Field Studies on Nitrogen and Water Management

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The Regional Board wants to see progress in brining applied nitrogen closer to nitrogen uptake by crops. Improving the efficiency of nitrogen application to crops is key to achieving this goal.

Improving Nitrogen Use Efficiency

- **The greatest progress in improving NUE has been made with lettuce**
- **There are an increasing number of growers using nitrate testing to account for residual soil nitrogen and adjusting fertilizer applications accordingly**
- **This is the key practice to facilitate improvements in the nitrogen applied to nitrogen taken up ratio**

Improving Nitrogen Use Efficiency

- **Cole crops in general and broccoli in particular have been shown to take up more nitrogen than is typically applied**
- **Broccoli is more complicated than other crops because it takes up nitrogen from deeper in the soil profile, which complicates soil nitrate sampling:**
  - **When, how deep, how often, etc.**
  - **Hassle factor**

Improving Nitrogen Use Efficiency

- The other question about broccoli, given its ability to scavenge nitrogen, how much of the residual nitrogen from a prior lettuce crop can it use and help reduce losses in both crops?
- To answer this question, we initiated a study funded by the Fertilizer Research and Education Program to study N dynamics in broccoli crops following a prior crop of lettuce

Improving Nitrogen Use Efficiency

- In 2014 and 2015 we surveyed a total of 10 broccoli fields that were following a prior crop of lettuce
- We evaluated soil nitrate levels at one foot interval down to 3 feet over the course of the crop cycle
- We evaluated crop nitrogen uptake and fertilization practices
- We evaluated the nitrogen budget
  - Total N uptake, residual soil nitrogen, potentially leachable nitrogen

Broccoli N Dynamics

2014

Site	Initial residual soil nitrate[1]	Nitrogen applied	Total available	Percent N taken up by Broccoli crop
1	146	178	324	97
2	372	178	550	67
3	134	190	324	82
4	183	190	373	99
5[2]	257	240	497	44

1 - In the top three feet of soil; 2 – loamy sand soil

Broccoli N Dynamics

2014

Site	Crop uptake	Final residual[1]	Unaccounted
1	313	9	32
2	370	132	77
3	268	19	67
4	369	48	-14
5[2]	220	92	214

1 - In the top three feet of soil; 2 - loamy sand soil type

Broccoli N Dynamics

2015

Site	Initial residual soil nitrate[1]	Nitrogen applied	Total available	Percent N taken up by Broccoli crop
1	274	169	443	72
2	281	180	461	68
3	408	180	588	56
4	163	180	343	106
5	431	205	637	40

1 - In the top three feet of soil

Broccoli N Dynamics

2015

Site	Crop uptake	Final residual	Unaccounted
1	318	5	150
2	315	59	116
3	333	108	177
4	364	20	-11
5	256	191	219

* In the top three feet of soil

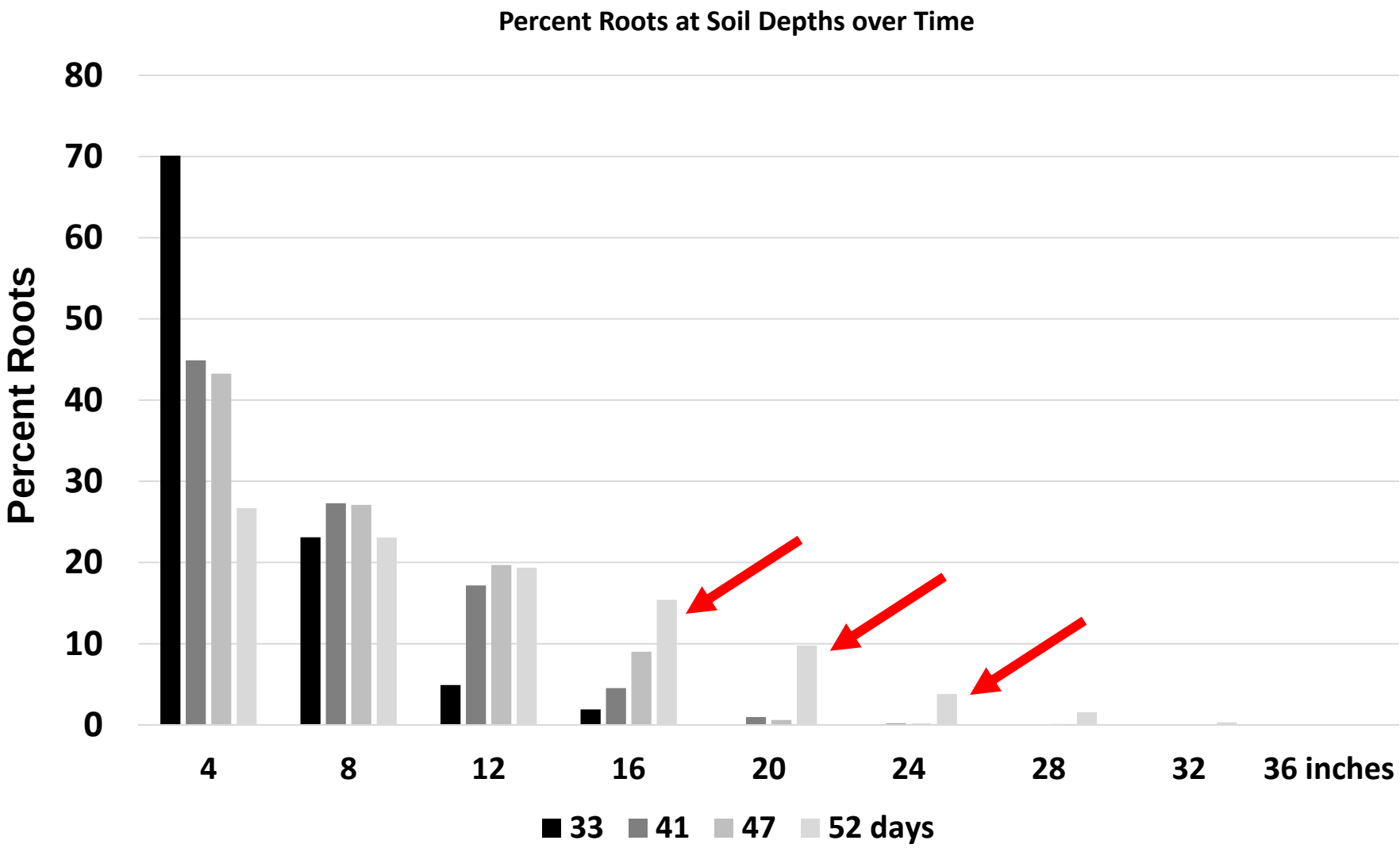
Summary of Broccoli Surveys

- Broccoli is capable to taking up a large proportion of the residual soil nitrate and applied fertilizer from the prior lettuce crop
- At some sites, broccoli completely utilized residual soil nitrogen from the prior lettuce crop
- At the sites where broccoli did not utilize all residual soil nitrate, the initial soil levels were higher than the crop was capable of taking up
- Fertilizer applications to the broccoli were moderate at all sites

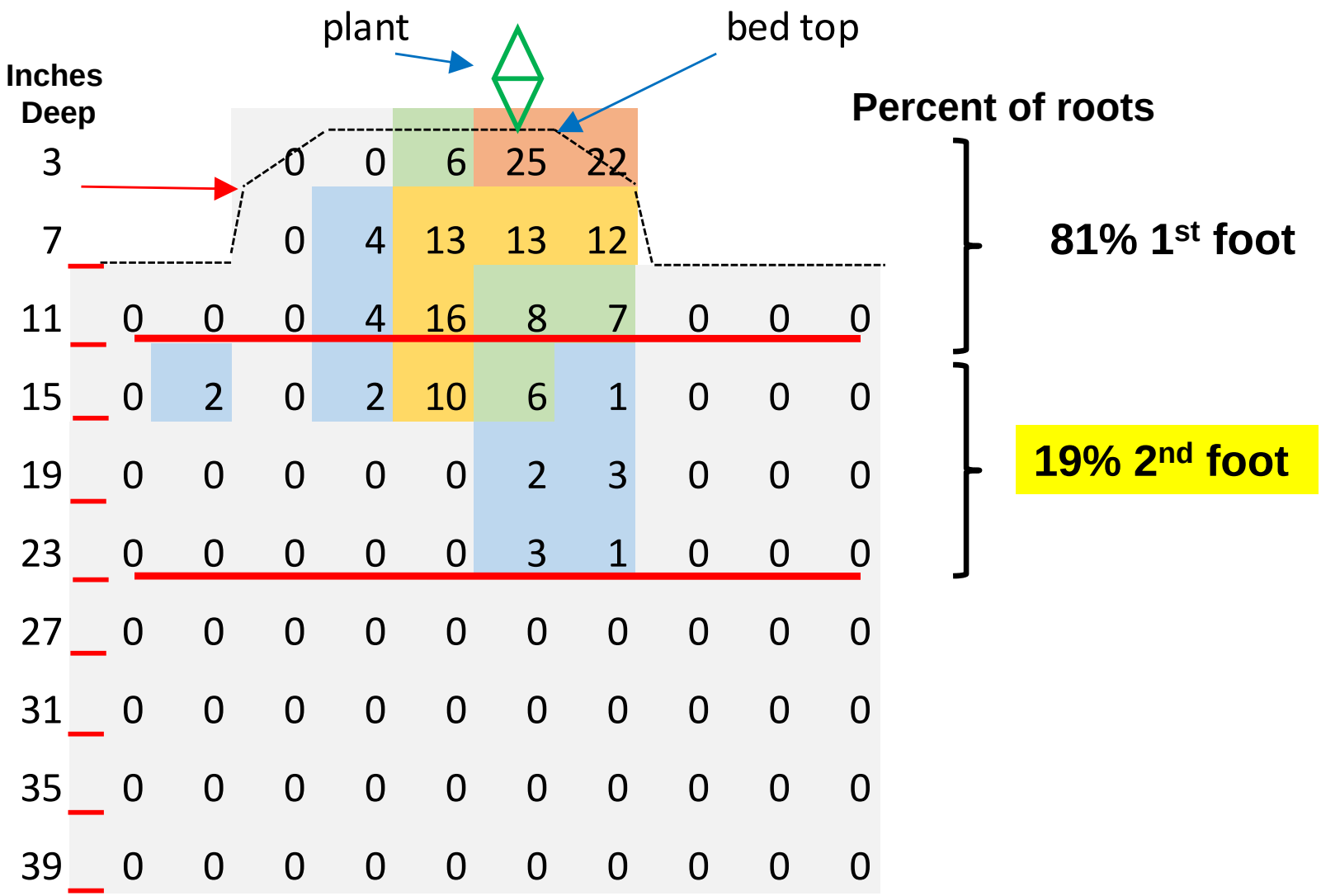
Evaluating the Ability of Broccoli to Utilize Residual Soil Nitrate

- **What are ways that we can make broccoli even more efficient at utilizing residual soil nitrate from prior crops?**

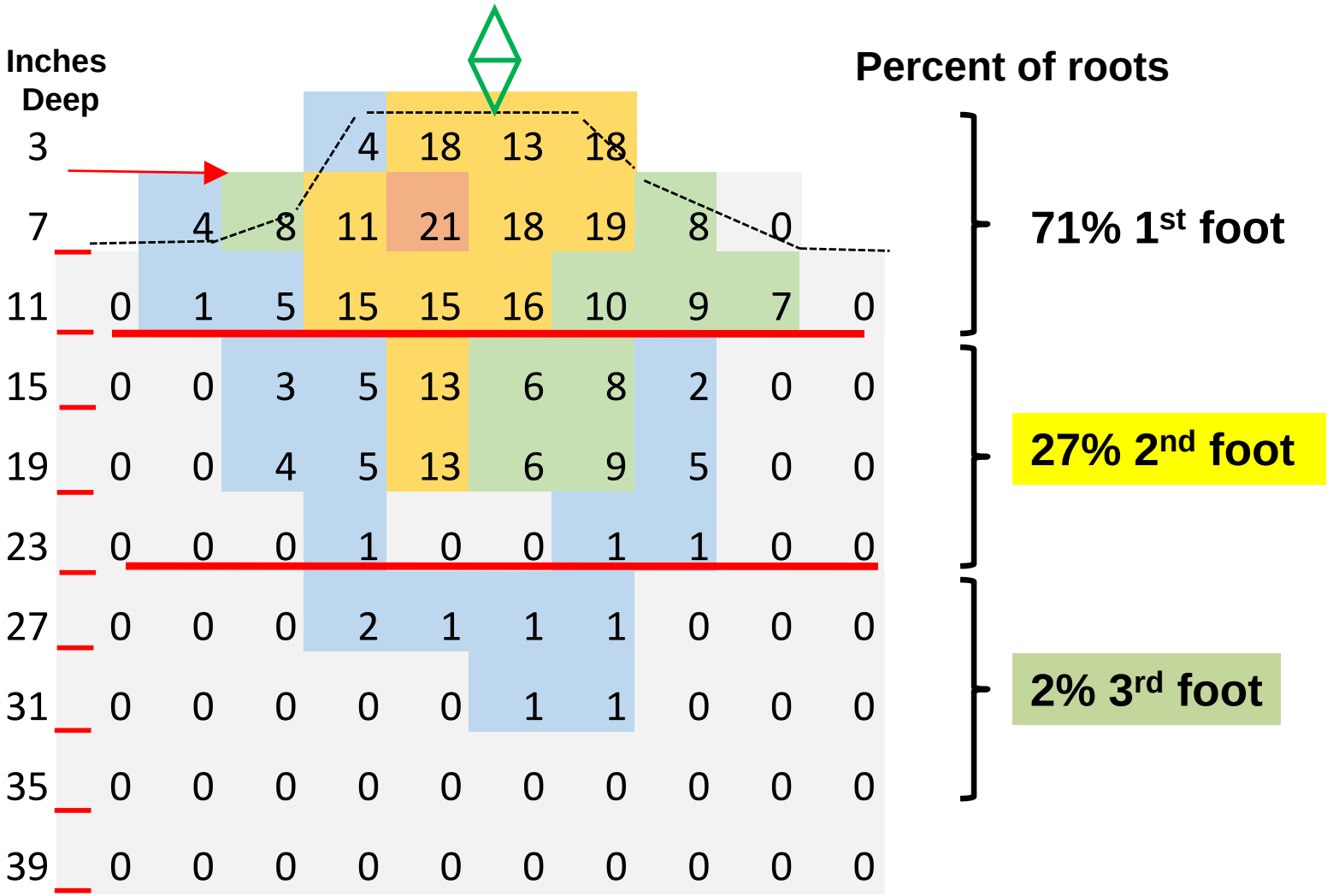
The Proportion of Roots in the 2nd Foot of Soil begins to Increase 50 days after 1st water



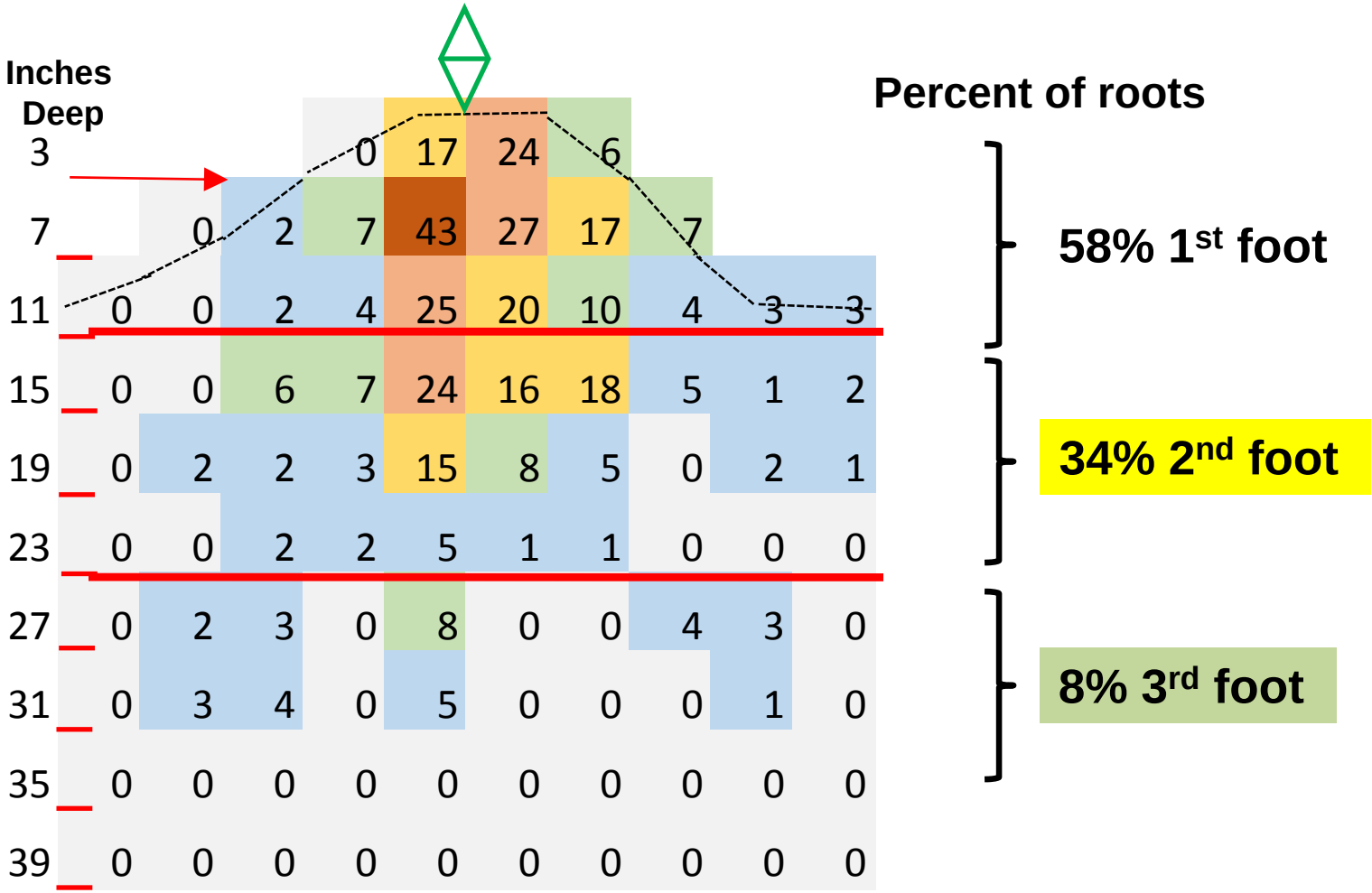
Cauliflower
56 days after planting



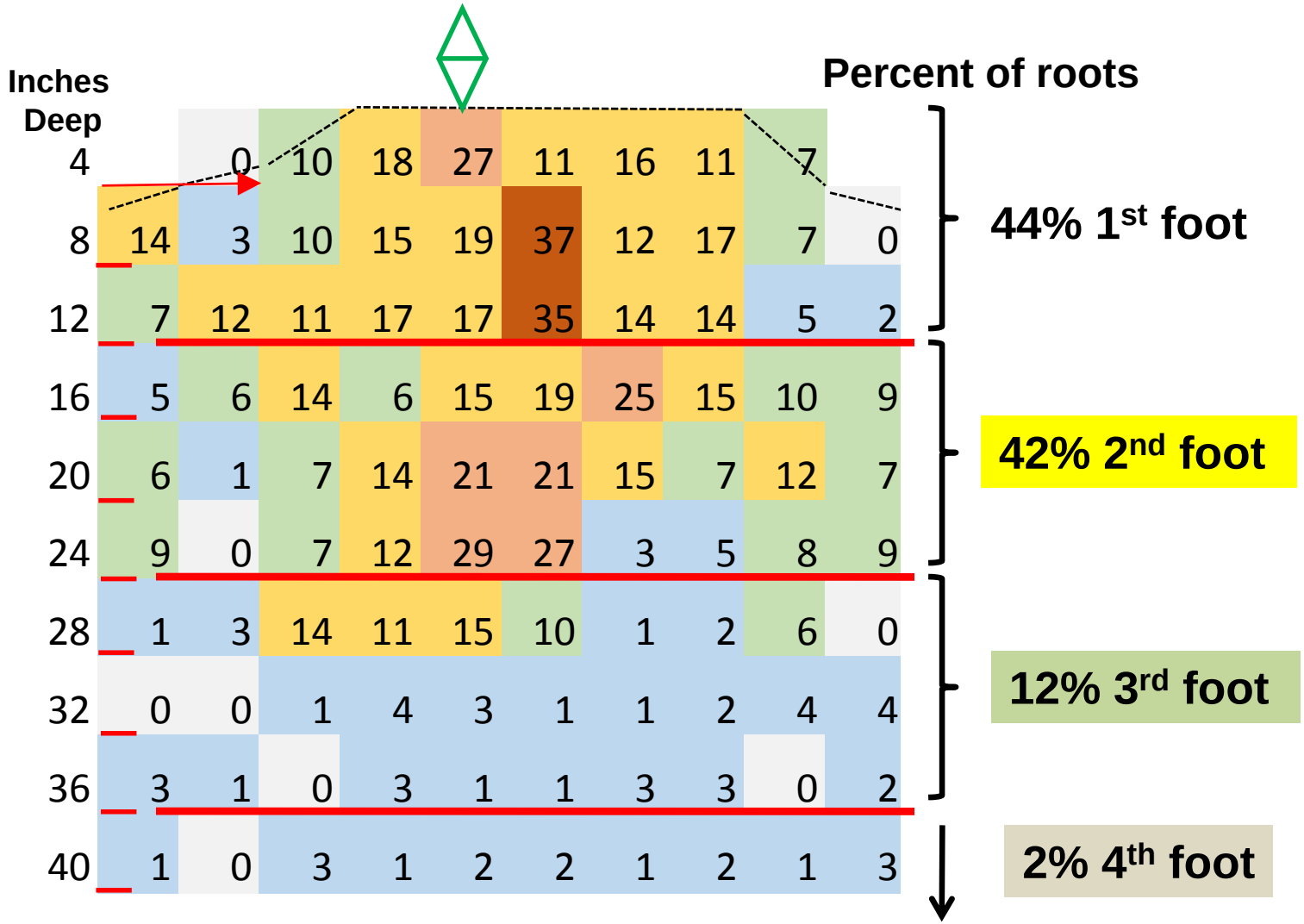
Cauliflower
63 days after planting



Cauliflower
70 days after planting



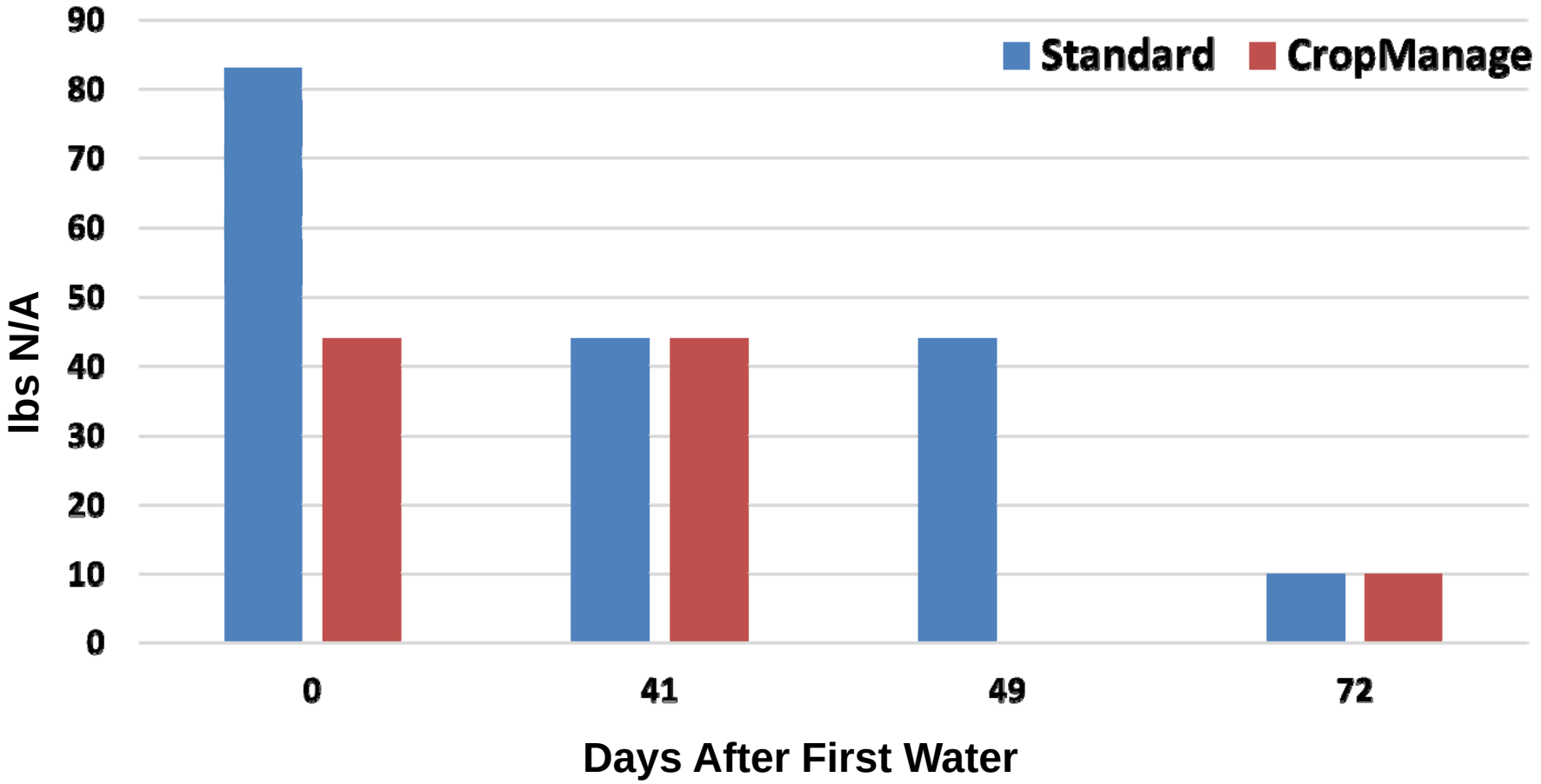
Cauliflower
113 days after planting



Studies Evaluating Improving NUE of Broccoli

- We conducted trials on growers fields comparing standard practices and water and fertilizer recommendations made by CropManage
- The trials were strips the width of a harvester by the length of the field
- The fields had two drip irrigation manifolds to allow separate watering and fertilization

Fertilizer Application to the Treatments



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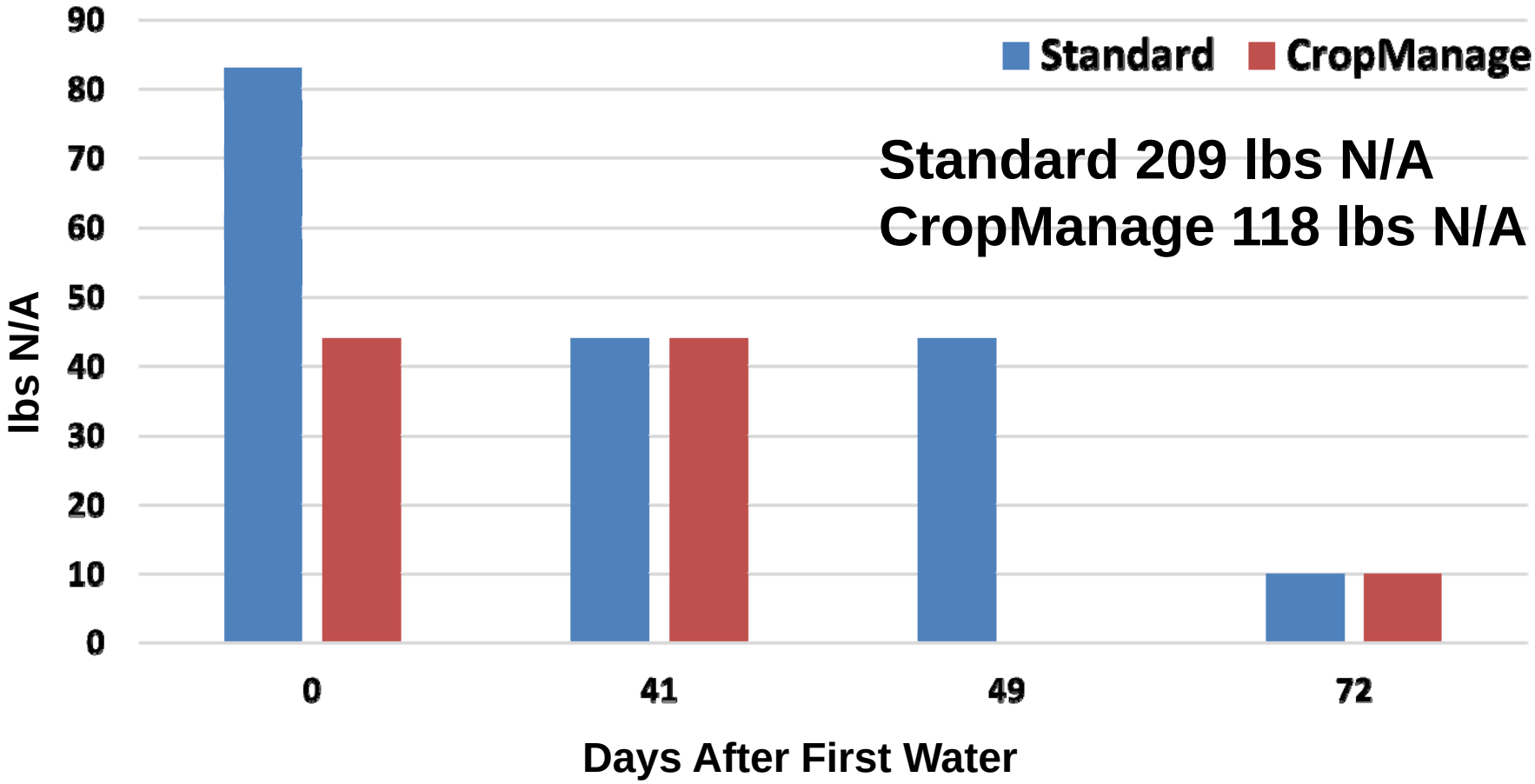

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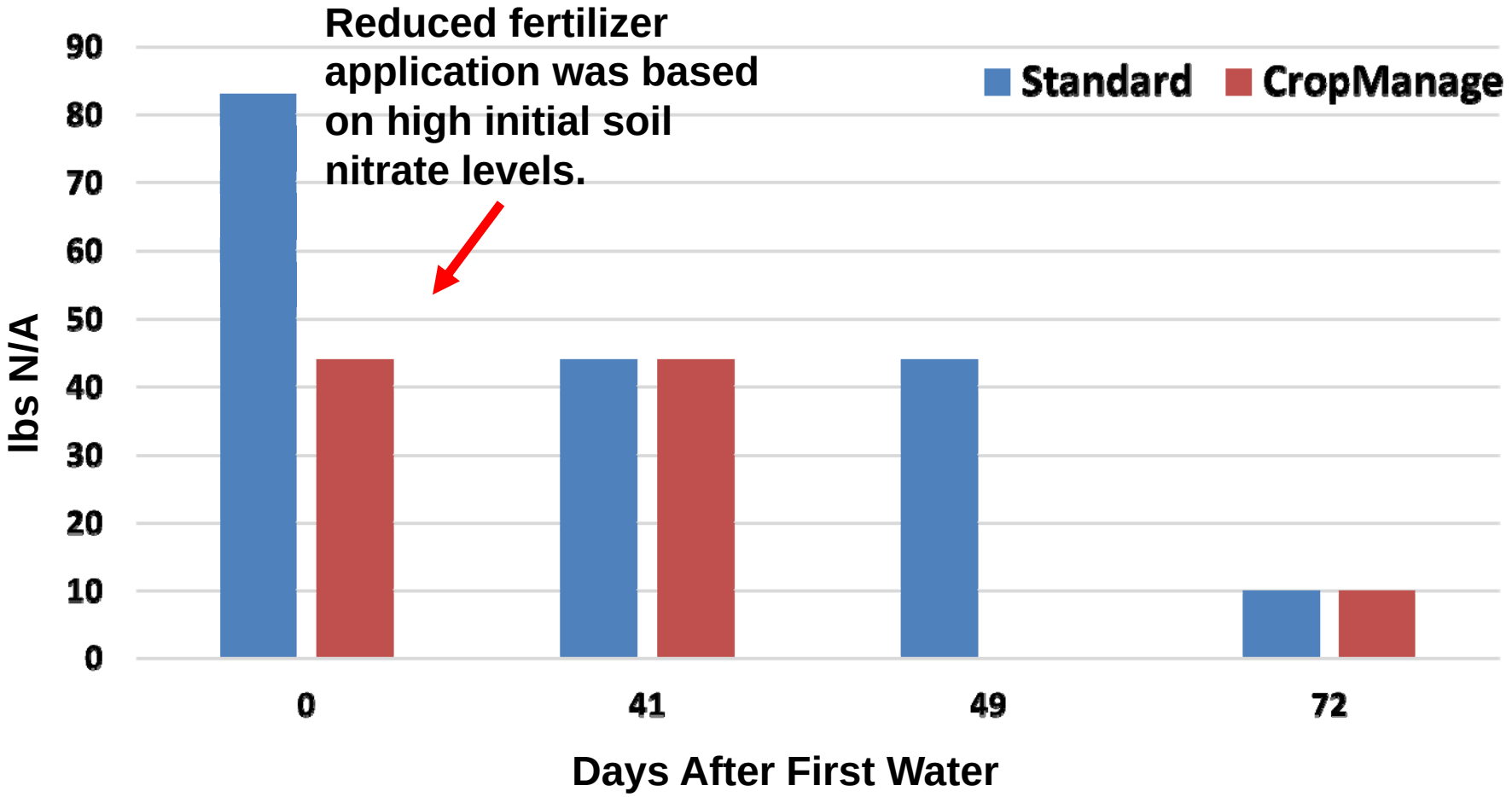
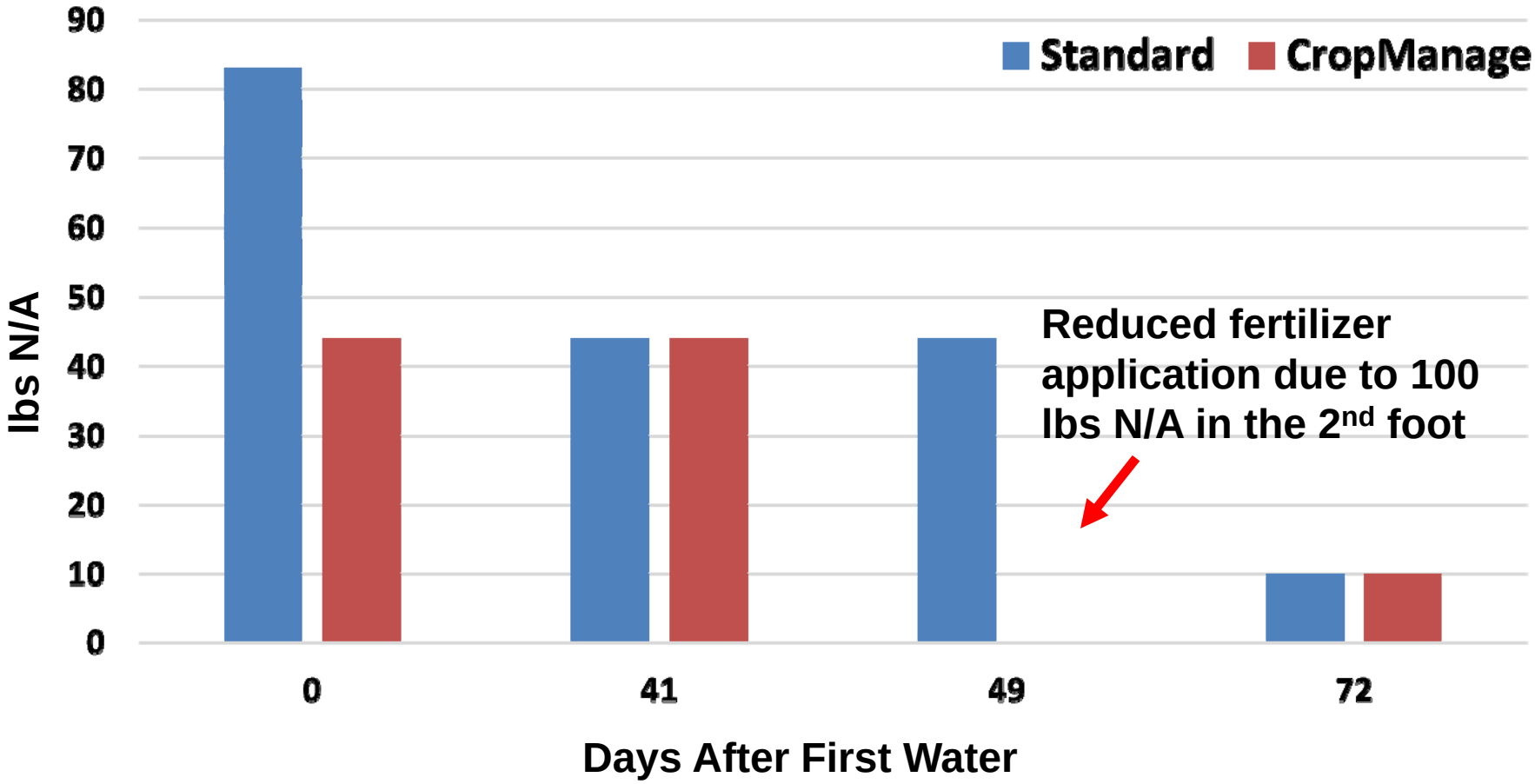


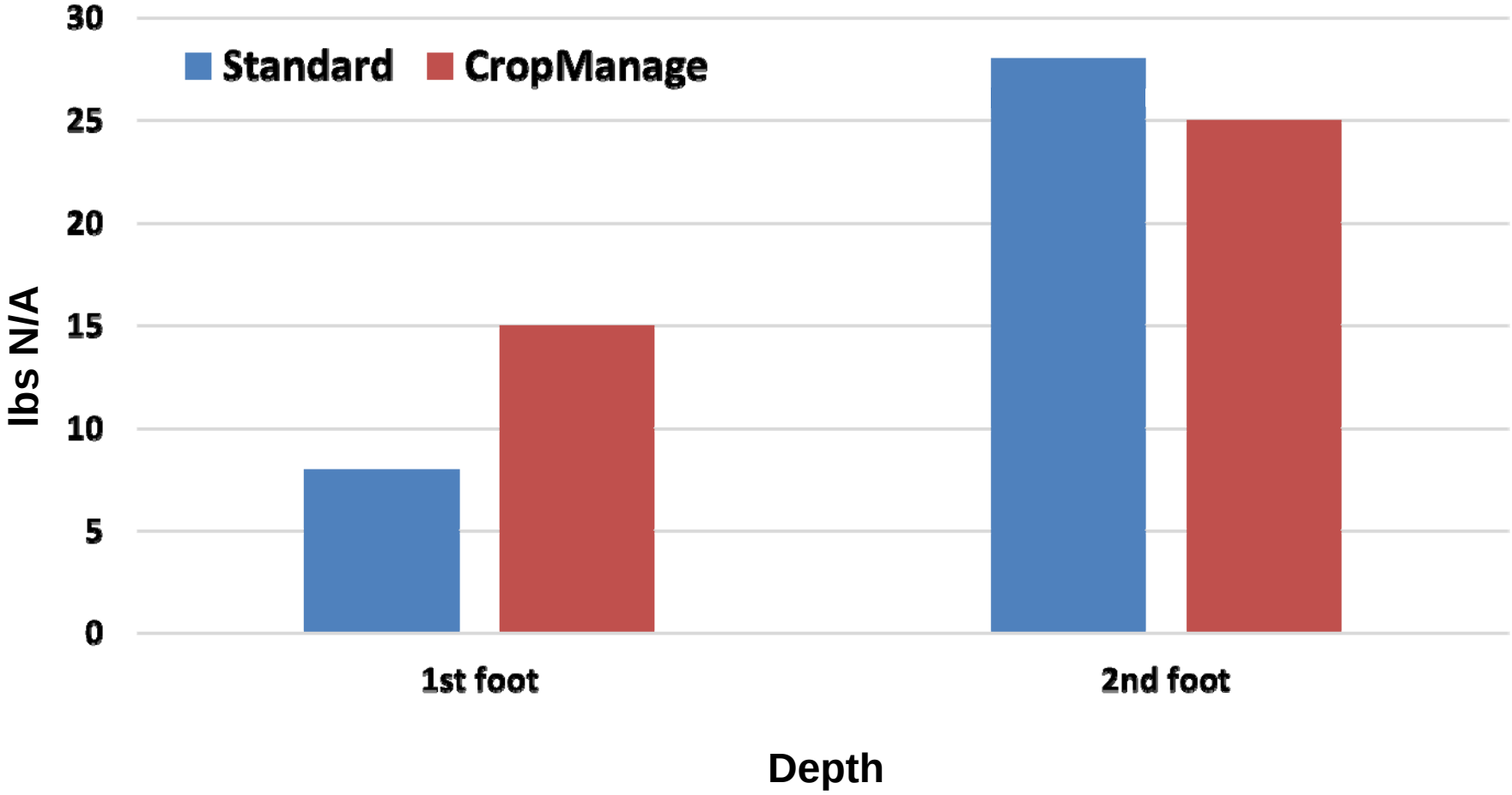
Fertilizer Application to the Treatments



Soil Nitrates (ppm)

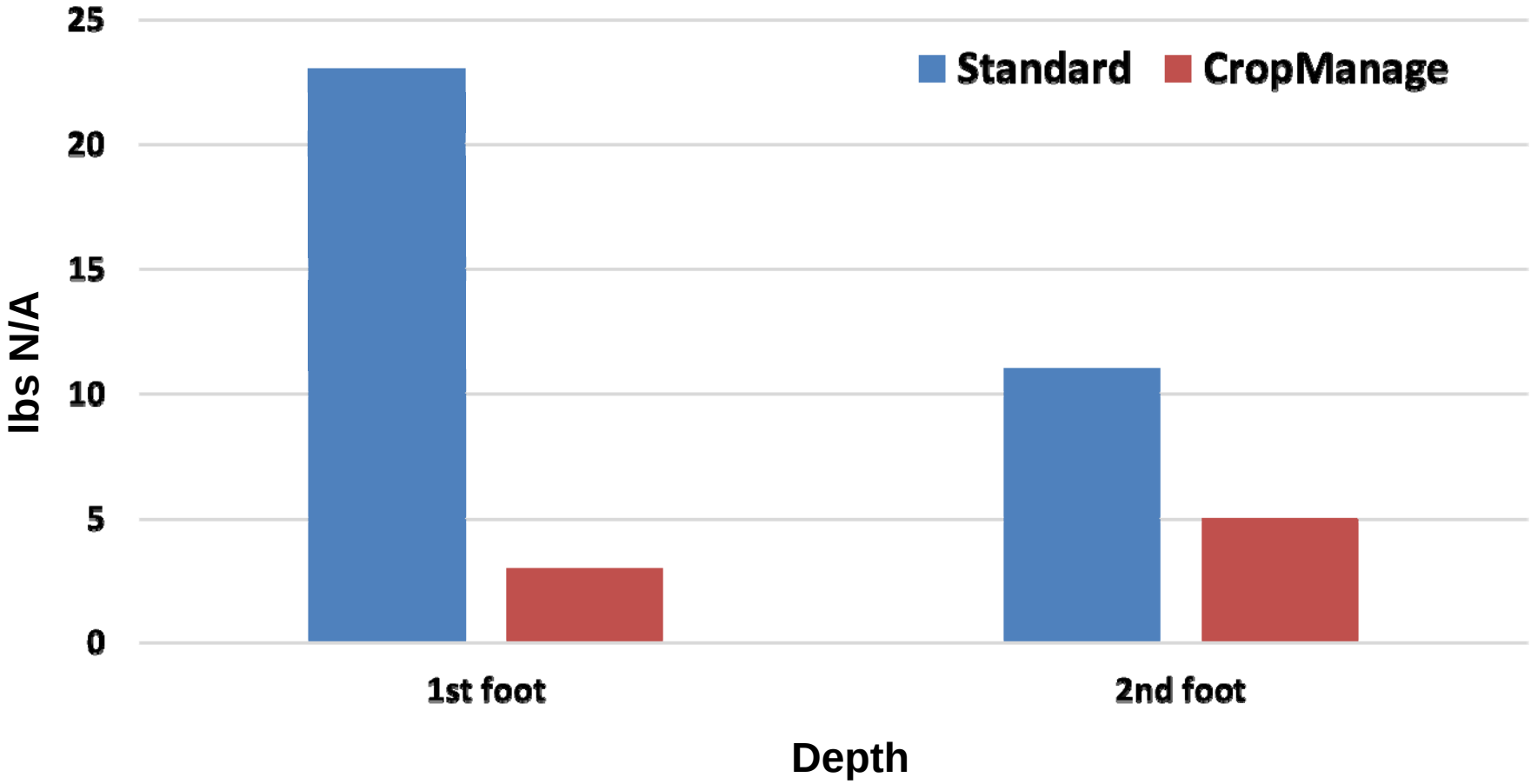
Mid-growth (46 DAGW)

(Left off 44 lbs of N due to high N in 2nd foot)

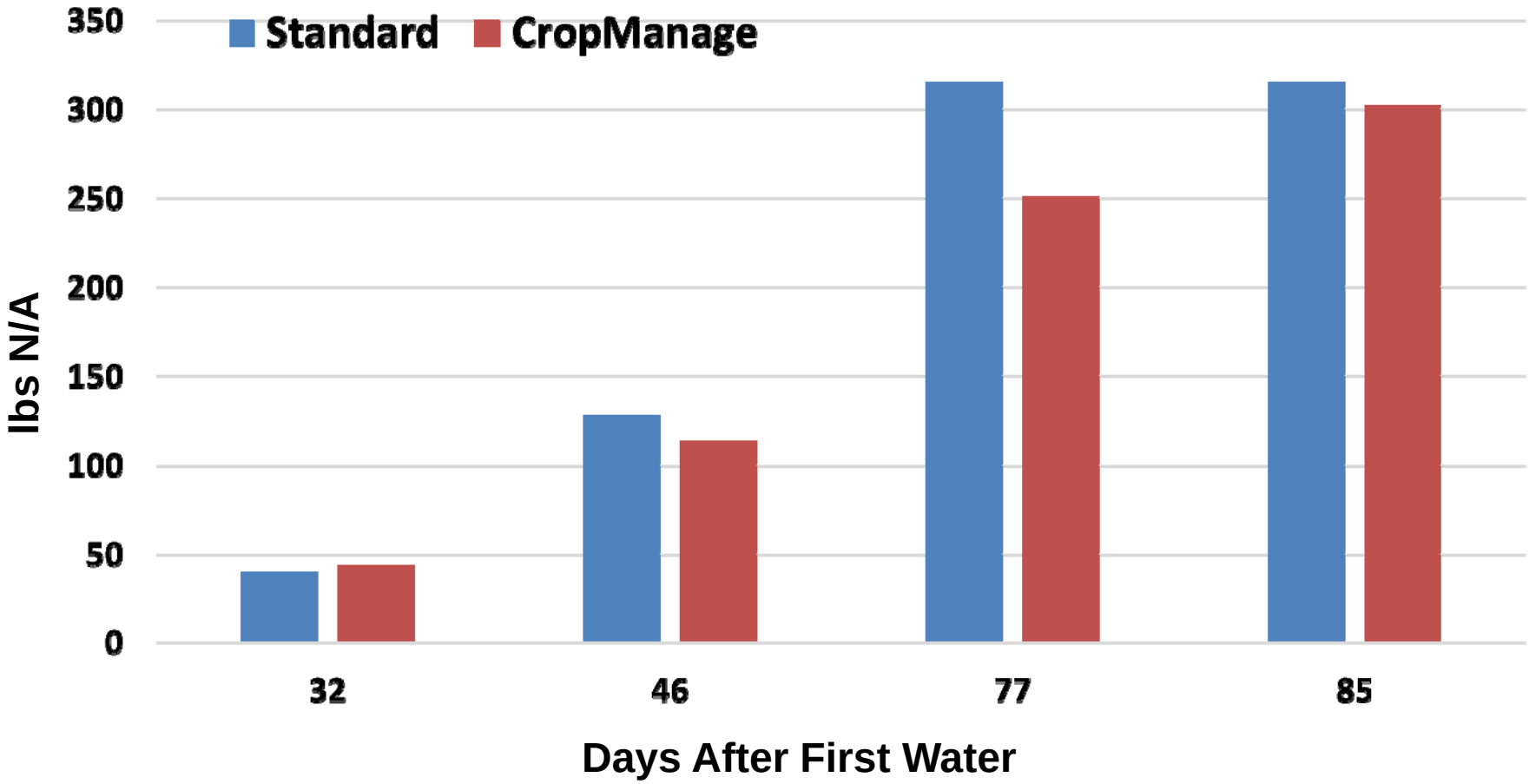


Soil Nitrates (ppm)

Heading (77 DAGW)



Nitrogen in Broccoli Biomass



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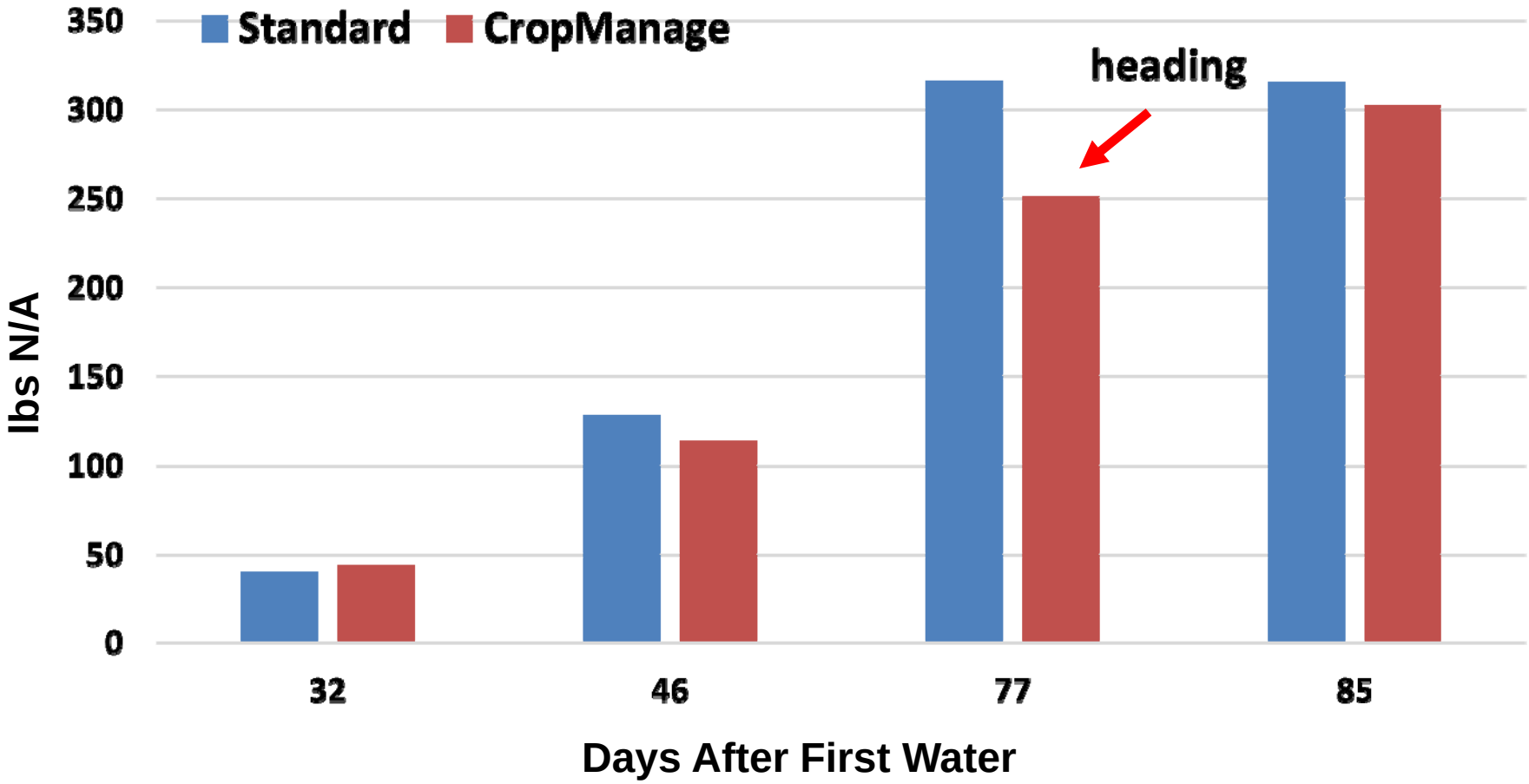


CropManage vs Standard

2015

Treatment	Total N Applied Lbs/A	Commercial Yield T/A	Unaccounted N/A
CropManage	118	3.87	106.2
Standard	206	4.03	130.7

Water application between the two treatments was basically the same

Summary

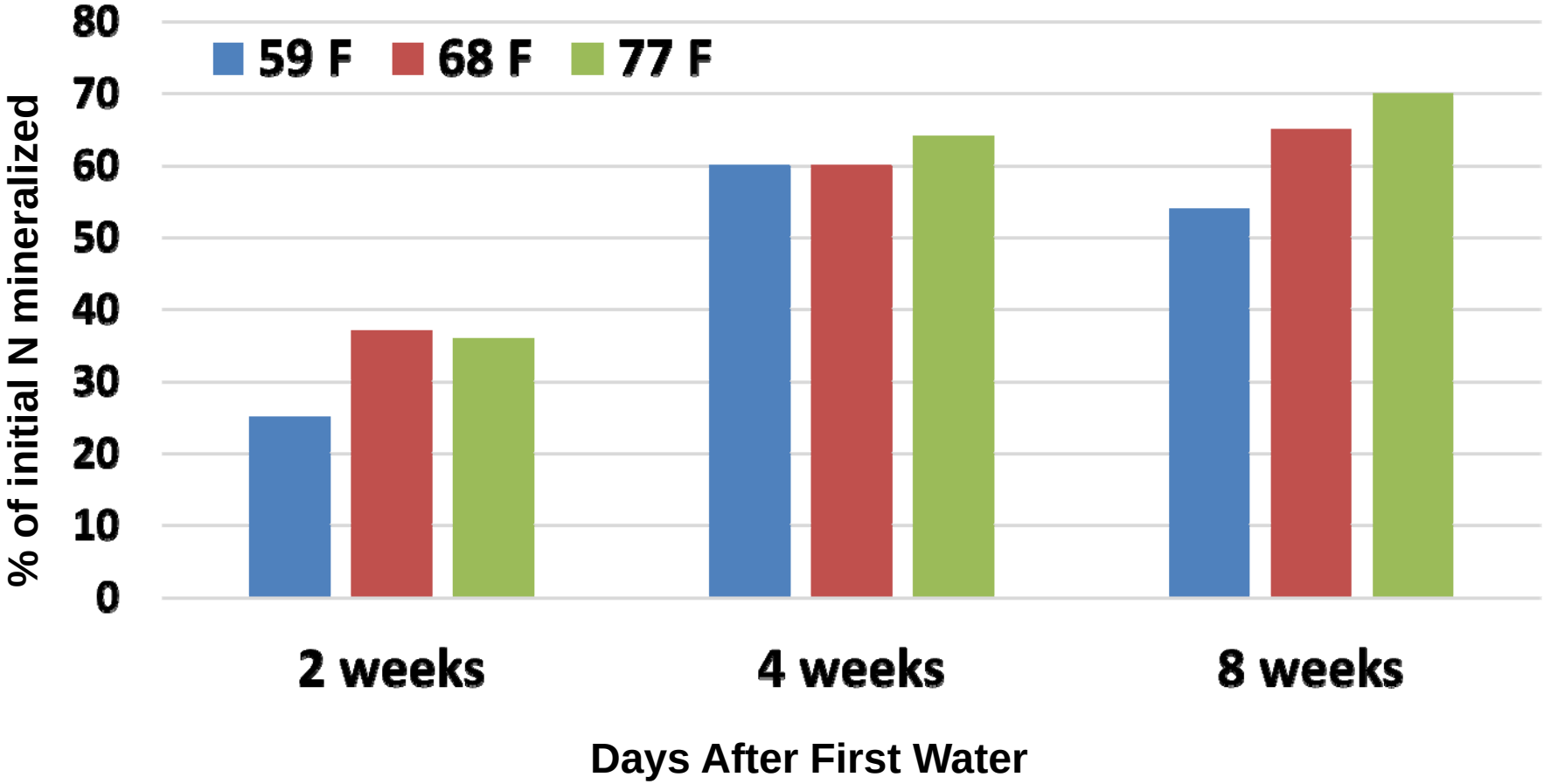
- **This evaluation was unsuccessful and the question is why:**
- **Did we try to use the N in the second foot before we had sufficient roots there?**
- **It may be that broccoli begins using nitrogen from the 2nd foot of soil later in the growth cycle than we realized**

Fate of Nitrogen in Broccoli Residue

- **Broccoli takes up from 250 to 350 lbs N/A**
- **The percent N that is taken away in the harvested product ranges from 25-30%**
- **Therefor a significant portion of the N contained in the crop stays in the field as crop residue (>200 lbs N/A)**
- **What is the fate of this nitrogen?**

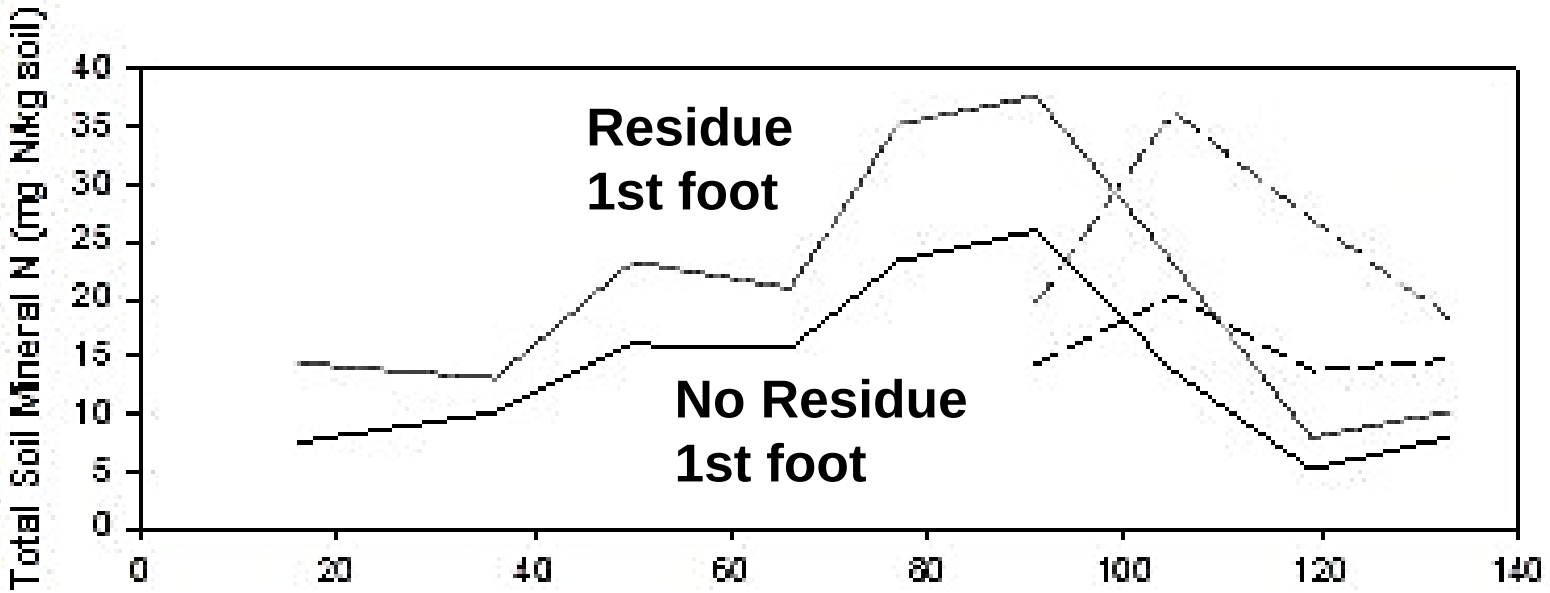
Percent of N in Broccoli Residue Mineralized

Three Timings and Temperatures



Fate on Nitrogen Mineralized from Broccoli Residue

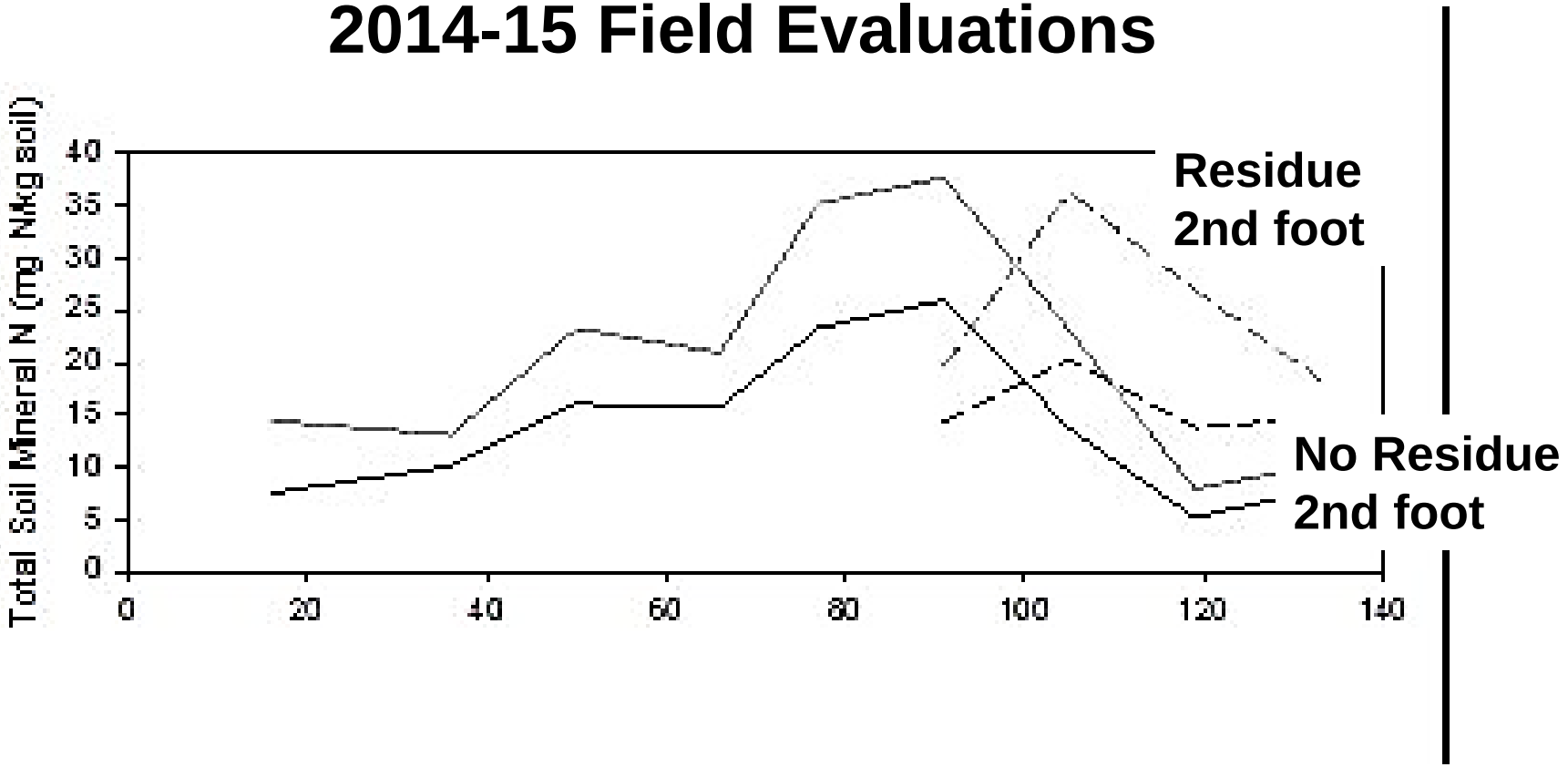
2014-15 Field Evaluations



We cleared broccoli residue from 40’ x 40’ areas and followed the soil nitrate levels over the winter

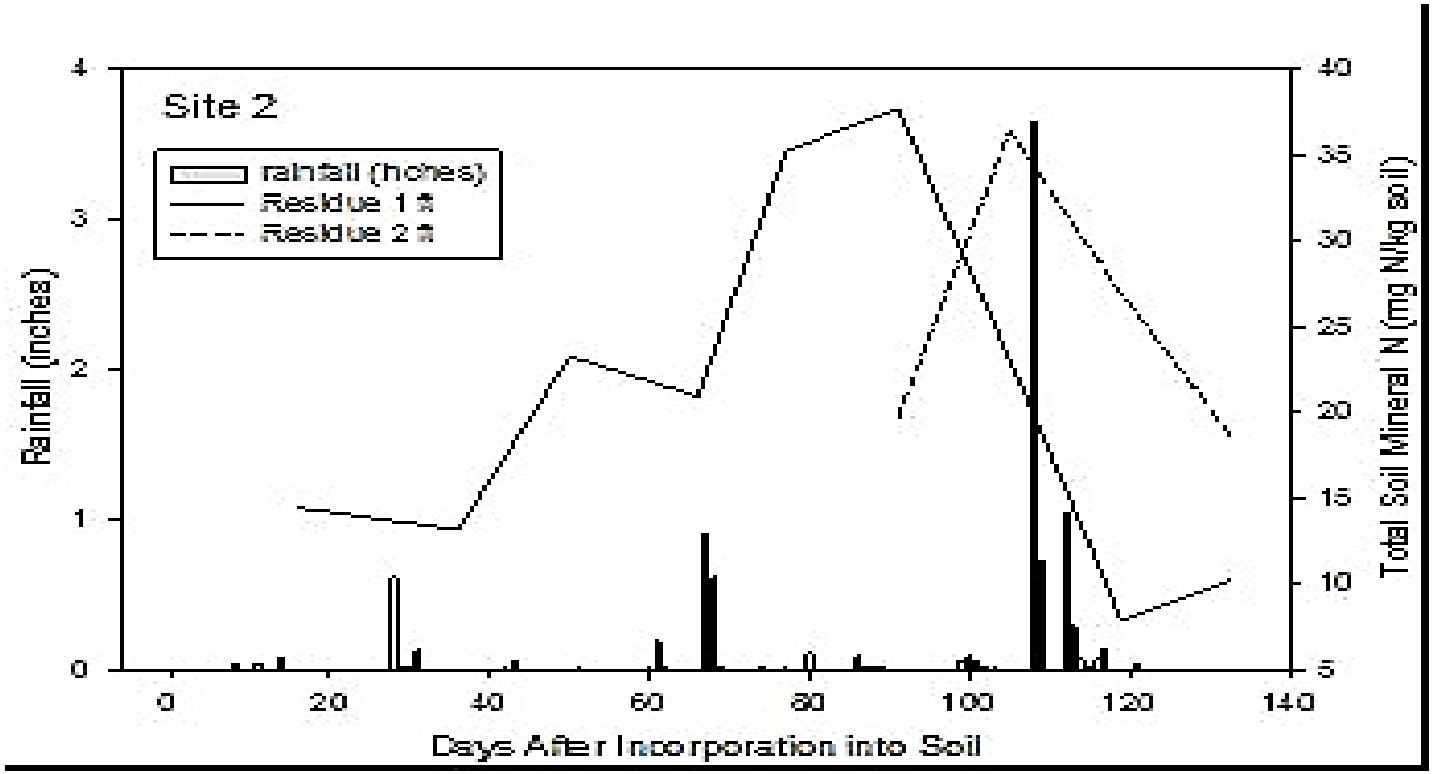
Fate on Nitrogen Mineralized from Broccoli Residue

2014-15 Field Evaluations



Fate on Nitrogen Mineralized from Broccoli Residue

2014-15 Field Evaluations



Summary

- **If residual soil nitrogen levels are not too high, broccoli can take up a large proportion residual soil nitrogen in the soil**
- **Moderate base fertilizer programs are needed to get the broccoli crop established, once that is done, the crop clearly utilizes residual soil nitrate deeper in the soil profile**
- **It may be that the moderate fertilizer programs being used by the growers are fine, they get the crop well established and capable of scavenging**

Summary

- **Our studies on reducing fertilizer programs by accounting for soil nitrate in the second foot of the soil need to be continued, as we are still figuring the N dynamics out**
- **A soil test taken >50 days after the first water gives can give information on the amount of nitrogen in the 2nd foot of soil**
- **The question is how best to use this information to manage fertilizer programs**
- **We are making adjustments to UC Guidelines and CropManage as we learn new information**