University of California

Nitrogen Management Training

for Certified Crop Advisers

MODULE 7 ~ PART 2

Nitrogen management in annual crops

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Agriculture and Natural Resources

Goals of this module

- Part 1:
  - Provide considerations for optimizing N management in annual rotations
  - Understand how to evaluate crop N needs
- Part 2:
  - Understand in-season tools that can be used to improve NUE in annual systems

The Goal: Improve Nitrogen Use Efficiency (NUE)

- Be realistic in estimating crop N requirements
- Time your applications according to crop demand
  - Apply to meet crop N uptake
  - Use in season testing when applicable
- Account for all N sources
  - residual soil NO_3-N
  - Irrigation water NO_3-N
- Reduce loss by controlling irrigation efficiently

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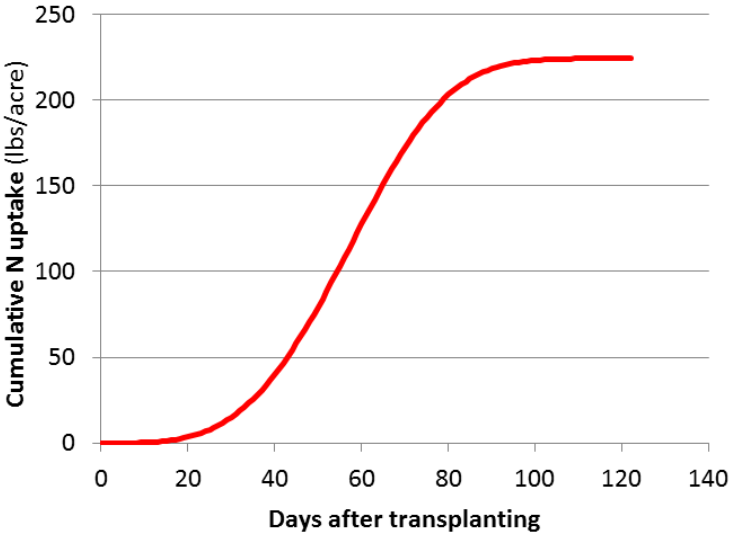
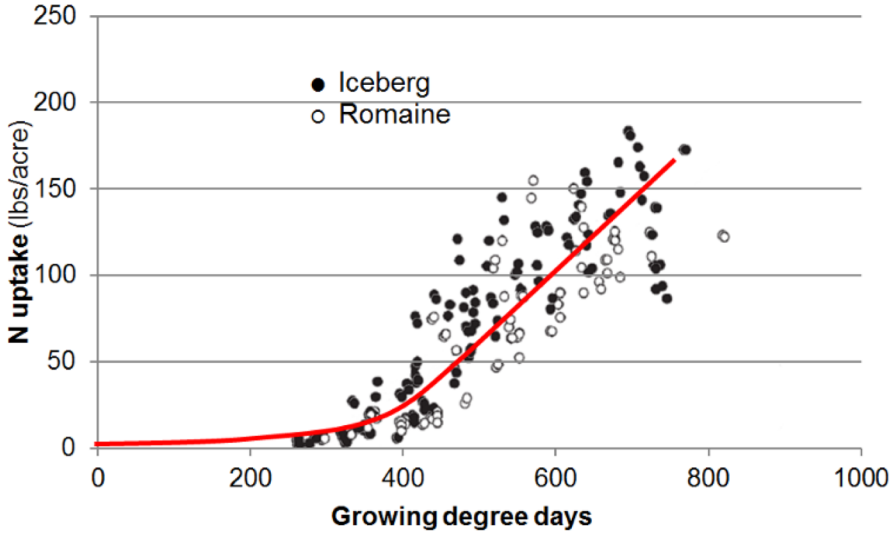
N uptake starts slowly in annual crops and leading to a steep increase during peak vegetative growth

Processing tomatoes



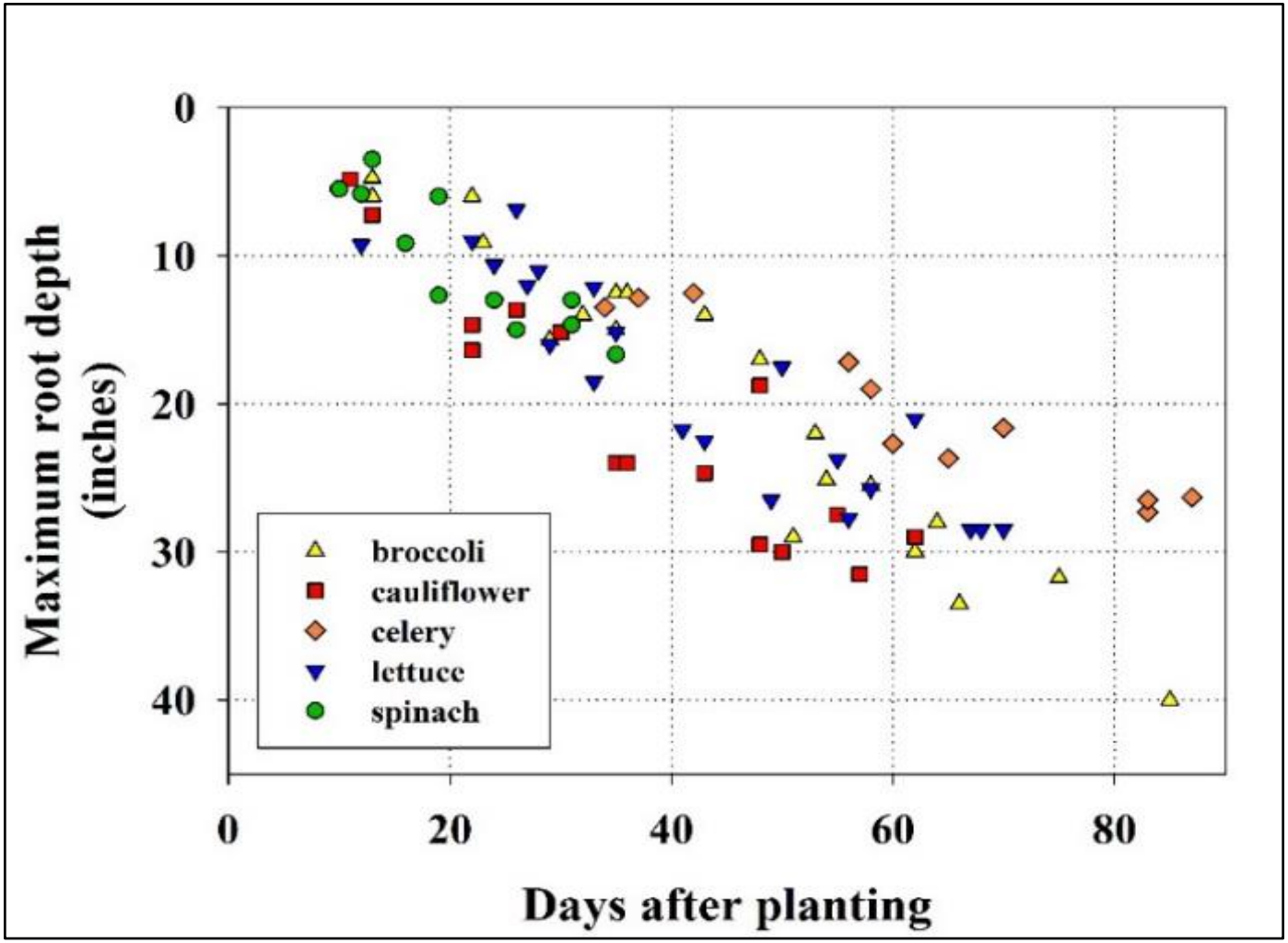
Lettuce



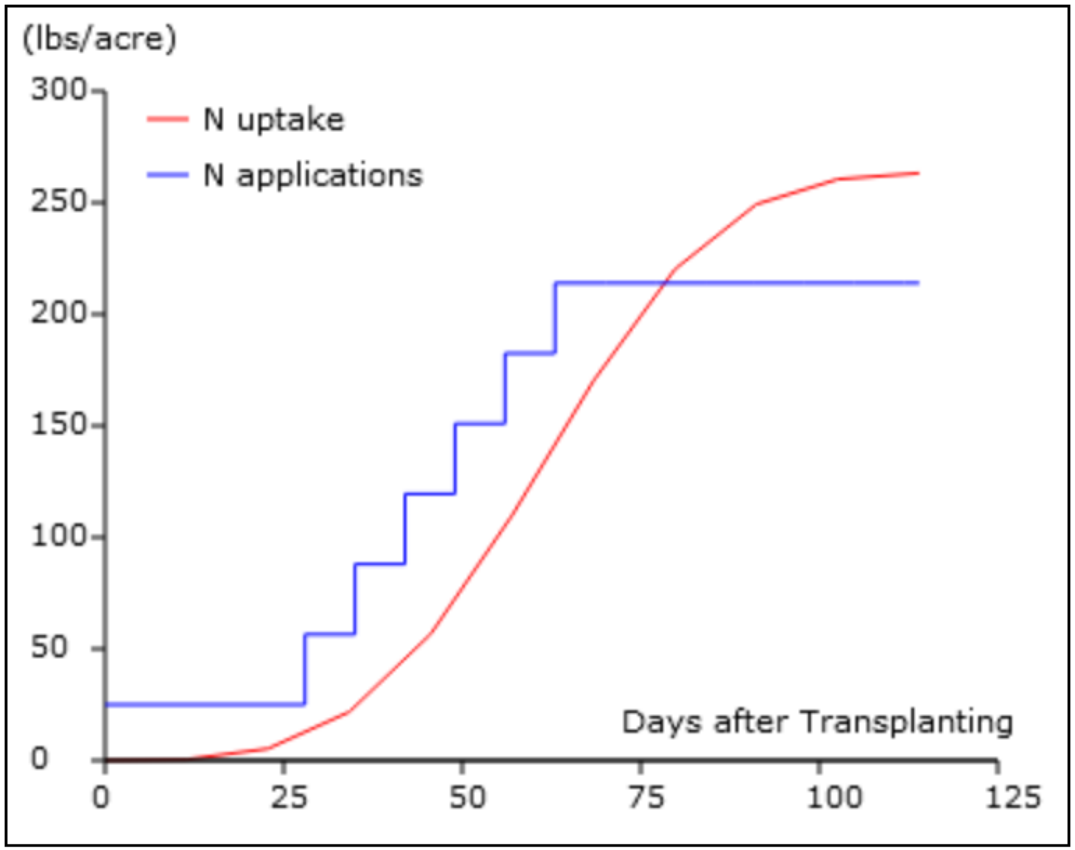
Geisseler et al., under review; Bottoms et al., 2012

Apply N 'just in time' to avoid N loss below the root zone:

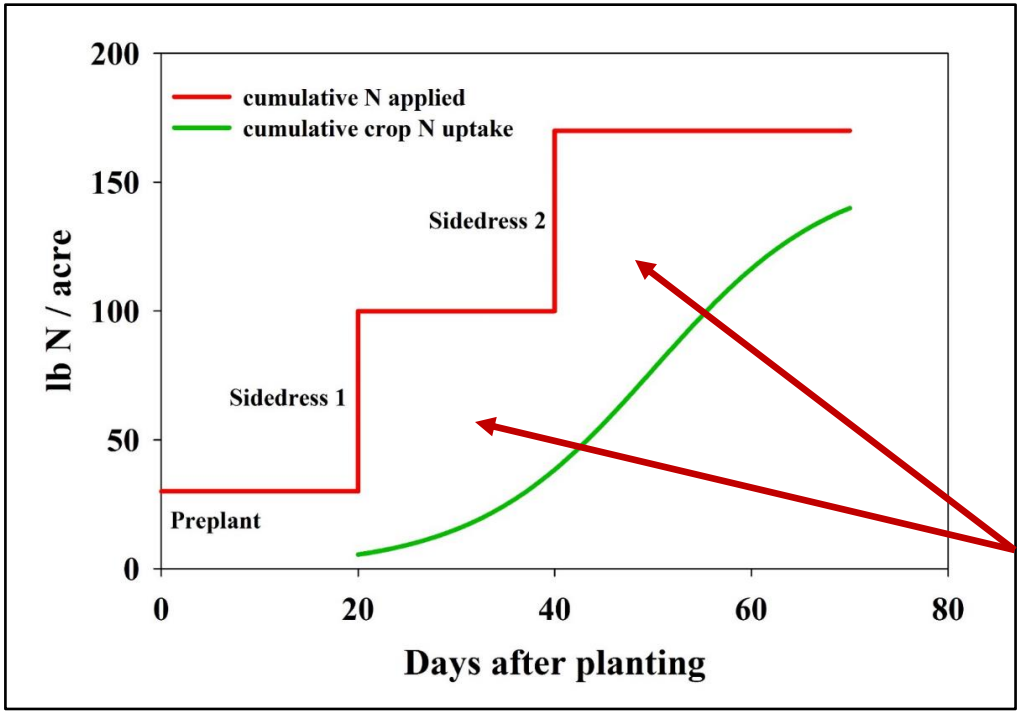
- **Root development takes time, and nitrate leaching is a special hazard early in the season:**



Fertigation with drip irrigation best meets crop uptake demand throughout peak crop demand and reduces N loss to the environment.



Traditional N sidedressing has opportunities for N loss to leaching after application because N levels in the root zone are higher than crop uptake potential

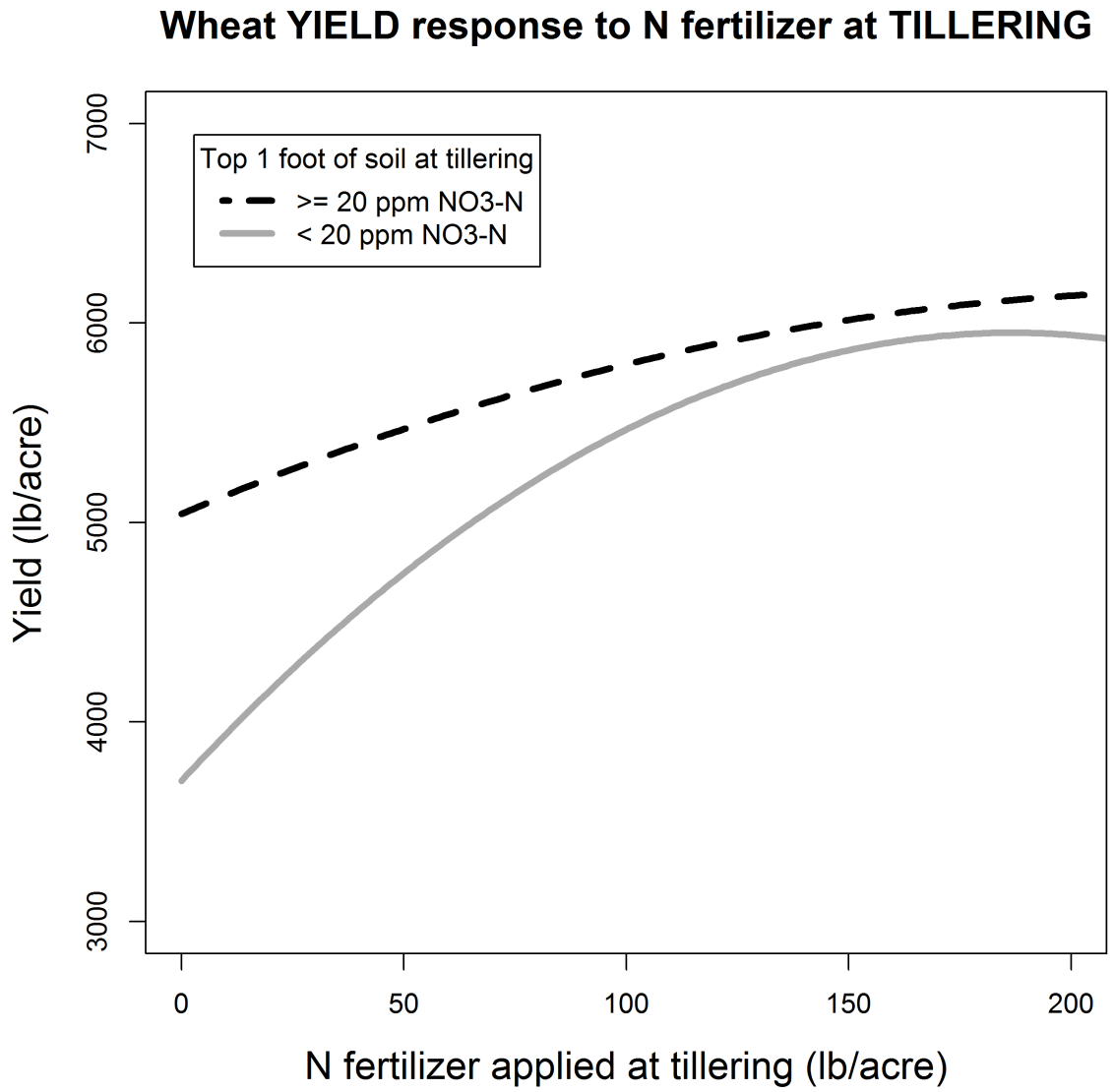


Opportunities for NO_3-N leaching

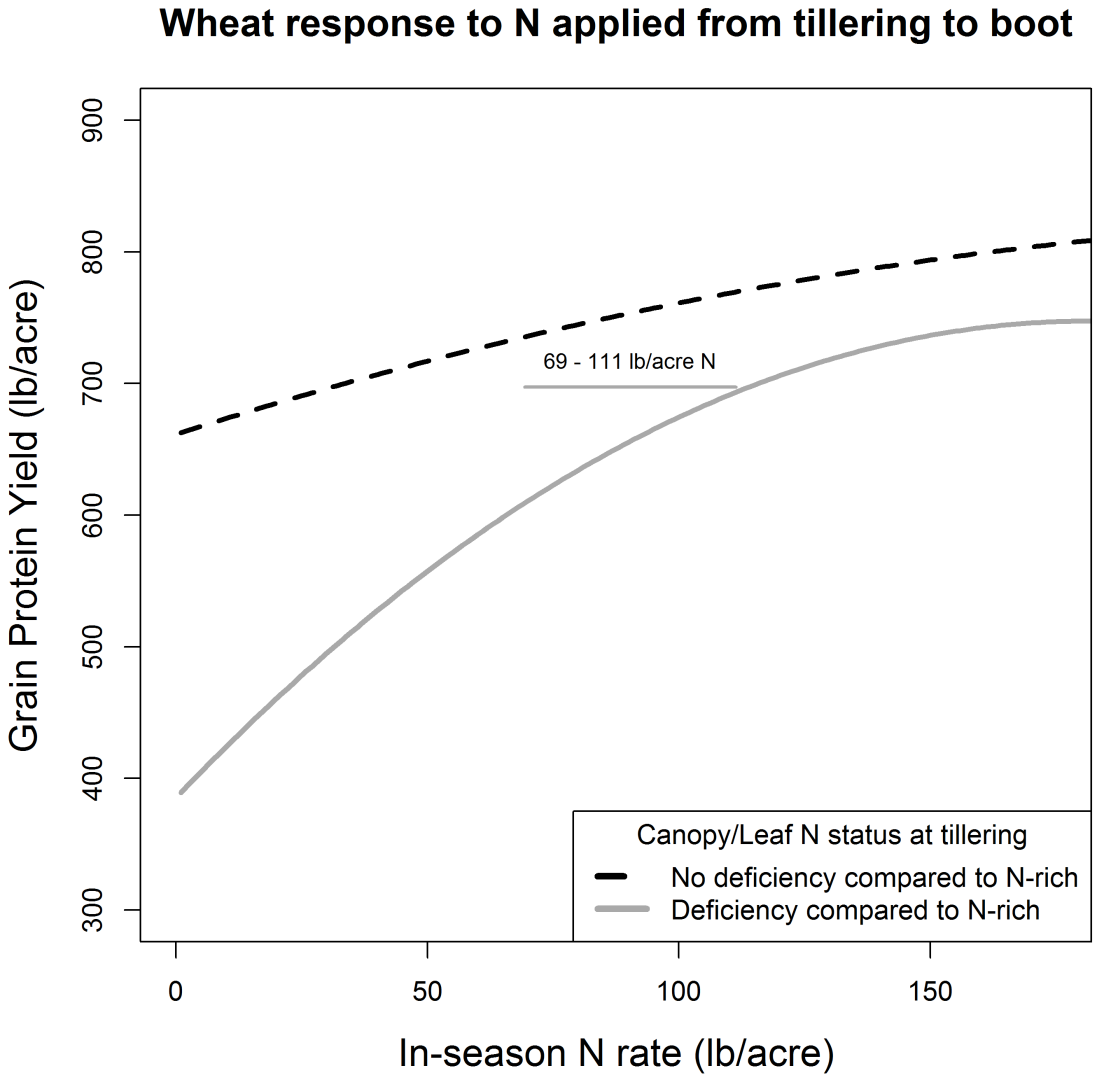
Importance of N '*residence time*' in the root zone:

- Plants do not soak up N like a sponge; rather, N is taken up selectively, *as needed*, to support new growth
- Therefore, applied N must remain in the active root zone for an extended period to be efficiently utilized

Wheat yields are similar when adequate N is applied at tillering regardless of low soil N rates earlier in the season. Applying N at tillering reduces loss.



Wheat crop with N stress signal is more responsive to in-season N application and yield difference is reduced when higher rates of N are applied in-season.



In-Season Soil Testing-PSNT

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Post-establishment soil NO_3-N

- **often called “Pre-sidedress”**
- **In annual systems, often the most important field-specific modification**

In-Season Soil Testing-PSNT

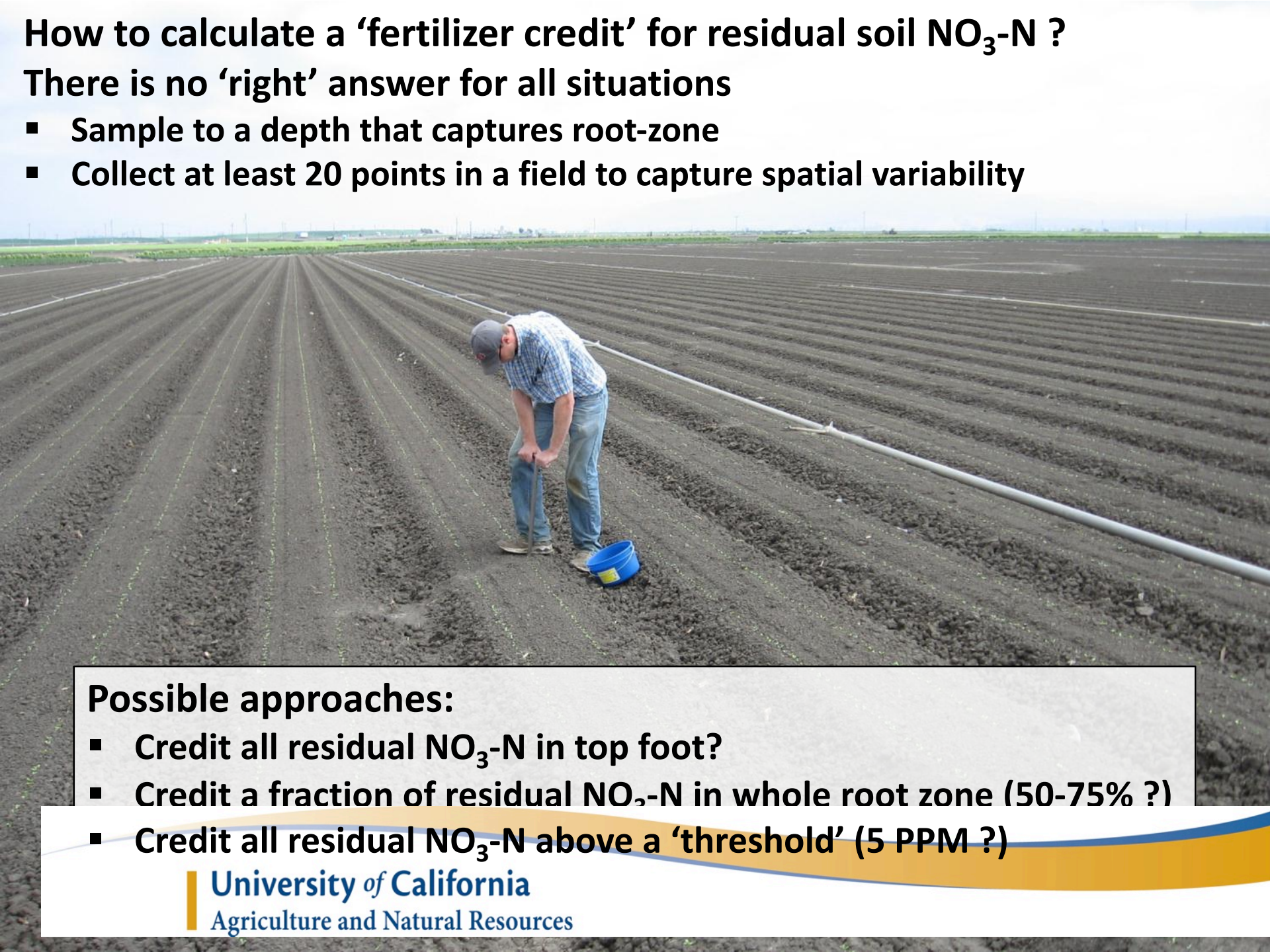
Why is PSNT sampling so important?

- It integrates the main factors influencing soil N mineralization
  - (rapid N mineralization from residues and amendments has already taken place in summer annual)
- The measurement is taken after crop establishment, when additional leaching should may controllable (given good irrigation management)

How to calculate a ‘fertilizer credit’ for residual soil NO_3-N ?

There is no ‘right’ answer for all situations

- Sample to a depth that captures root-zone
- Collect at least 20 points in a field to capture spatial variability



Possible approaches:

- Credit all residual NO_3-N in top foot?
- Credit a fraction of residual NO_3-N in whole root zone (50-75% ?)
- Credit all residual NO_3-N above a ‘threshold’ (5 PPM ?)

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Tissue N monitoring for *annual crops*:

Leaf total N

- **Measures overall crop N status**

Petiole NO_3-N

-

Leaf total N monitoring :

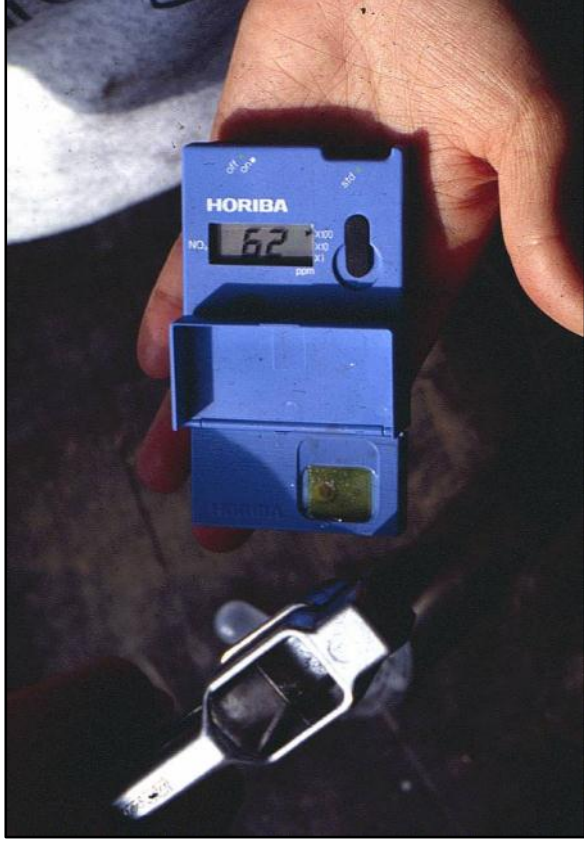
- Reliable indicator of plant N status
- changes relatively slowly over time, and is unaffected by short-term weather fluctuations

Limitation of leaf total N:

- poorly correlated with soil NO_3-N availability early in the season when crop N uptake is slow
- only reflects soil N availability during high N uptake period
- *Thus, limited value in early season fertilization decisions*

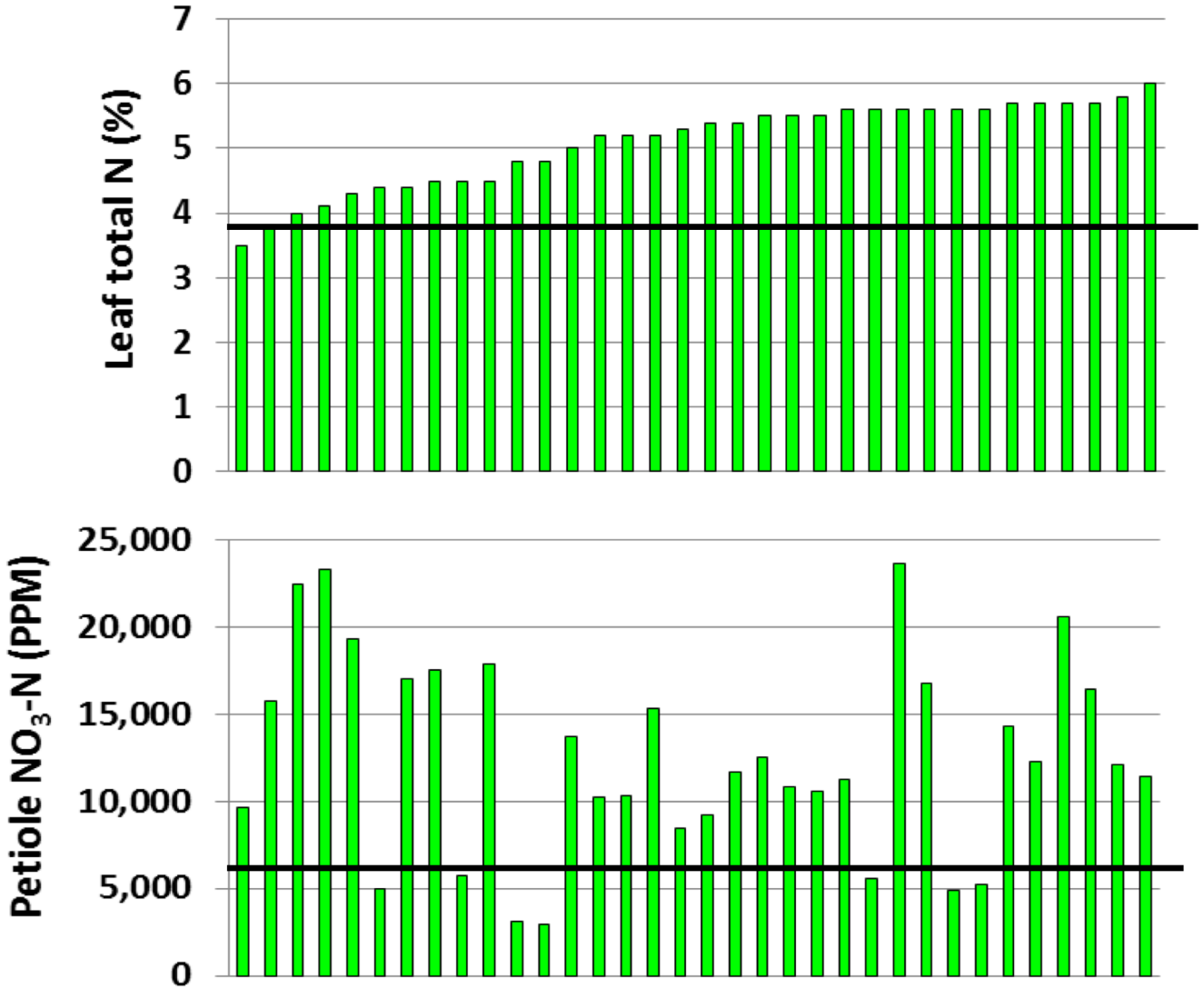
Petiole NO_3-N :

- An indicator of what the plant is in the process of assimilating
- Most NO_3-N is not in the transpiration stream, it is already stored in cell vacuoles
- Environmental factors unrelated to soil N availability affects the rate of NO_3-N assimilation into organic compounds



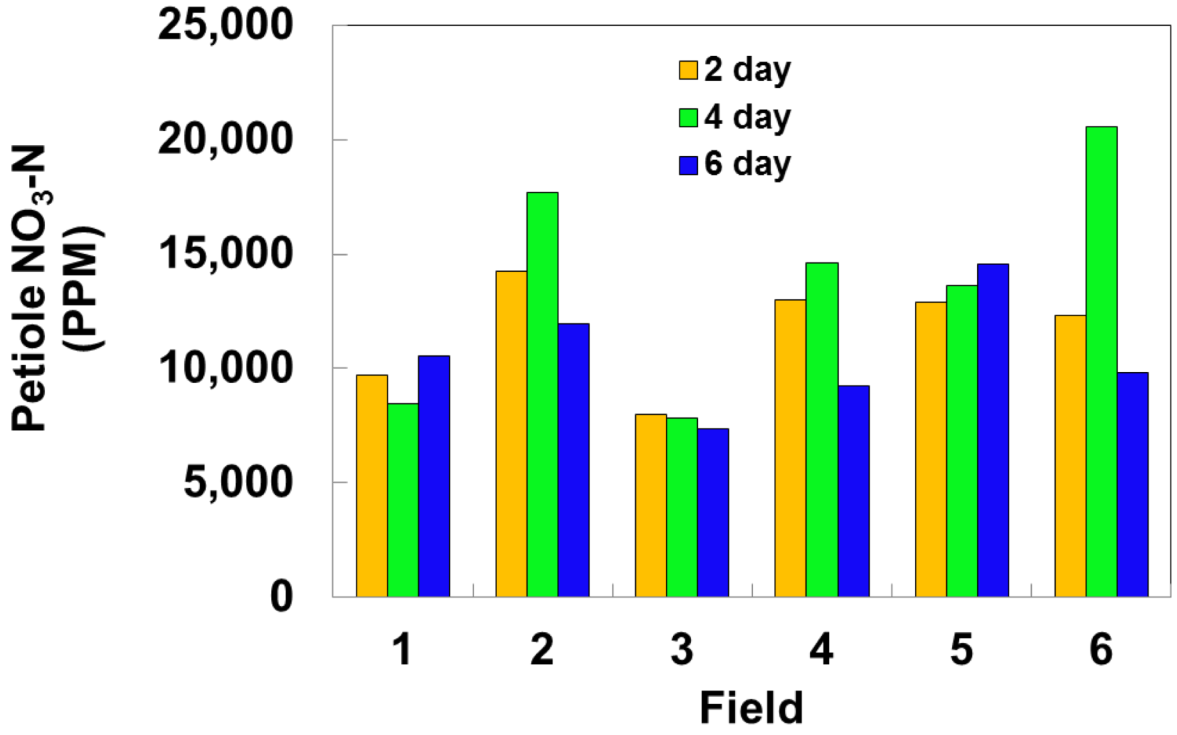
Petiole NO_3-N is standard practice in many cropping systems but can be much more variable than leaf total N, and can be poorly correlated with leaf N

2009 Lettuce N trials, cupping stage:



Petiole NO_3-N can be influence by environmental factors and if used, petioles should be collected uniformly (same time of day) and quickly to reduce variability

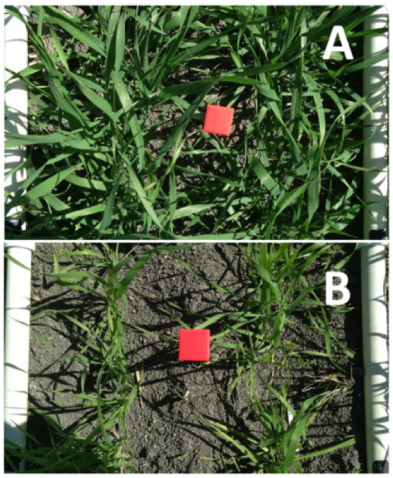
- Six sprinkler-irrigated coastal broccoli and cauliflower fields, sampled every 2 days over a sprinkler irrigation cycle :



Summary: annual crop tissue testing

- **Whole leaf sampling gives a good snapshot of current crop N status, but it is more useful to confirm N sufficiency than to predict future N fertilizer need**
- **Maintaining high petiole NO_3-N throughout the season will probably ensure crop nitrogen sufficiency; *however, using petiole analysis to guide N fertilization often leads to unnecessary fertilization***
- **Tissue testing is not a substitute for soil sampling, which should be taken before in-season N applications.**
- **Follow crop specific guidelines and models when available (wheat) to improve NUE**

Applying most N in-season to wheat based on crop and soil measurements can increase NUE.

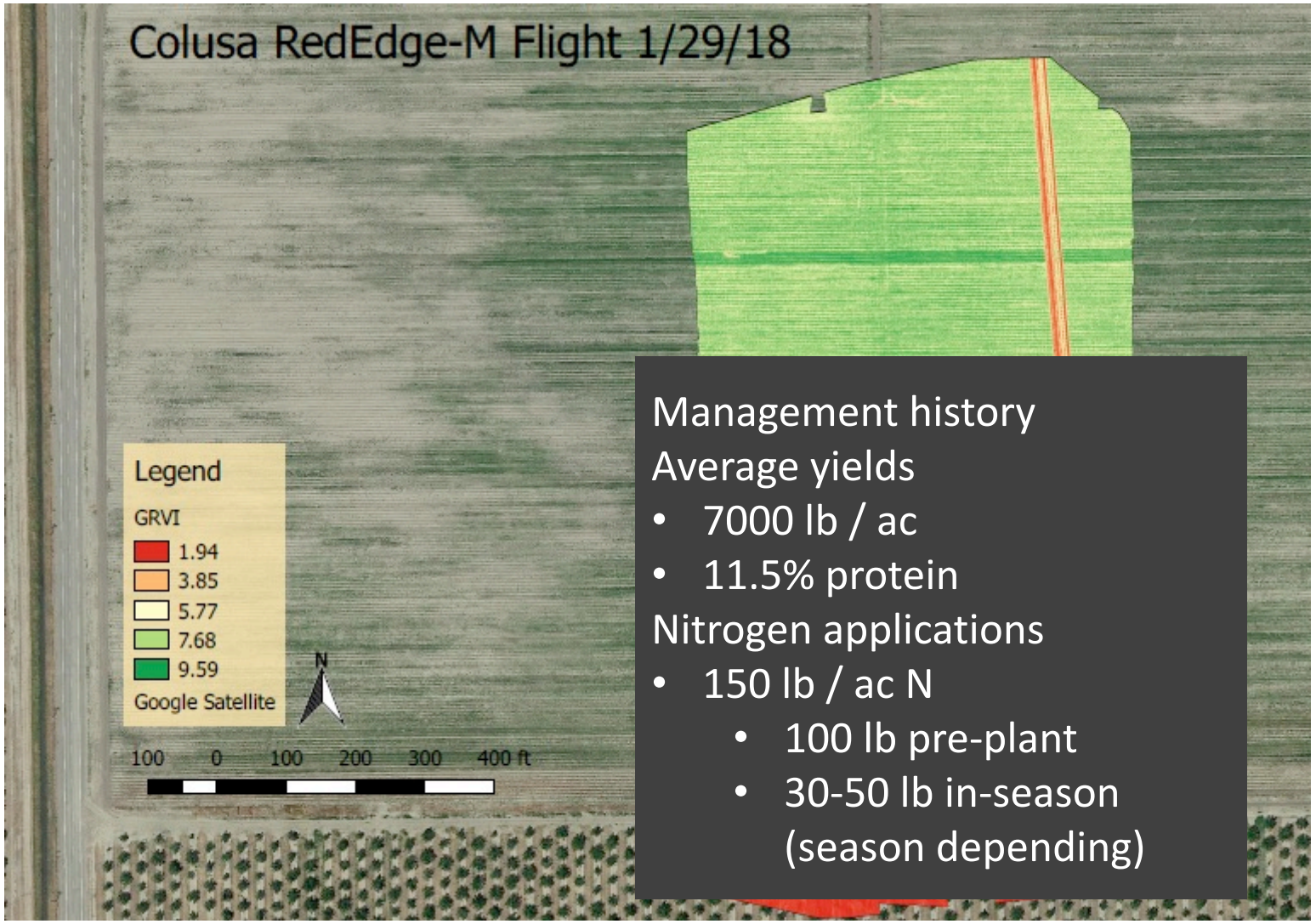


Value of in-season vs preplant N applications

Soil nitrate-N quick tests

N-rich reference strips

How can we improve the predictability of crop response to N fertilizer? An example



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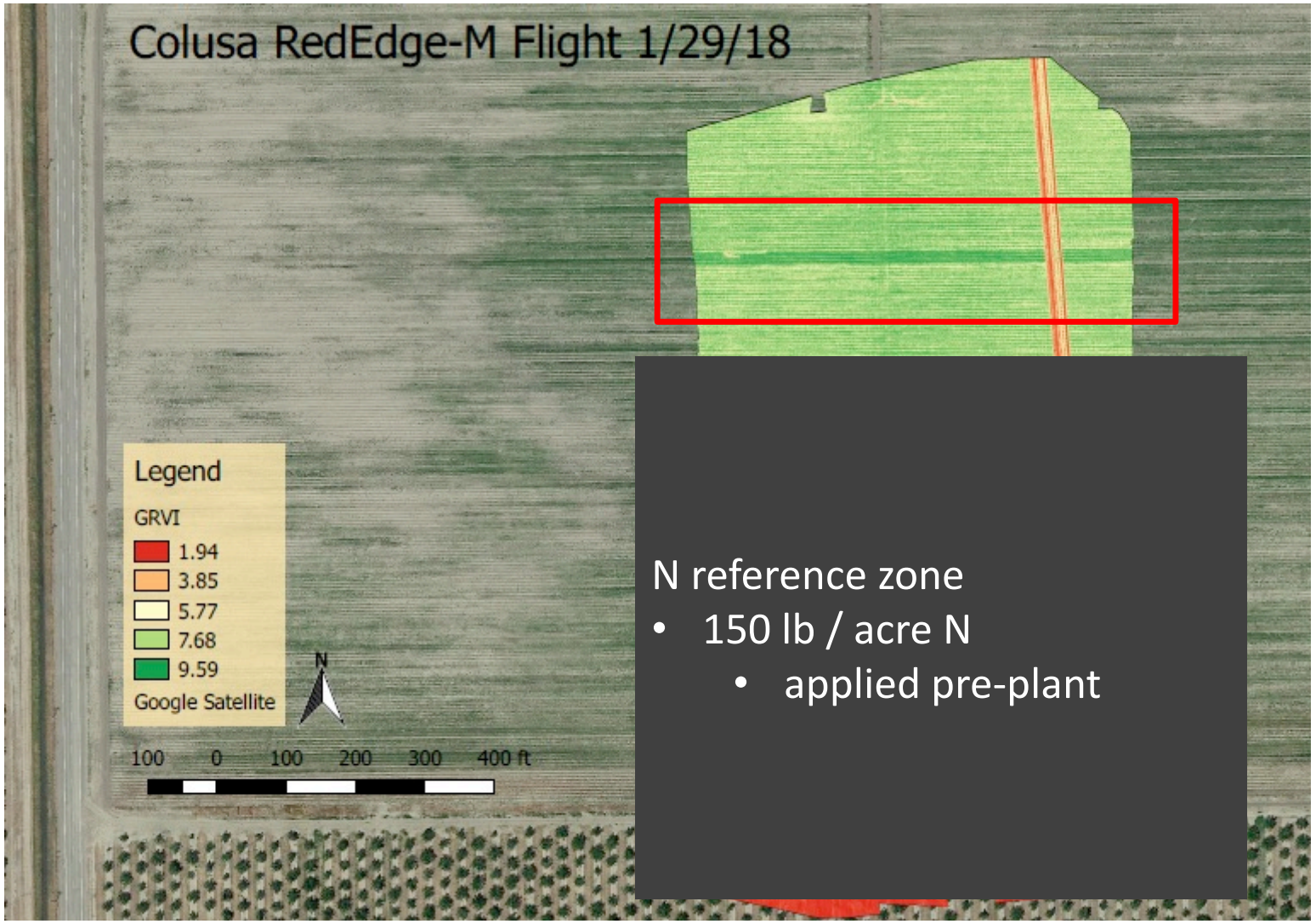
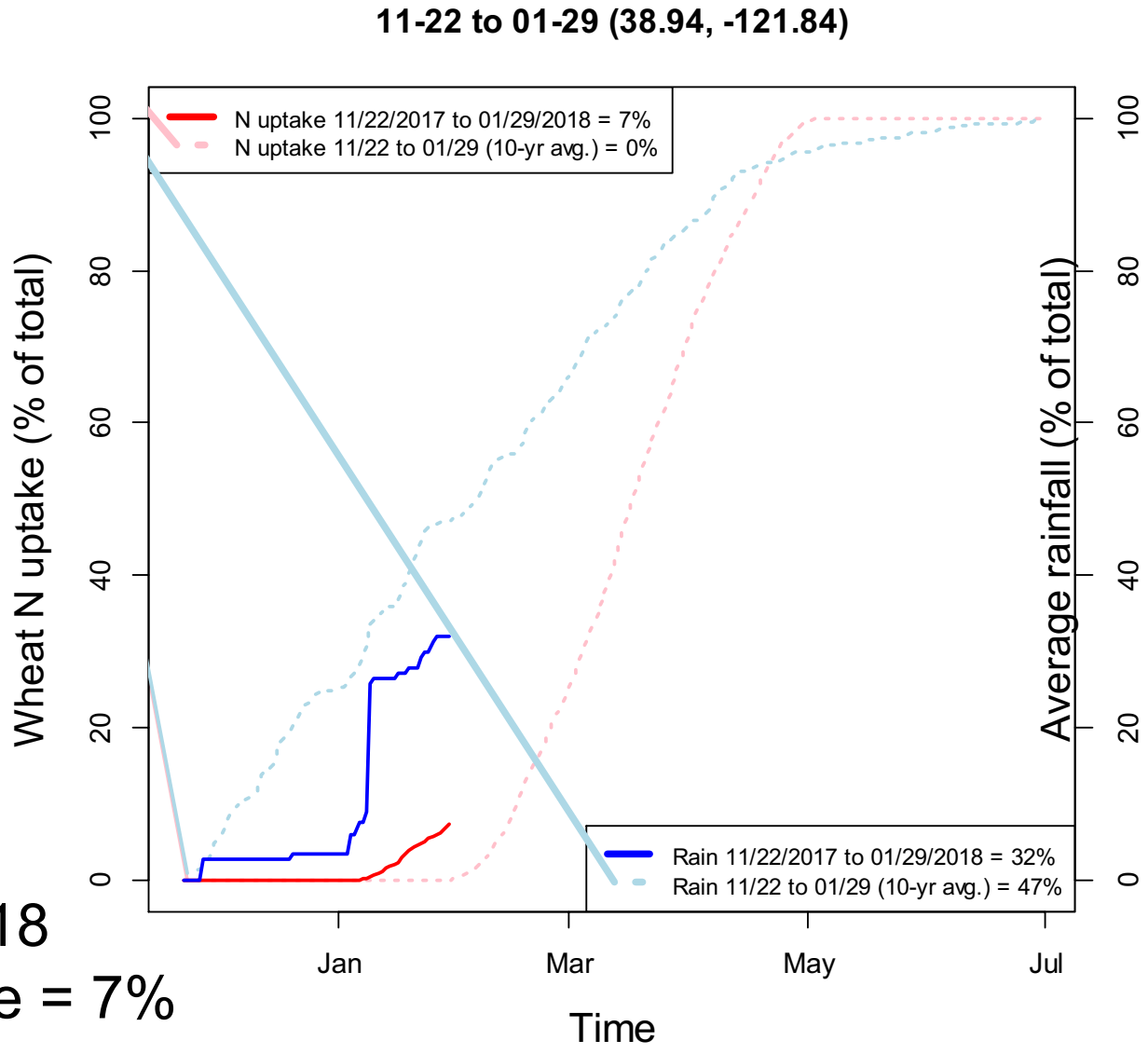
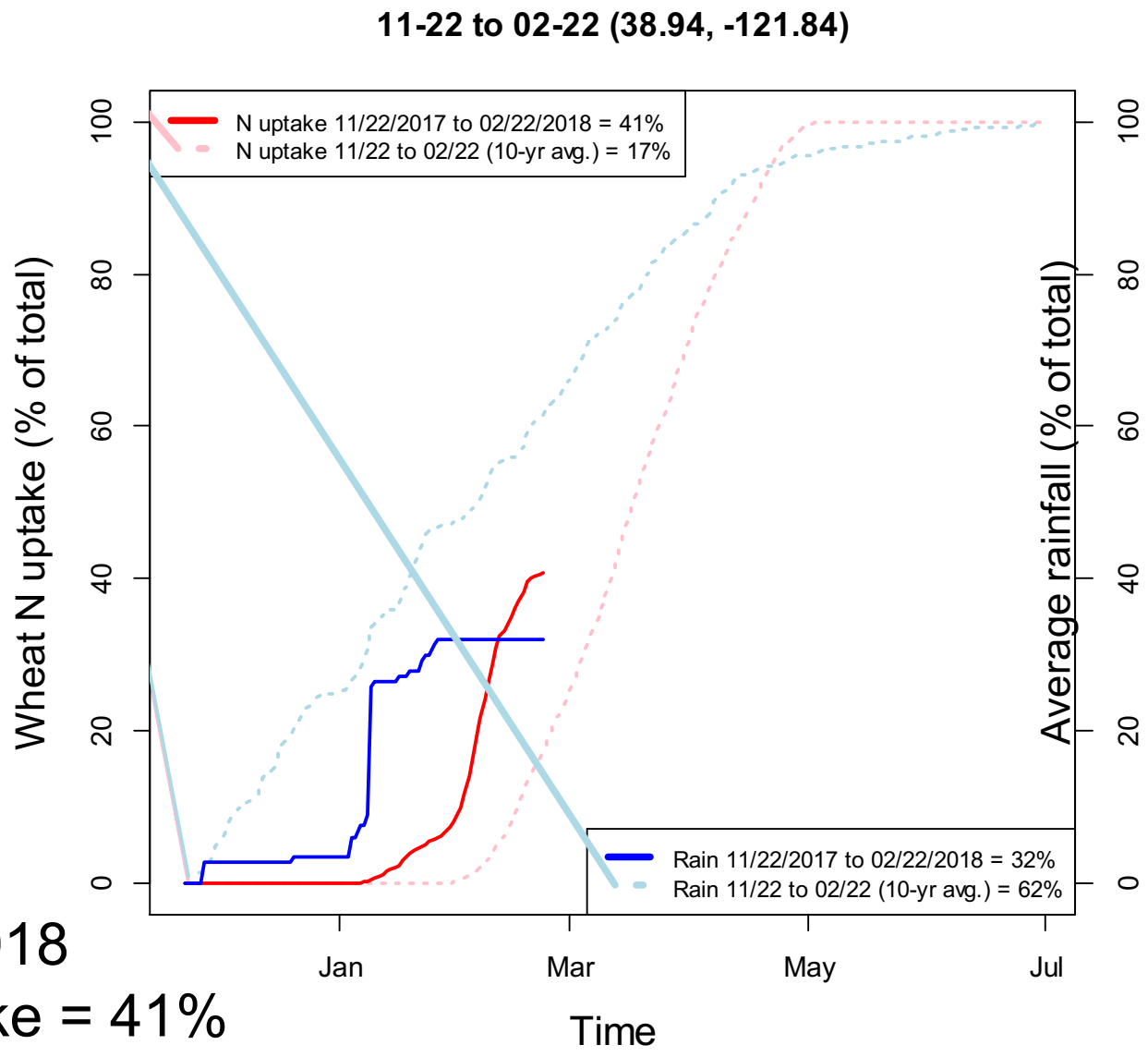




1/29/2018
N uptake = 7%

1/29/2018
Rain = 32%

Planting Date = 11/22/2017

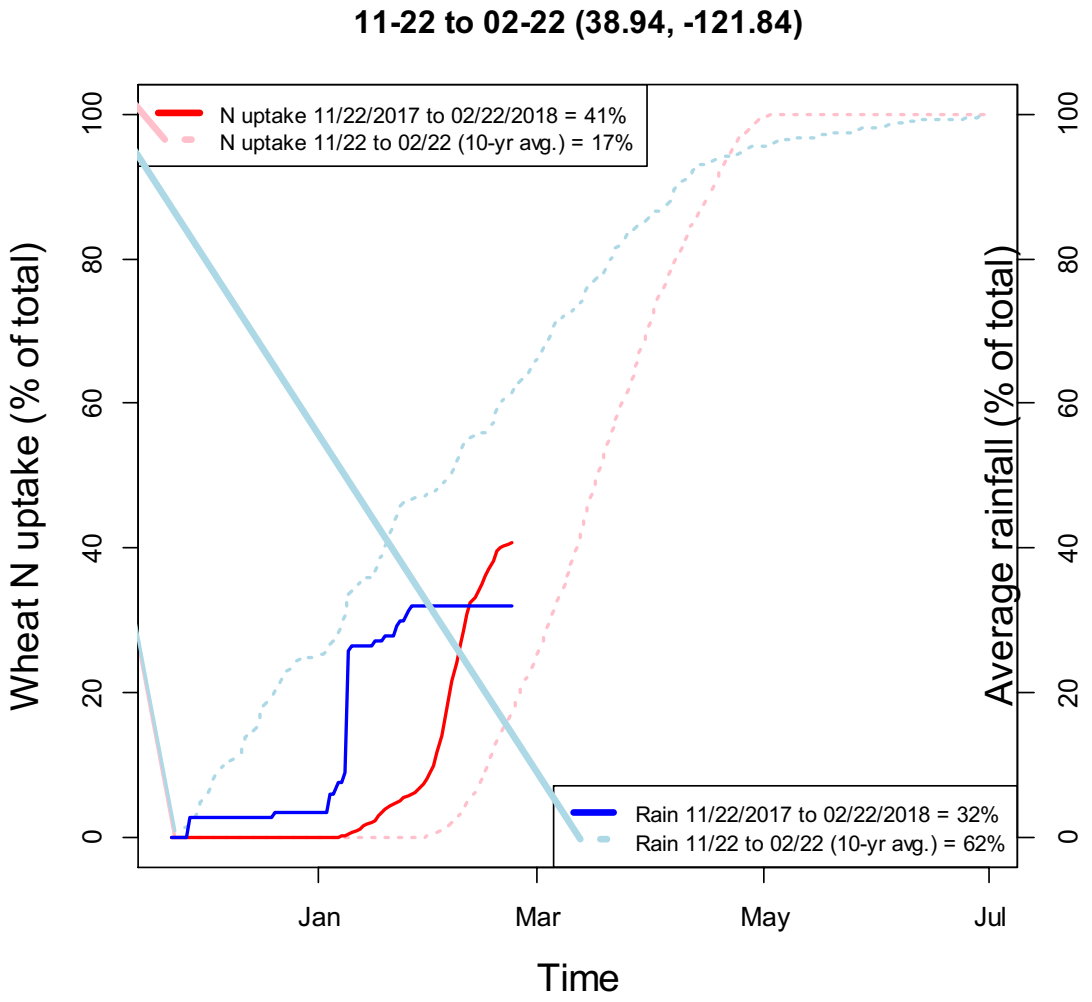


2/22/2018
N uptake = 41%

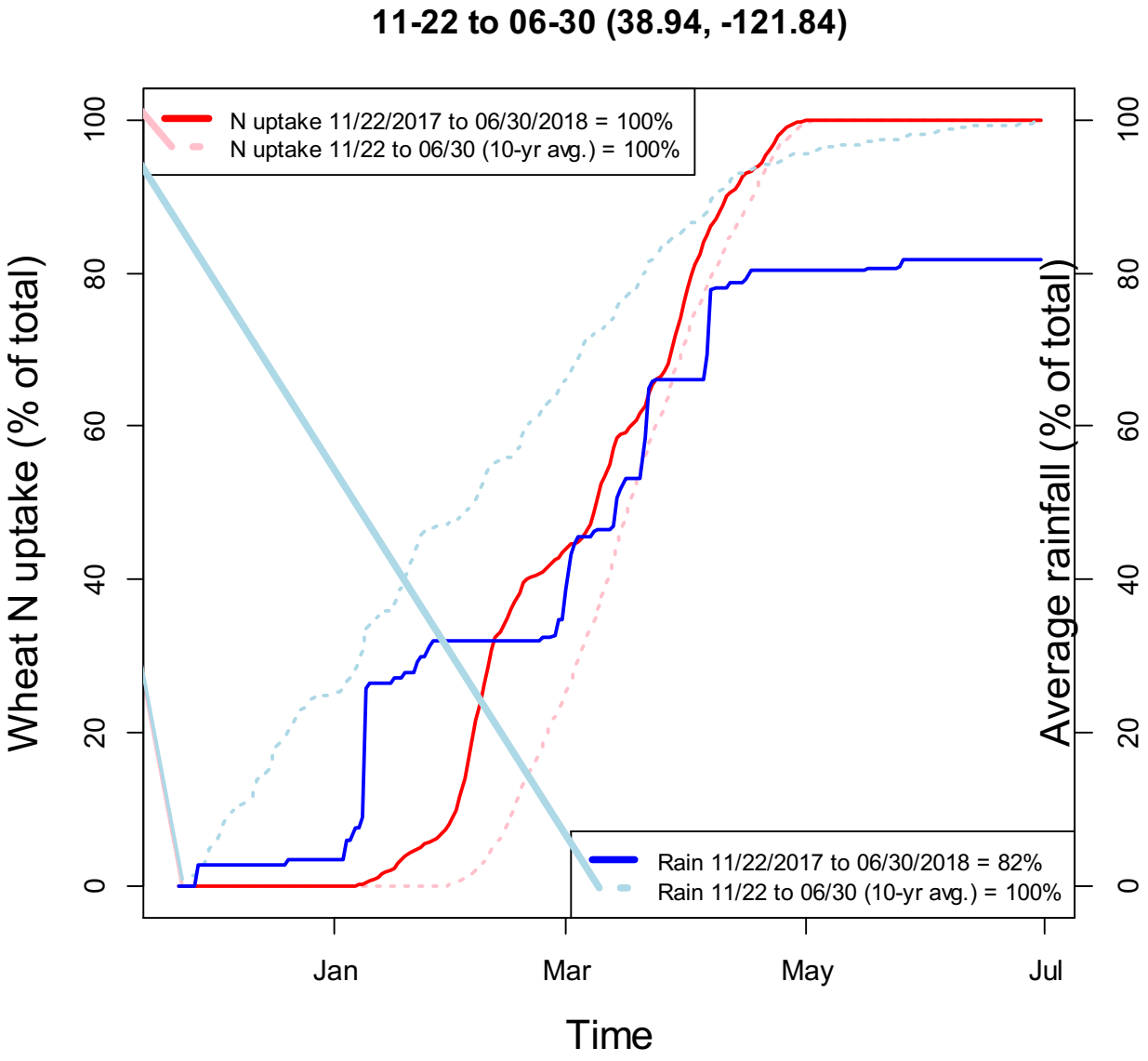
2/22/2018
Rain = 32%

Planting Date = 11/22/2017

Using the UC model, in-season N application rates were calculated based on potential grain yield (N uptake and rain).



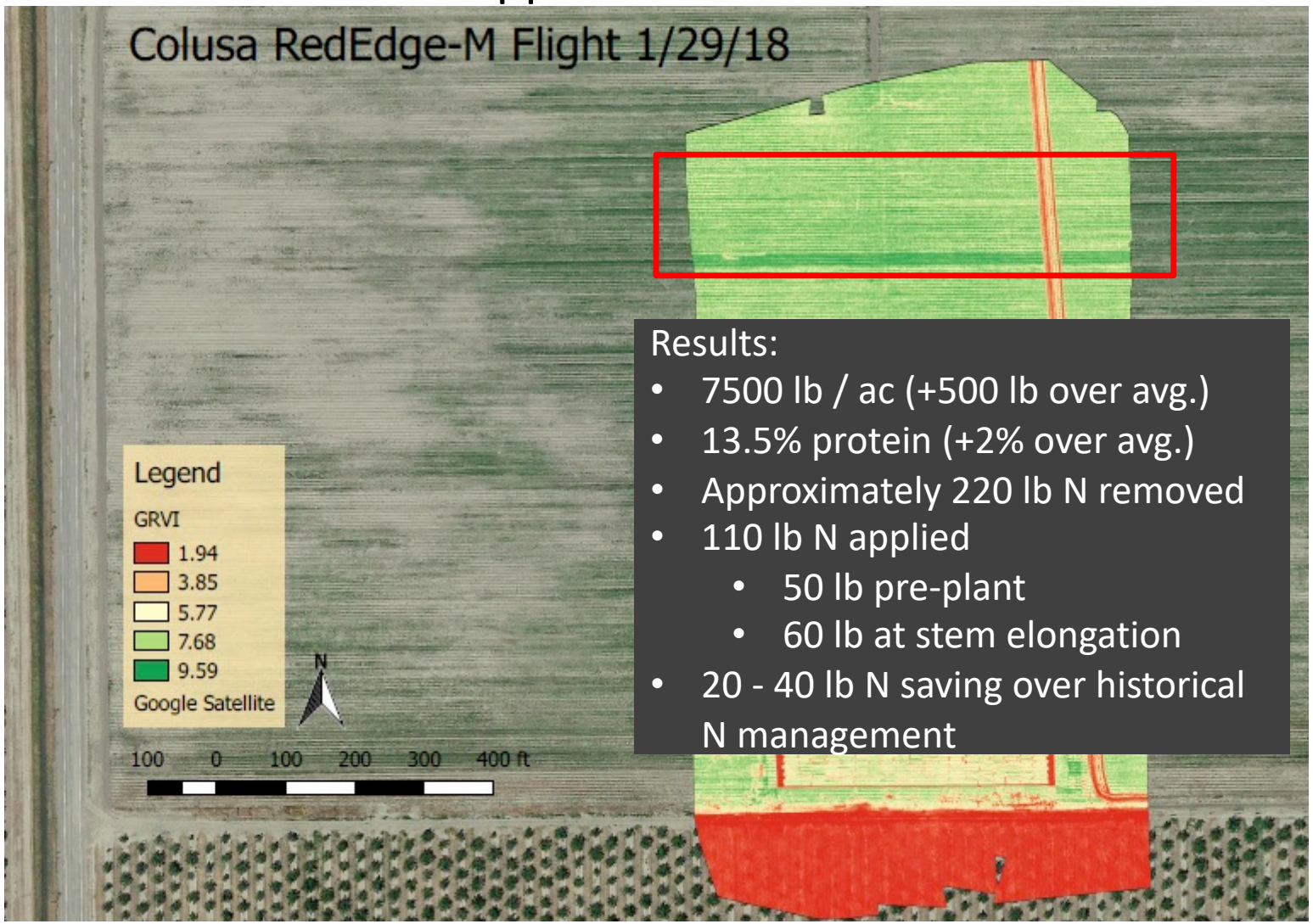
175 lb /acre (N removal) * 59% N uptake remaining * 0.6 – 0.9 response coefficient = probable linear response between 62 - 93 lb / acre N



Seasonal Rain = 82% of average

60% of seasonal total post-application

Nitrogen reference strips combined with plant-soil measurements improved the precision of in-season N management and increased yield and protein despite reduced N application.



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