

## Environmental Factors Nutrients

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## Environmental and Cultural Factors Limiting Potential Yields

- Atmospheric Carbon Dioxide
- Temperature (Extremes)
- Solar Radiation
- Water
- Wind
- **Nutrients (N and K)**
- Others, ozone etc.,
- Growth Regulators (PIX)

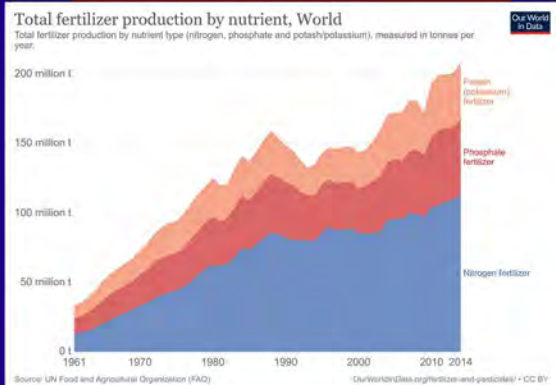
## Nutrients - Objectives

The objectives of this lecture are to:

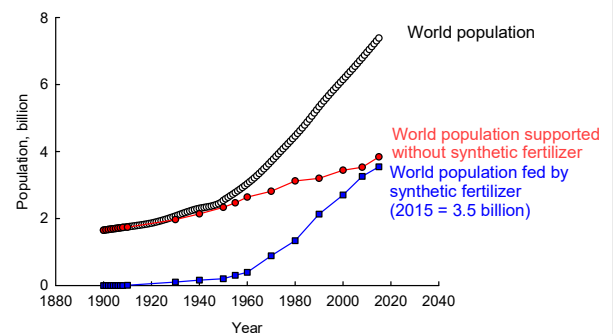
- Learn temporal trends in fertilizer usage (Major nutrients).
- Influence of major nutrients on plant growth and development.

## Major Nutrients Trends and some Statistics

### Trends in World Commercial Fertilizer Use



### How Many People does Nitrogen Fertilize Feed?



Erismann, J. W., Sutton, M. A., Galloway, J., Klimont, Z., & Winiwarter, W. (2008). How a century of ammonia synthesis changed the world. *Nature Geoscience*, 1, 636-639.

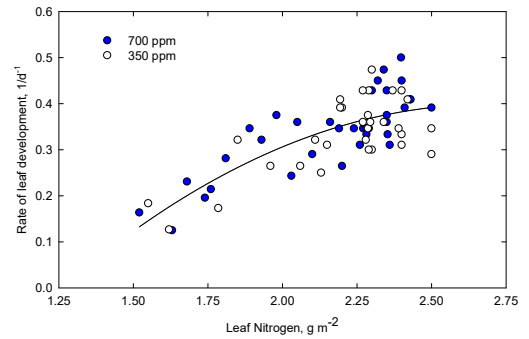


## Question:

- Do processes within a crop vary in their response to nutrients?

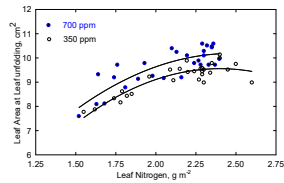
## Nitrogen and Cotton Growth and Development

### Leaf developmental response to N and elevated CO<sub>2</sub>

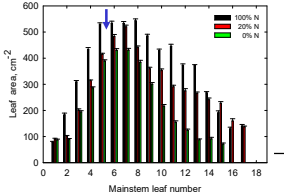


## Nitrogen and Crop Growth and Development

### Leaf growth response to N and elevated CO<sub>2</sub>



Cotton leaf area at leaf unfolding



Caster mature leaf sizes

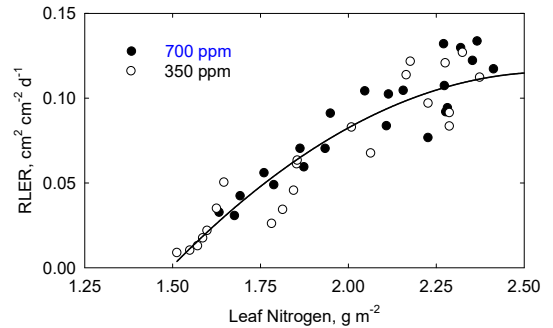
✓ N treatments were imposed when leaf 5 was just unfolding



## Nitrogen and Crop Growth and Development

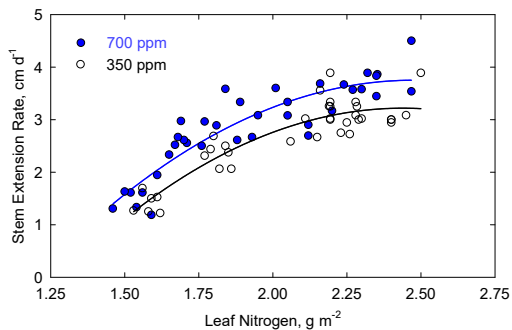
### Cotton leaf growth response to N and elevated CO<sub>2</sub>

RLER = Relative Leaf Expansion Rate



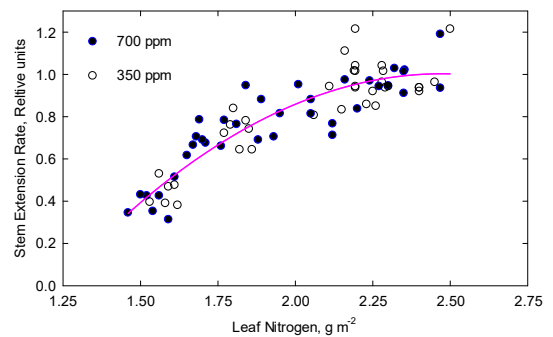
## Nitrogen and Cotton Growth and Development

### Stem elongation response to N and elevated CO<sub>2</sub>



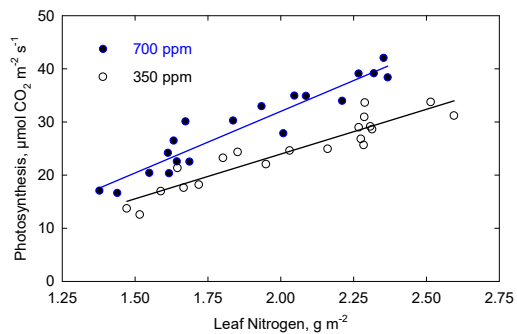
## Nitrogen and Cotton Growth and Development

### Stem Elongation Rate Response to N and elevated CO<sub>2</sub>



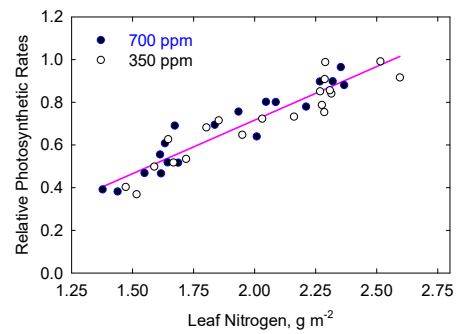
## Nitrogen and Cotton Growth and Development

Leaf photosynthetic response to N and elevated CO<sub>2</sub>



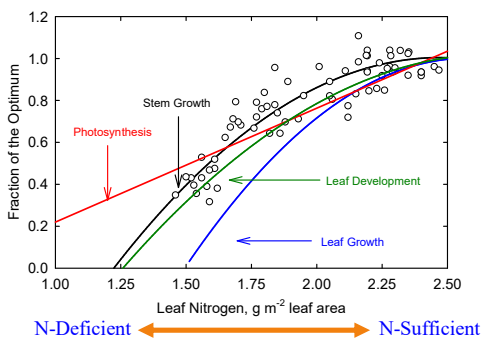
## Nitrogen and Cotton Growth and Development

Relative Rates of Photosynthesis



Can we use one function for all processes in a given crop?

Functional relationships – cotton for growth and developmental processes

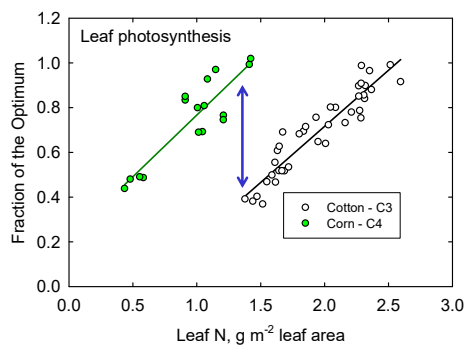


## Questions:

- Do species vary in their response to nutrients?
- How about functional groups such as C<sub>3</sub> versus C<sub>4</sub>?
- Is there a difference between the functional groups in their response to nutrients?

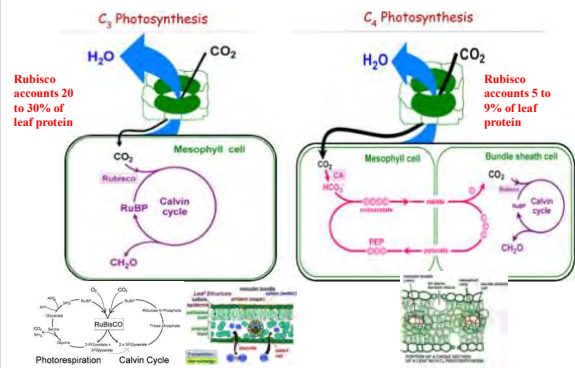
Can we apply cotton algorithms for other crops?

N and Photosynthesis – Functional Groups



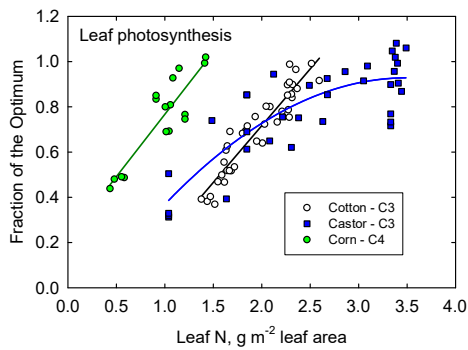
Can we apply cotton algorithms for other crops?

Why do they differ in their response to N



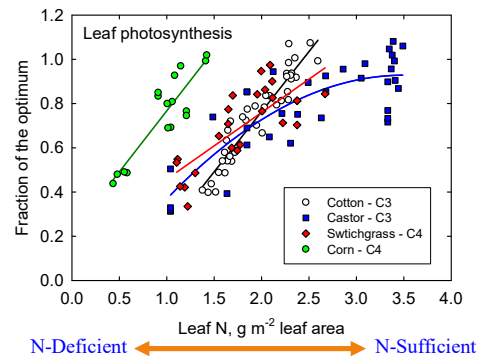
### Can we apply cotton algorithms for other crops?

#### N and Photosynthesis – Several Crops

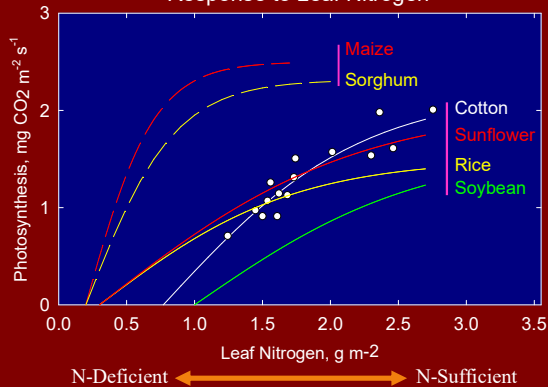


### Can we apply cotton algorithms for other crops?

#### N and Photosynthesis – Several Crops

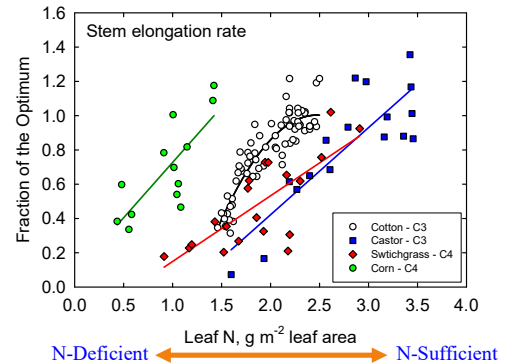


### Photosynthesis - Variability Among Species Response to Leaf Nitrogen



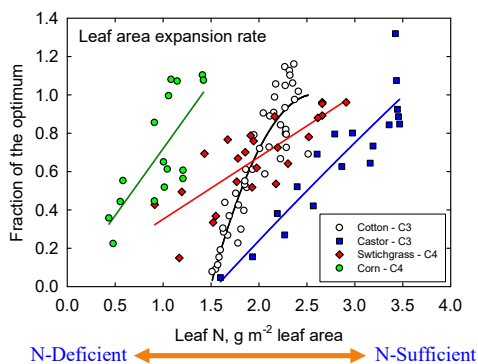
### Can we apply cotton algorithms for other crops?

#### N and several crops – Stem elongation rates



### Can we apply cotton algorithms for other crops?

#### N and several crops – Leaf area expansion rates

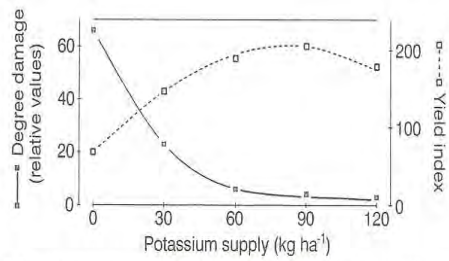


### Summary and Conclusions

#### Nitrogen Responses across Species and Processes

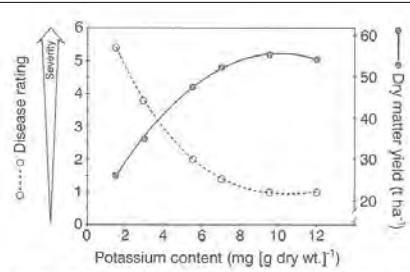
- Functional algorithms varied among crop species and even among crop species within a functional physiological group such as C<sub>3</sub> or C<sub>4</sub> species.
- Functional algorithms varied among crop processes for a given species.
- Among the growth, developmental and physiological processes, leaf growth was more responsive to leaf N than other processes in almost all crops.
- N also affects cell division and cell elongation process leading to a cascade of effects on several processes in plants, and finally yield.

### Potassium Supply and Plant Growth



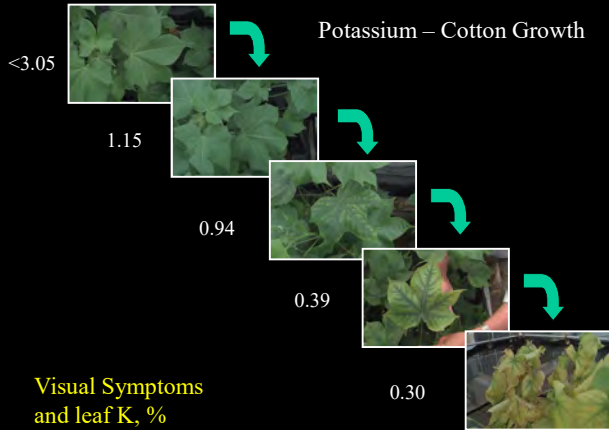
7 Effect of potassium supply on grain yield of wetland rice and incidence of stem rot (*thosporium sigmoideum*). Basal dressing of nitrogen and phosphorus constant at 120 and 60 kg ha<sup>-1</sup>, respectively. (Based on Ismunadj, 1976.)

### Potassium Supply and Plant Growth

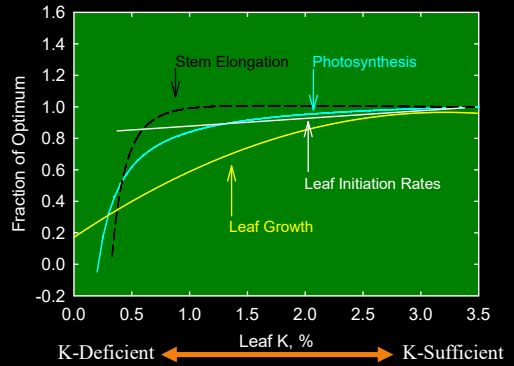


8 Severity of leaf spot disease (*Helminthosporium cynadonis*) and dry matter yield in bermudagrass (*Cynodon dactylon* L. Pers.) versus leaf potassium content. (Reproduced in Matocha and Smith, 1980, by permission of the American Society of Agronomy.)

### Potassium – Cotton Growth

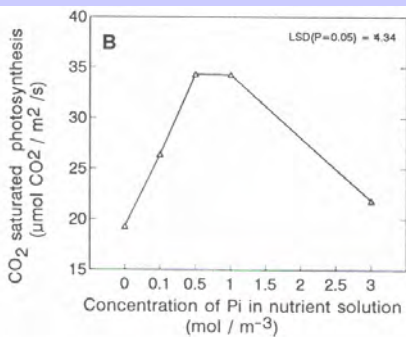


### Potassium and Cotton Growth and Development

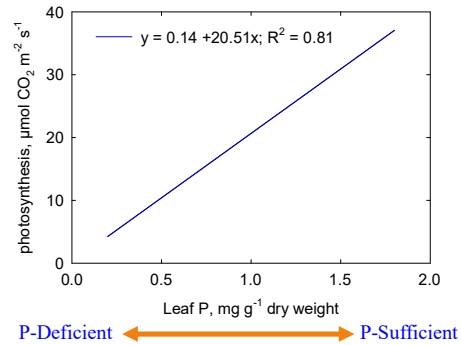


### Photosynthesis and Environment

Response to phosphorus – Sub-to supra-optimal supply of Pi



### Photosynthesis and Management Response to Phosphorus Nutrition - Cotton



Singh et al. 2013

## Summary and Conclusions

### Nutrient Responses across Species and Processes

- Functional algorithms or responses varied among crop species.
- Functional algorithms varied among crop processes for a given species.
- Similar to N effects, among the growth, developmental and physiological processes, leaf growth was more responsive to leaf K.
- The effects of P on various processes are less quantified to arrive a conclusion.