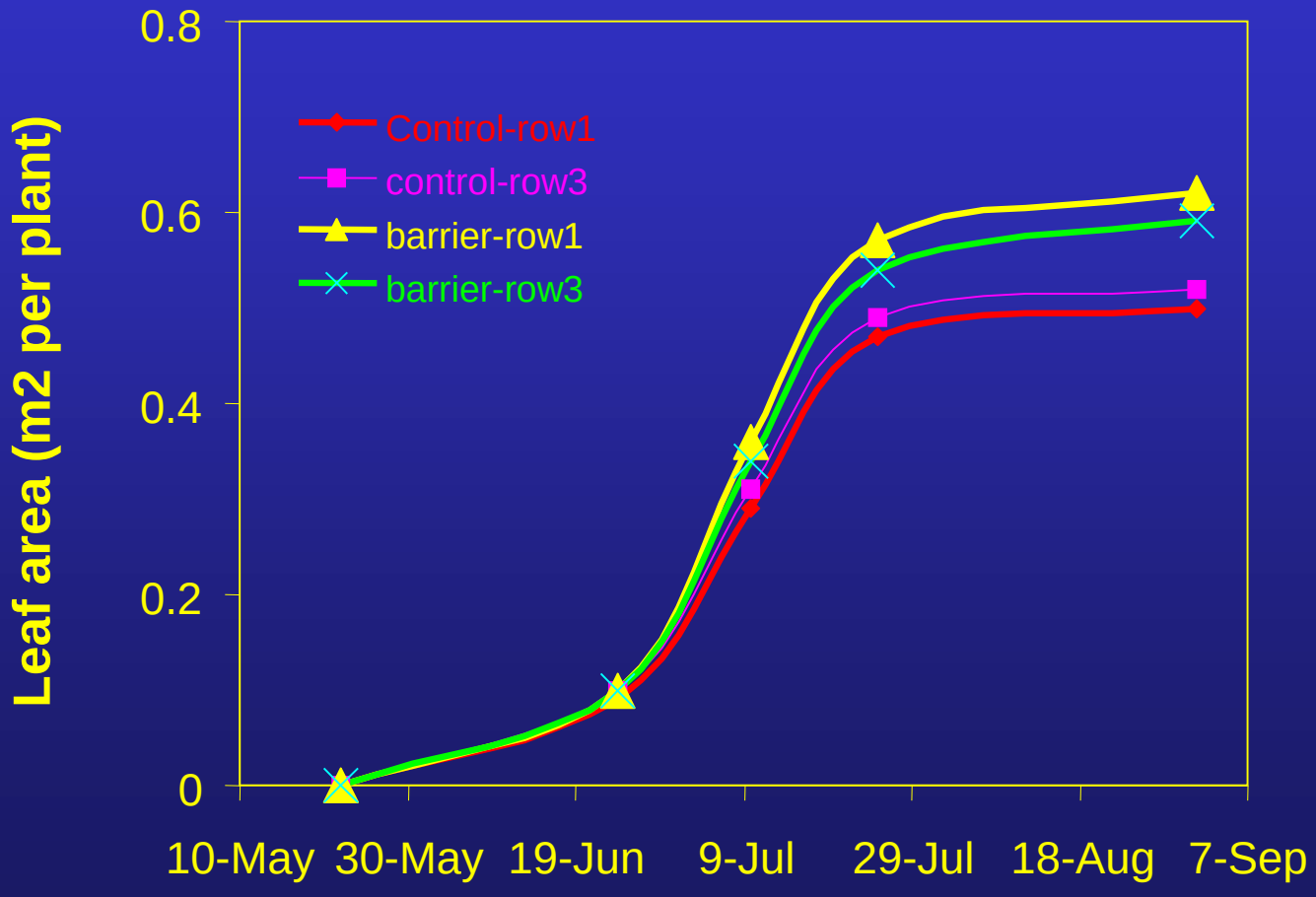


Minirhizotron: Root studeis made easier?

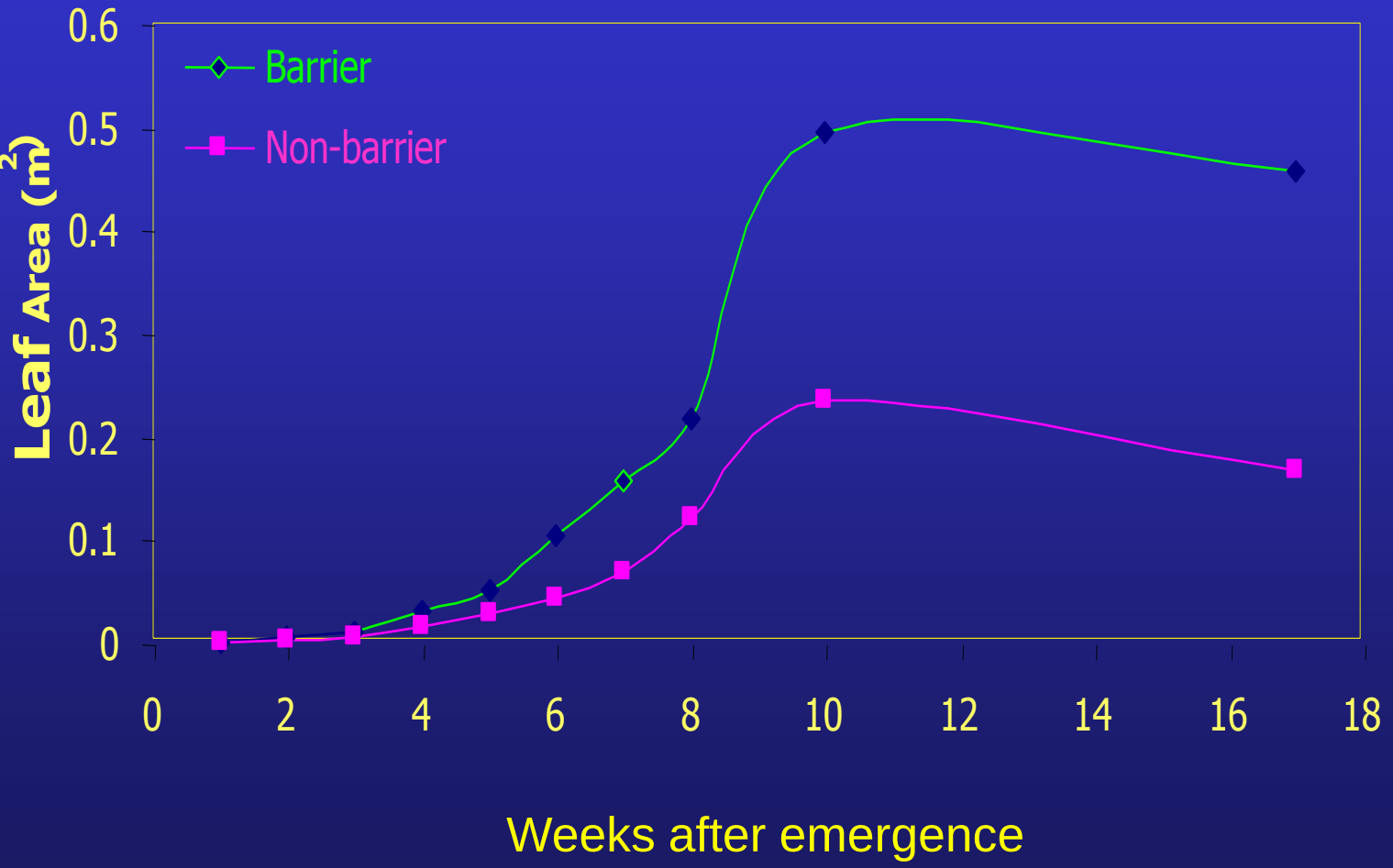
Root area vs. root biomass for Corn



Water stress and leaf area-Corn

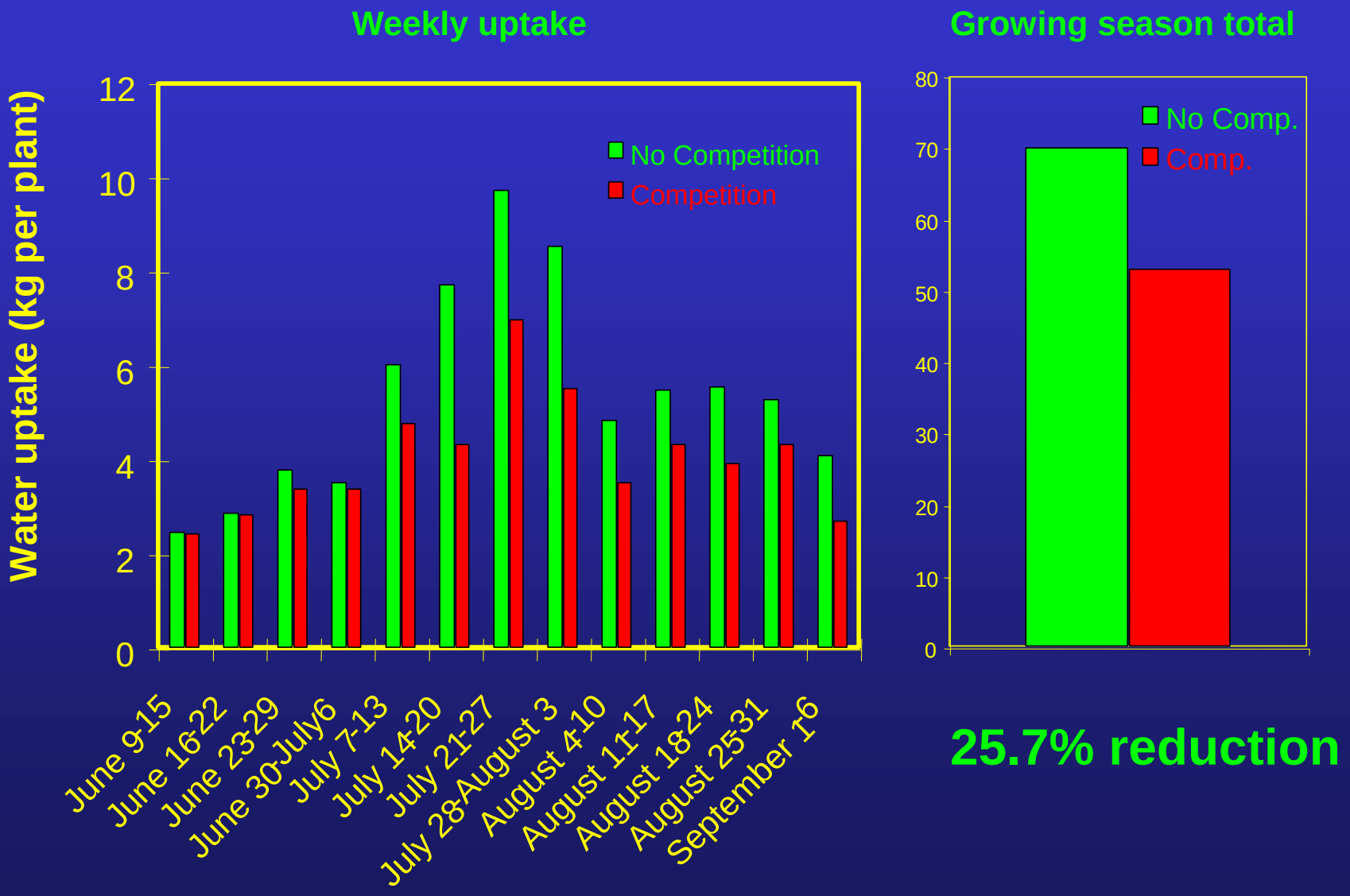


Water stress and leaf area-Cotton

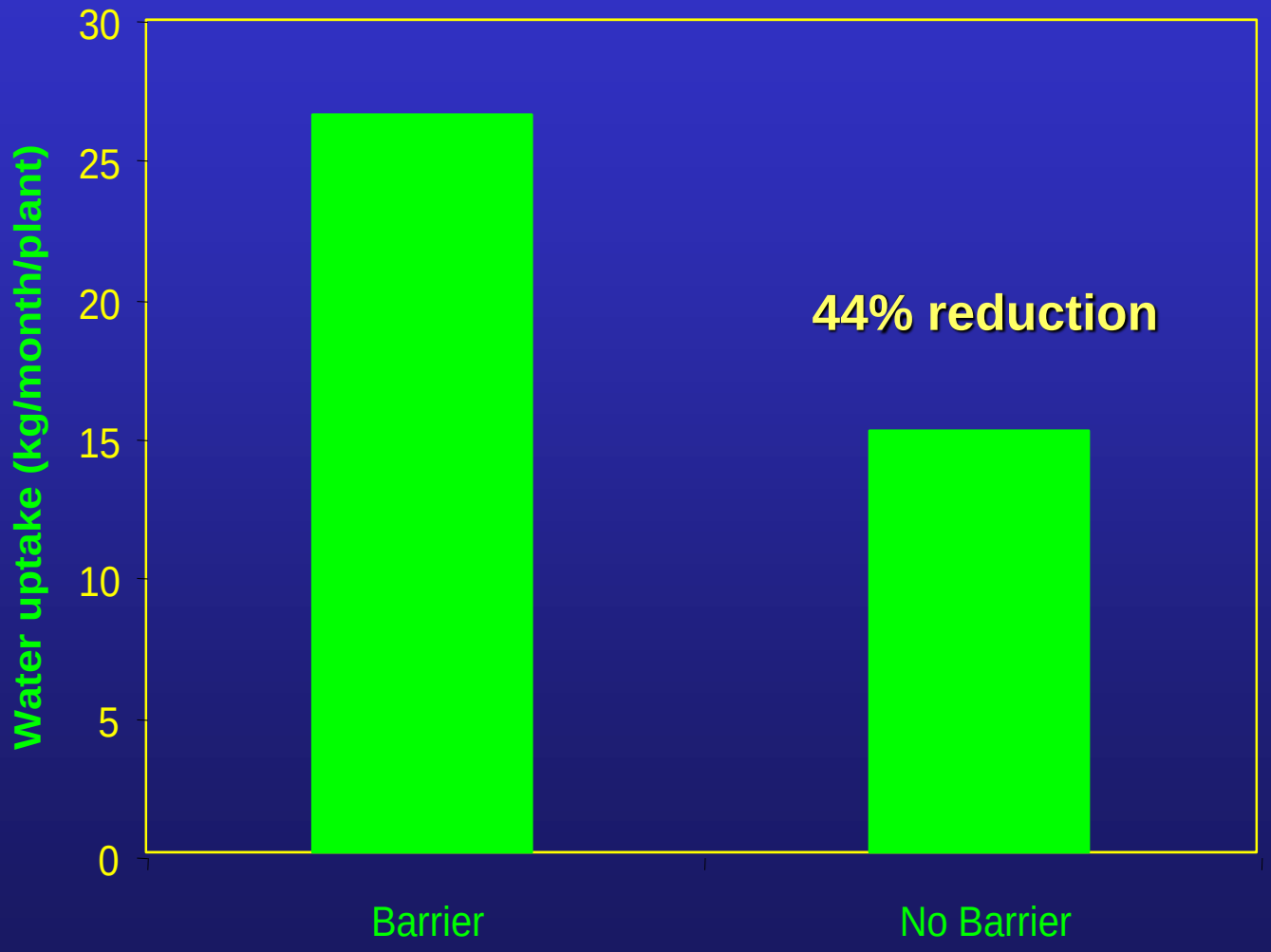


Water uptake

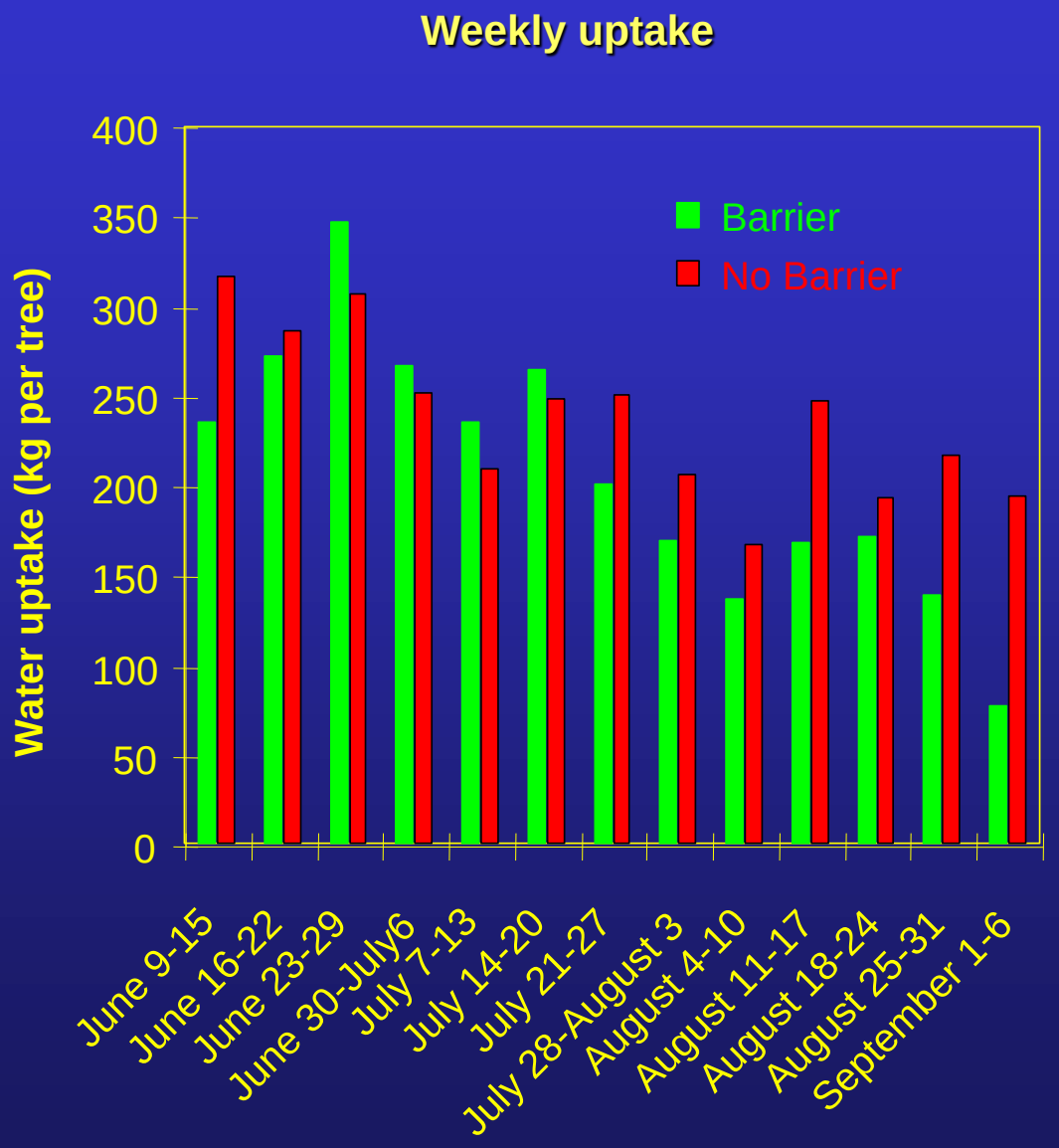
Corn water uptake

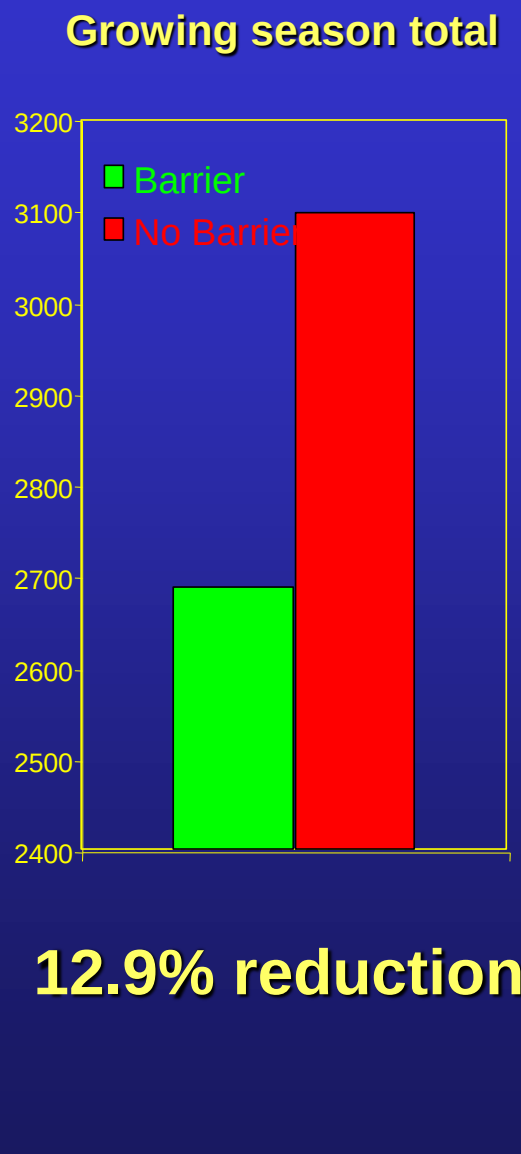


Cotton water uptake



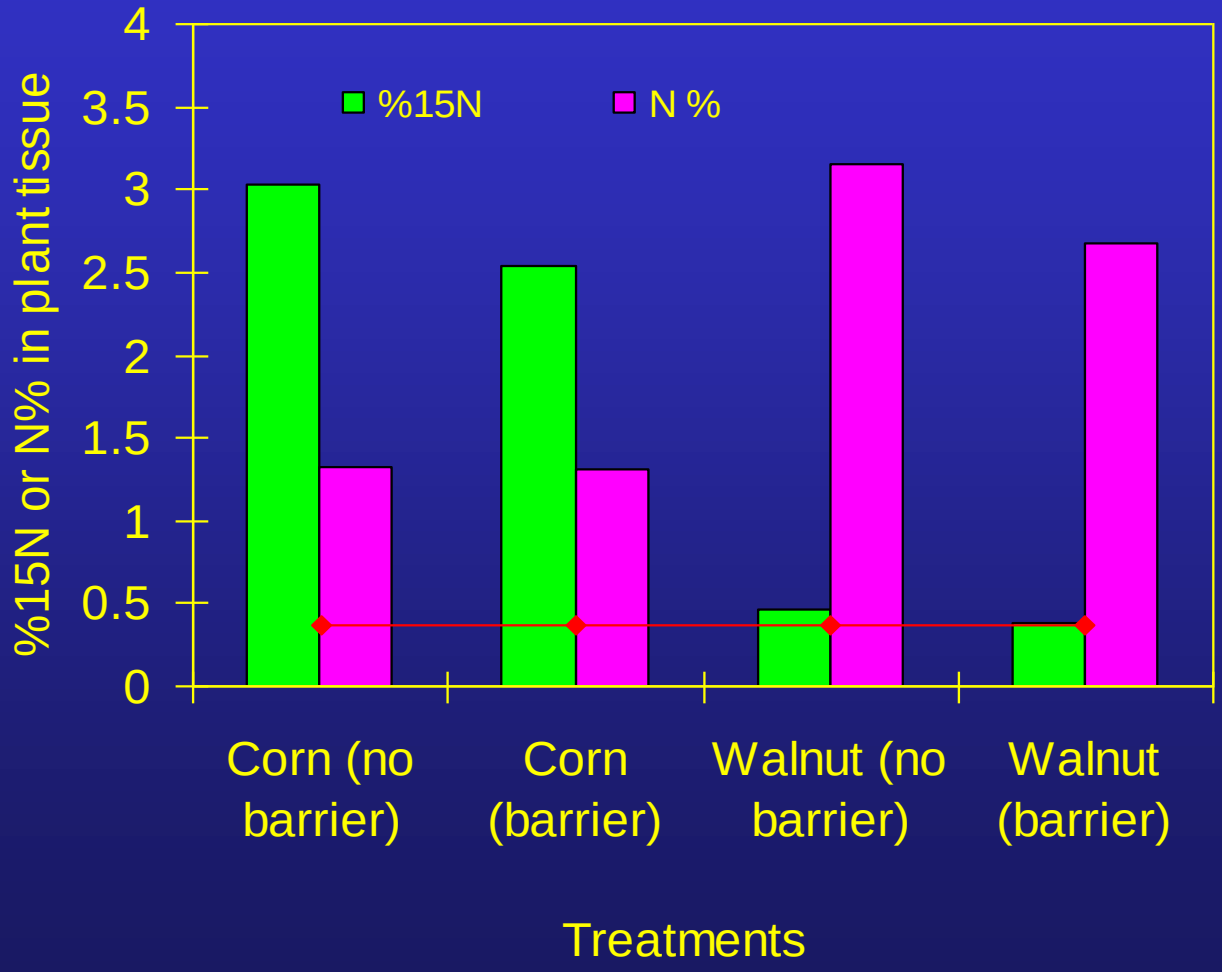
Black Walnut water uptake



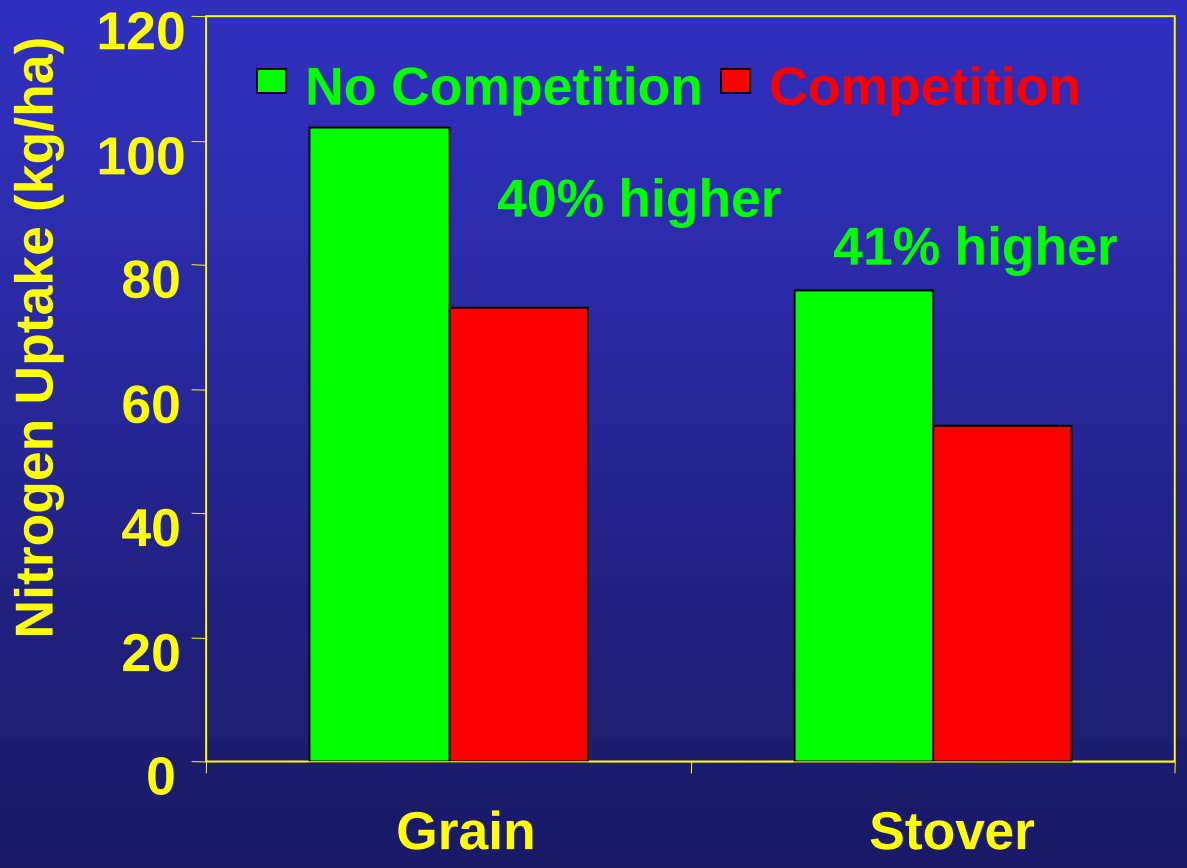


12.9% reduction

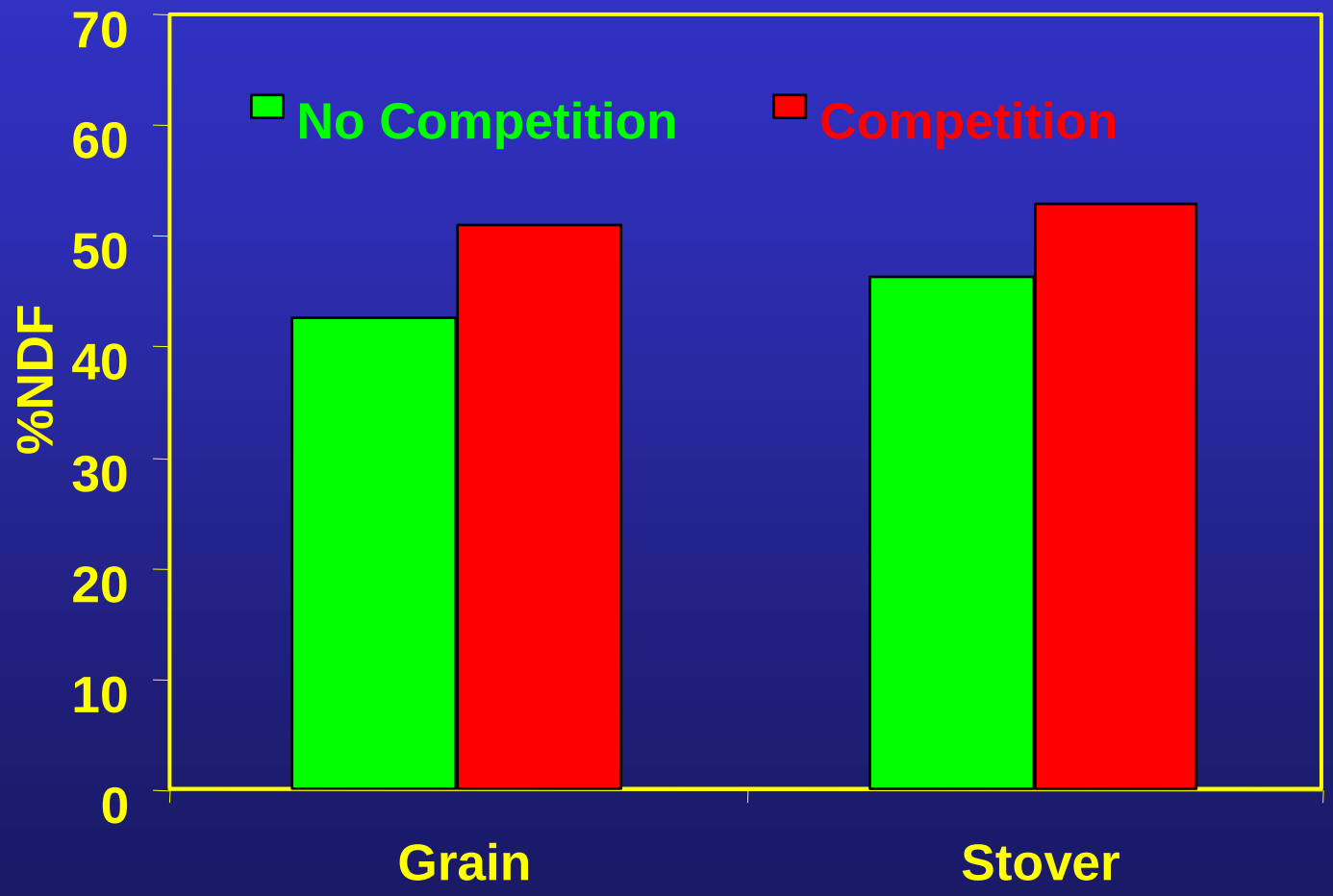
Competition for Nitrogen



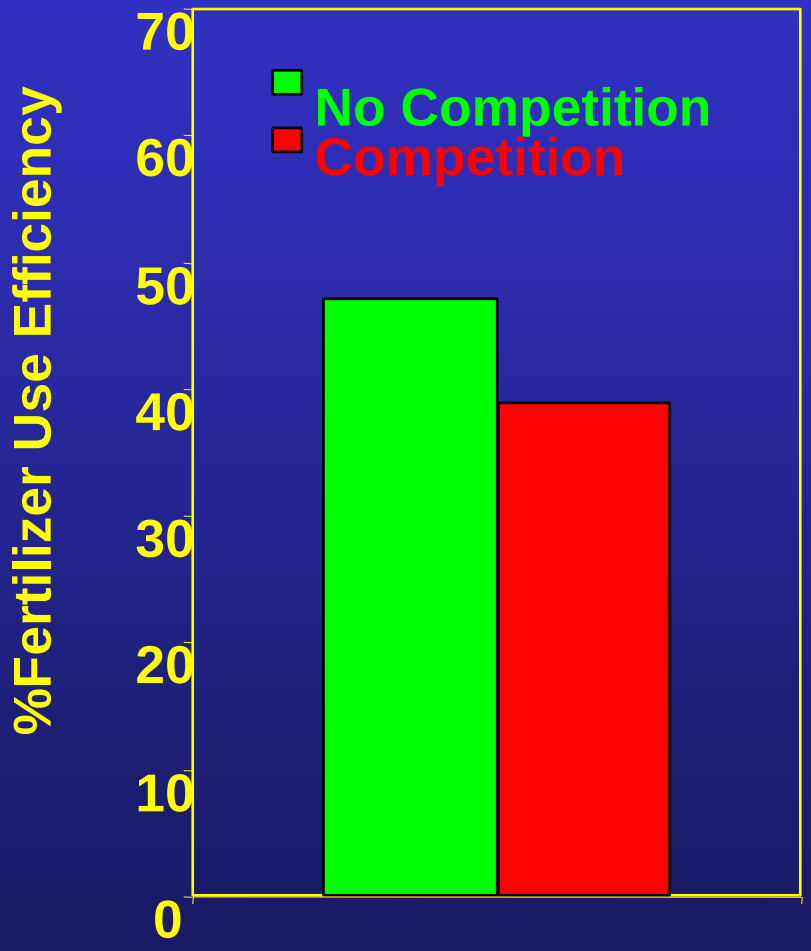
Total Nitrogen Uptake

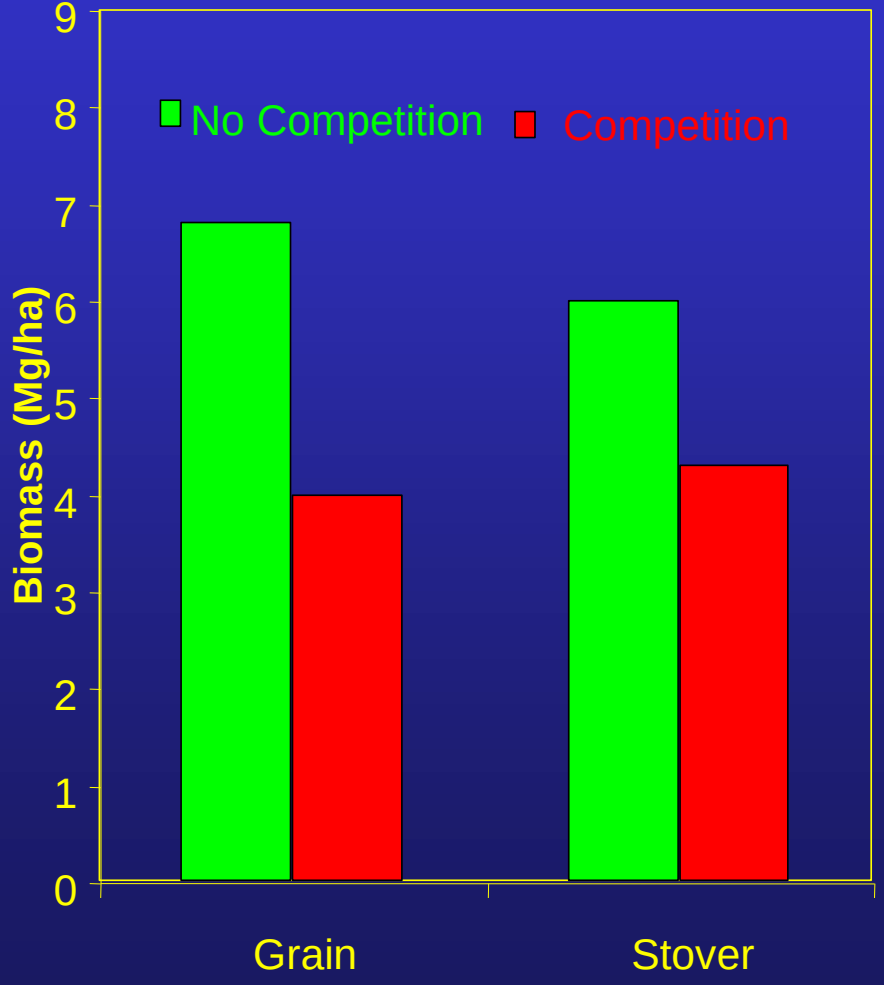


Nitrogen derived from Fertilizer

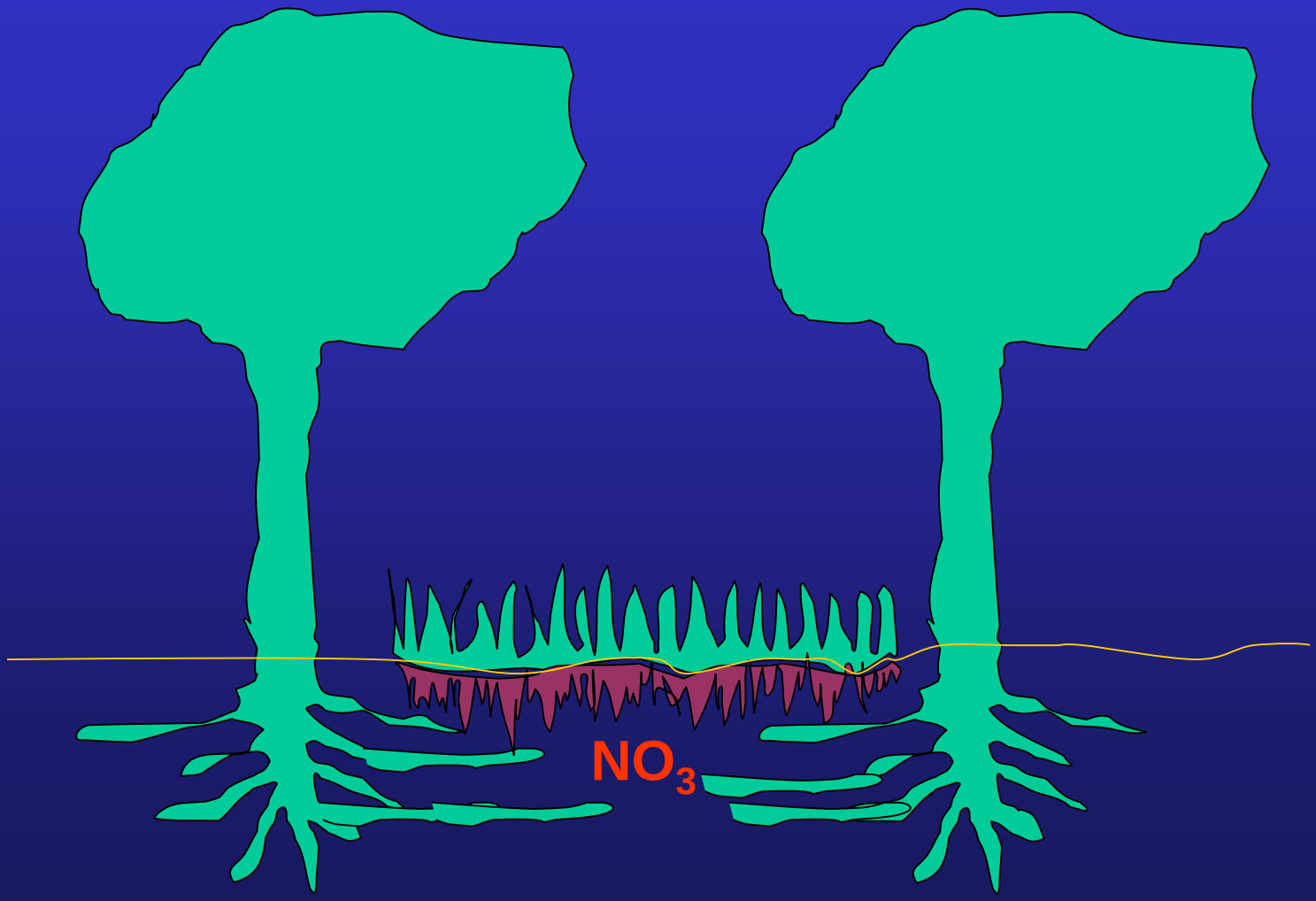


Fertilizer Use Efficiency



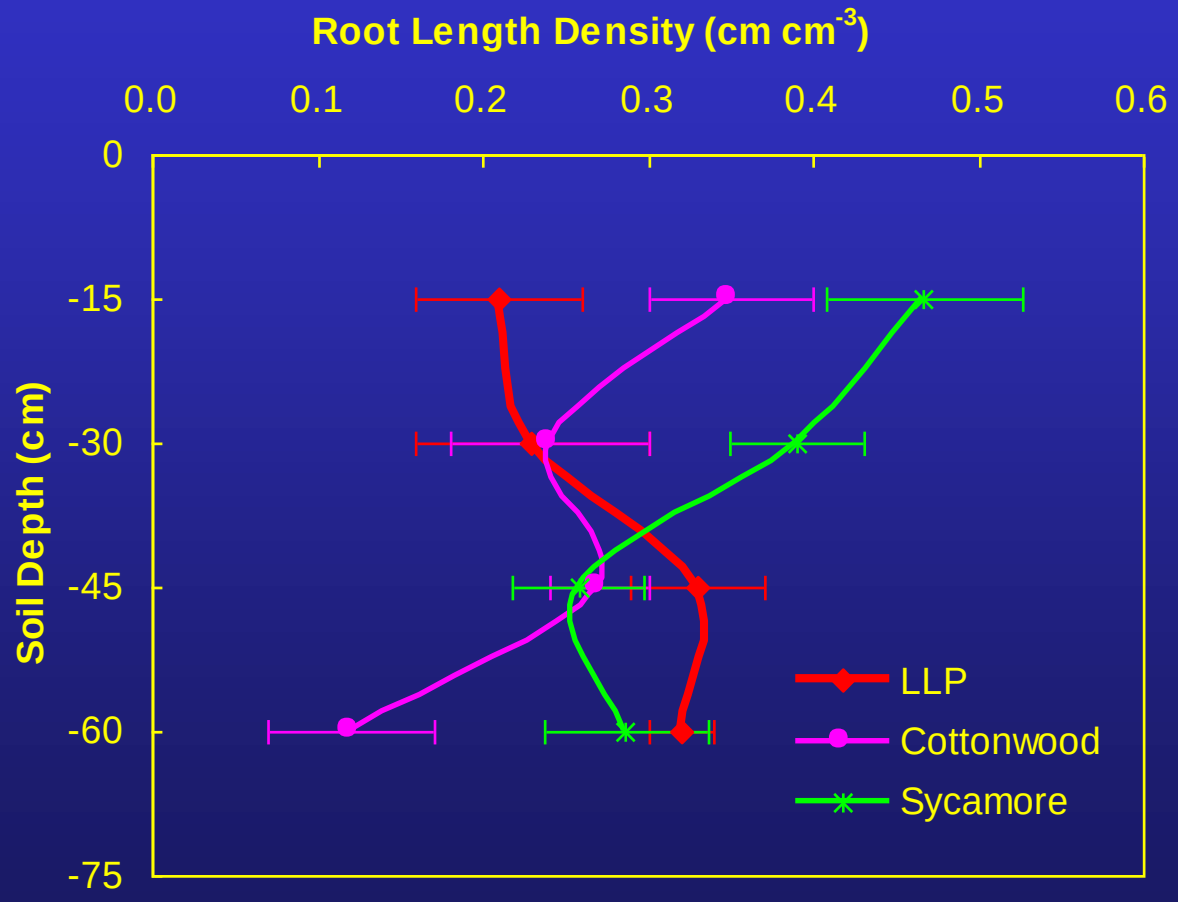


Safety net role of tree roots

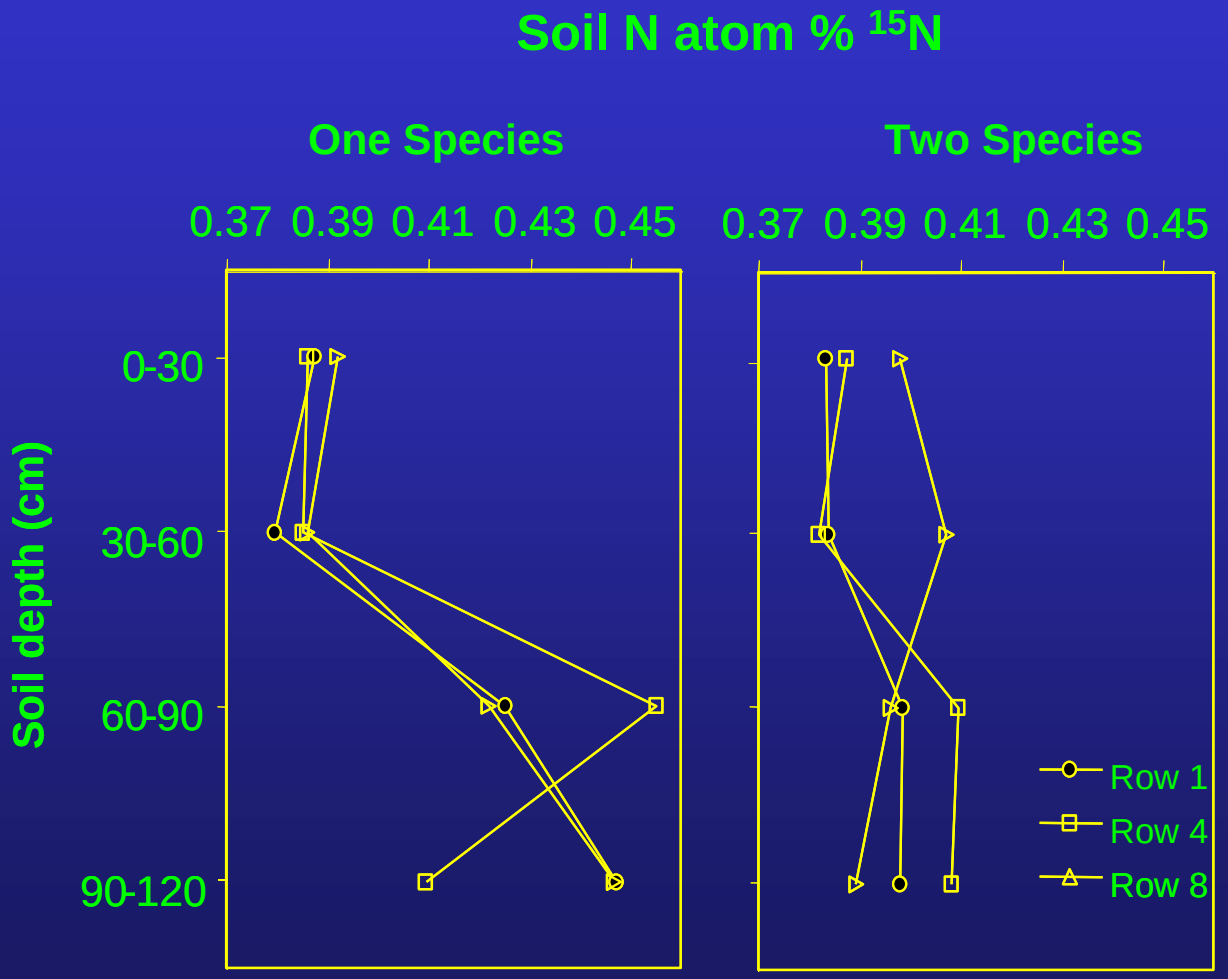


Safety net in nature?

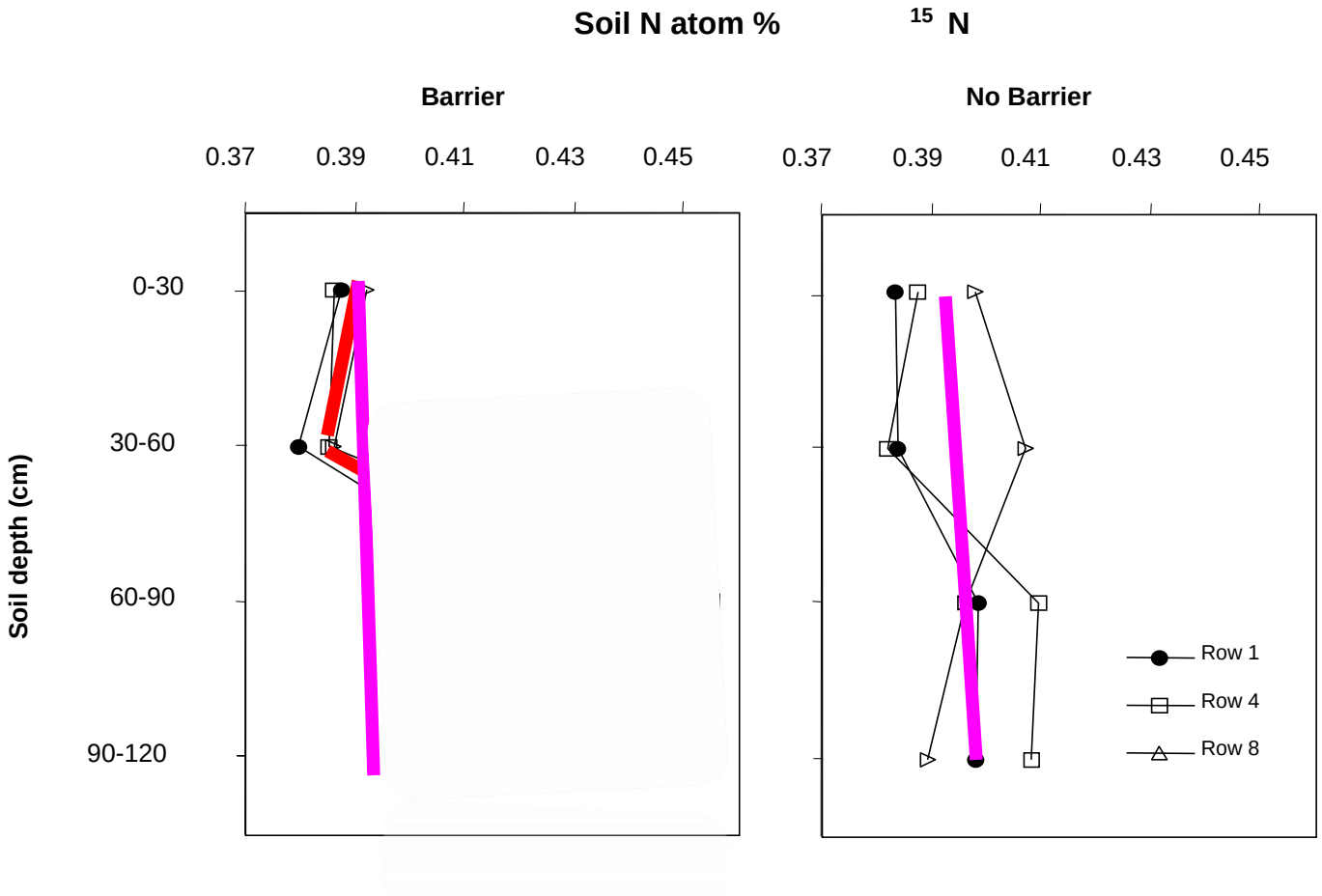
Belowground Niche separation in mixed species forests



Safety net role: Evidence?



^{15}N in the soil profile: Safety net



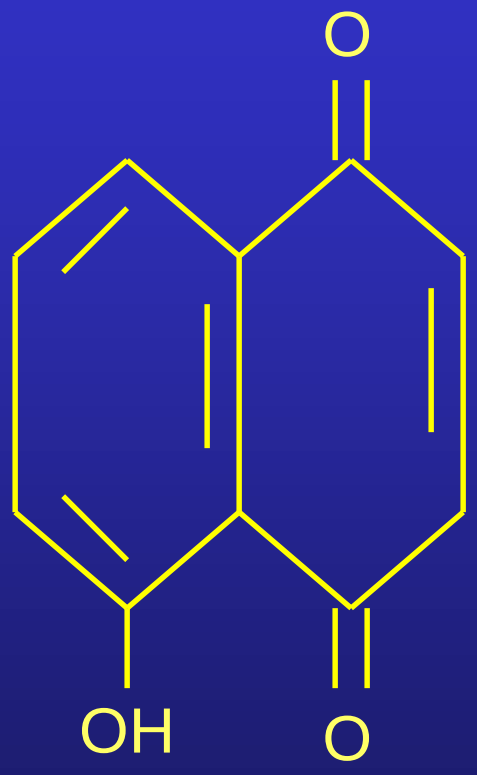
Net Retention Index

0 = No Retention

1= Total Retention

Observation Period	NO_3-N	
	0.3 m	0.9 m
2001 Growing Season (June-November)	0.64	0.55
2002 Growing Season (May-August)	0.45	0.97
Whole Study Period (June 2001-August 2002)	0.57	0.66

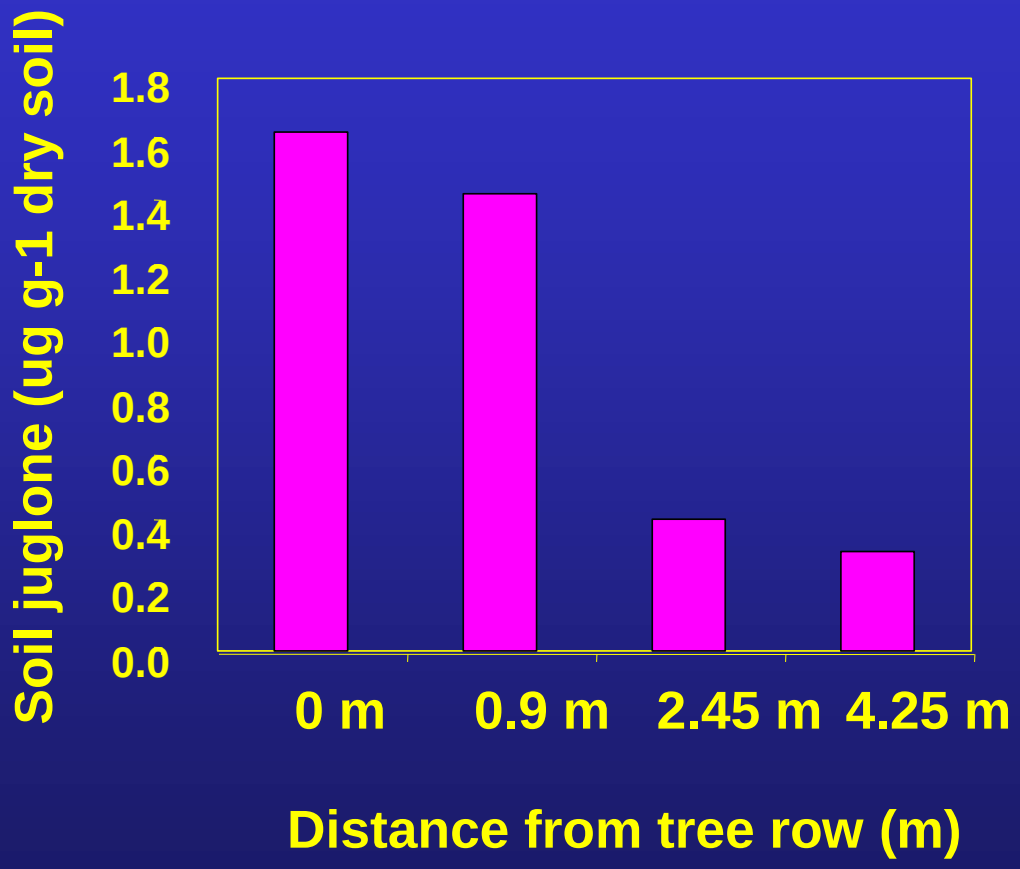
Phytotoxicity / Allelopathy



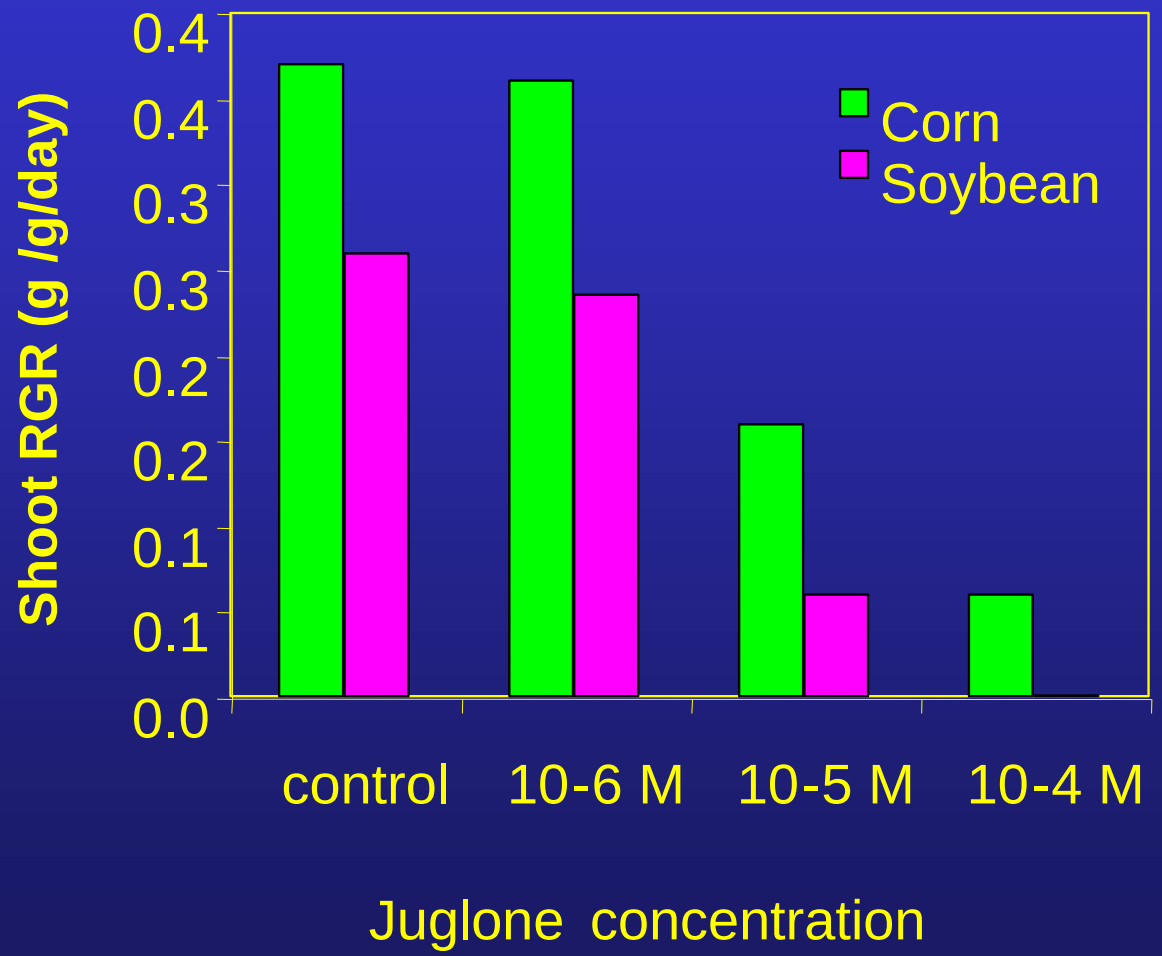
Juglone:

5-hydroxy-1,4-napthoquinone

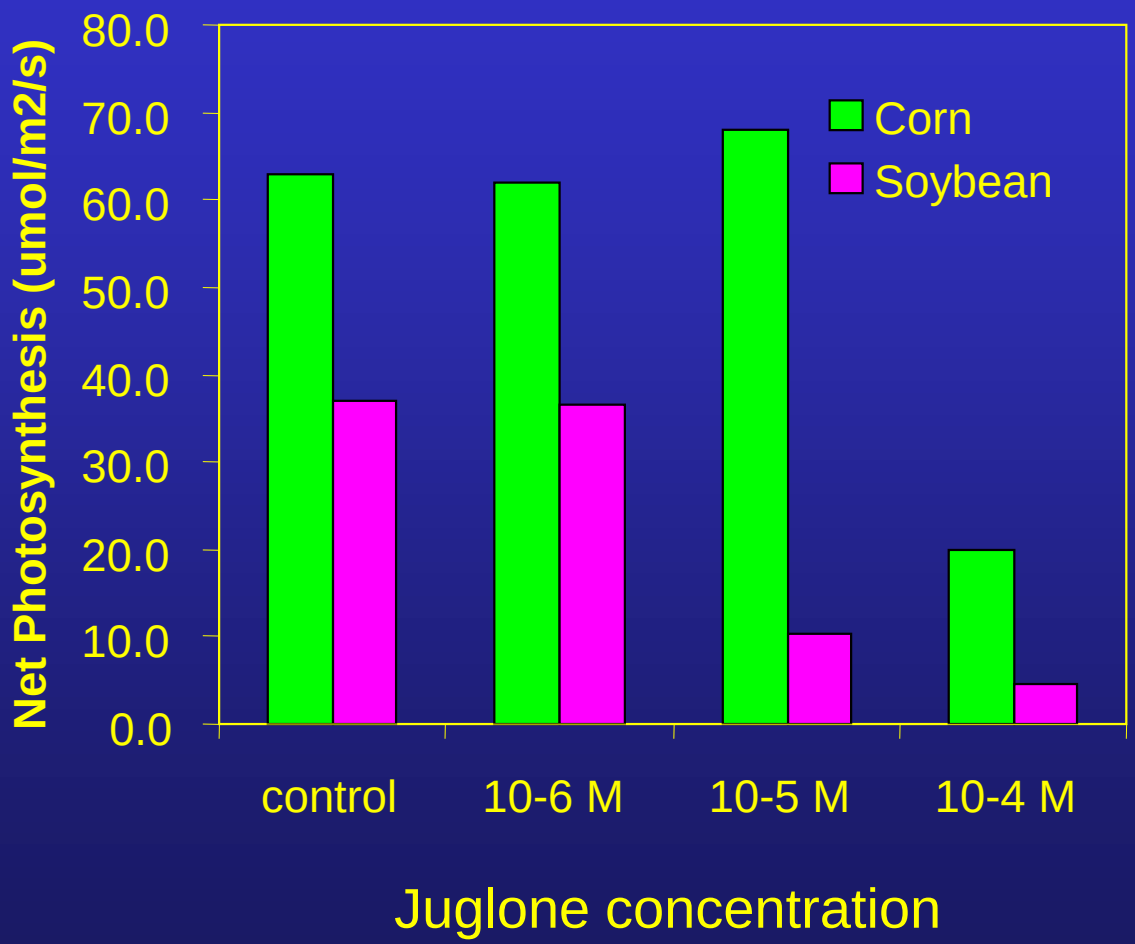
Soil Juglone: Spatial variation



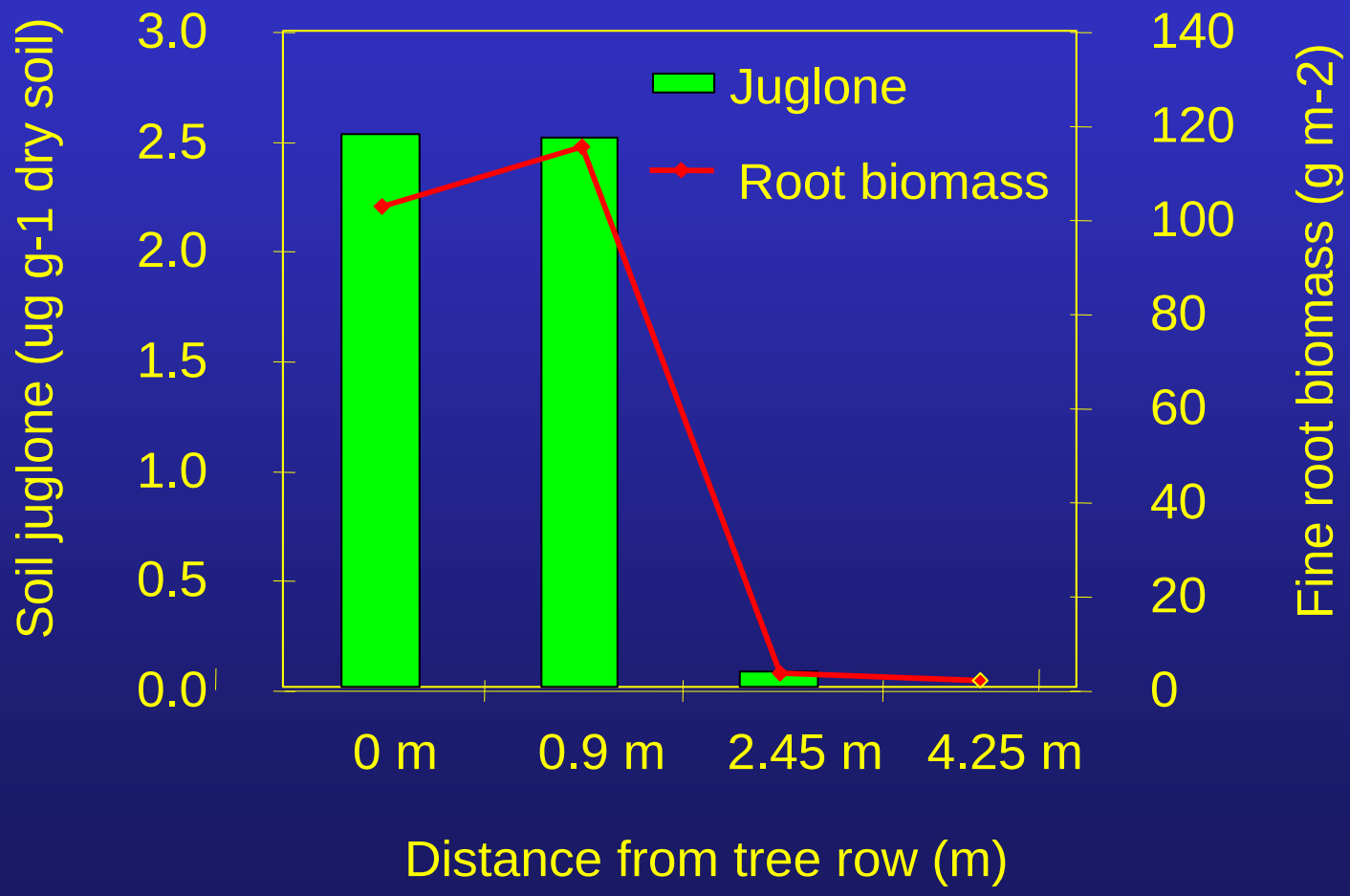
Juglone: Effects on crop growth



Juglone: Effects on crop physiology



Allelopathy: Management intervention



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