25th ANNUAL 2017
FREP WPHA
CONFERENCE

Nutrient Management:
Challenges and Opportunities

November 1-2, 2017
Modesto, California
DoubleTree Hotel

cdfa
CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE

FERTILIZER RESEARCH AND EDUCATION PROGRAM
FREP

Speed Updating

Project #150492SA

Prediction of Summer Leaf Nitrogen Concentration from Early Season Samples to Better Manage Nitrogen Inputs at the Right Time in Walnuts, Prunes, and Pears

Project leaders: Patrick Brown, Emilio Laca

Project Scientist: Sebastian Saa

Cooperators: Katherine Pope, Franz J.A. Niederholzer, Chuck Ingels, Saiful Muhammad, Rachel B. Elkins (Joe Evans), Dani Lightle, Amber Bullard, Richard Buchner, Elana Peach-Fine

Current challenge

- July/August leaf sampling is useful to monitor general performance or identify deficiencies, but is inadequate as a management strategy.
  - Does not provide rate or timing information.
  - Too late to respond for current year, too early for next year.

- UCD has developed new early leaf sampling (UCD-ESP) methods for almond and pistachio, in progress for walnut.
  - Useful as a means to determine if leaves will have adequate N for the season.

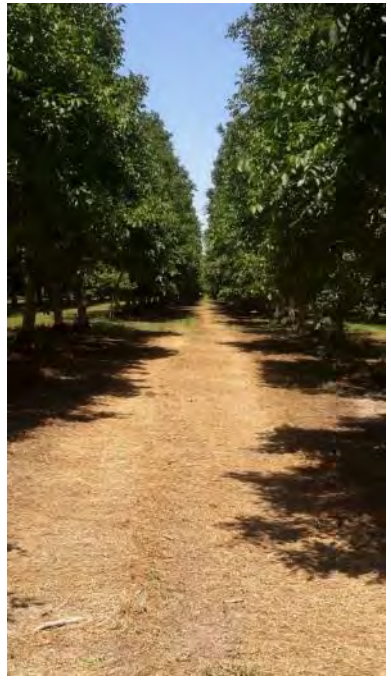
- Several labs have adopted these methods.
  - Ask your lab if they use the UCD-ESP program.

Examples of the 90 orchards selected in CA

Prunes in Sutter

Pears in Lake Eutinier

Walnuts in Tehama

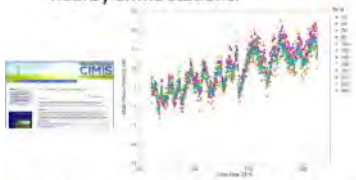


Soil samples collected in each orchard in Spring

Leaf samples collected in Spring and Summer in each orchard

Weather data collected throughout the season

- Growing Degree days were calculated from nearby CIMIS stations.



Each color represents the closet CIMIS weather station to the select orchards.

Orchard management data collected with F.A. at each site

Survey method: Face to face, phone, email, combination

Deliveries…

1. A new early leaf sampling for Prunes, Pears, and Walnuts.

   ***Status*: Results indicate a high accuracy level for each crop.**

2. A user friendly online interface to help growers, extension specialists and consultants design nutrient plans based on early season leaf samples.

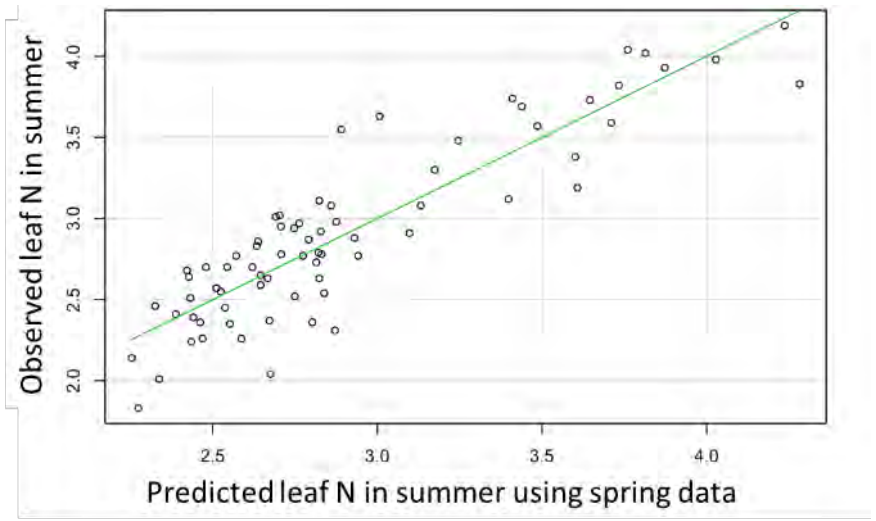
   ***Status*: Under development by UC Davis, Plant Sciences IT.**

3. Outreach material to promote the use of this tool, and an understanding of these models, to better manage nitrogen inputs at the right time in these nut and fruit trees.

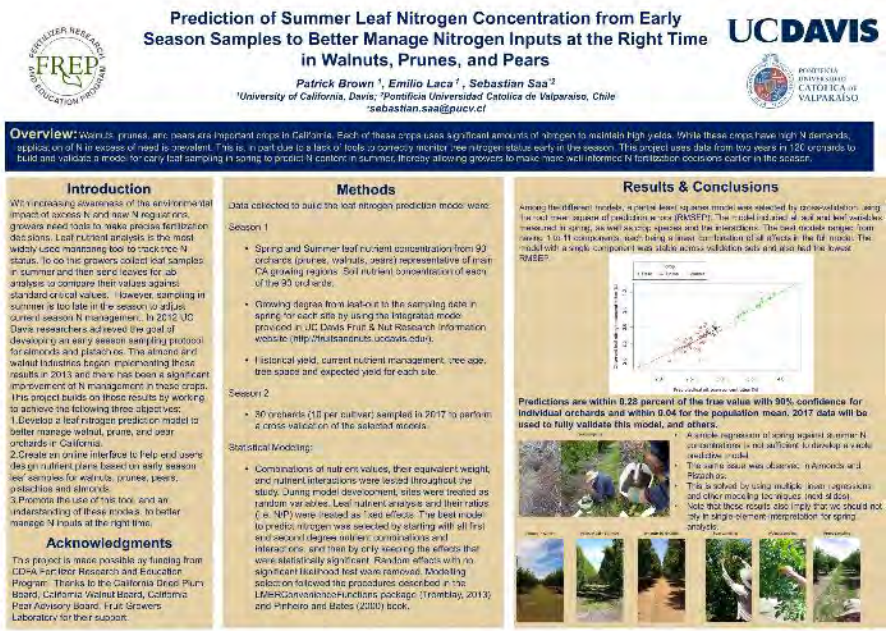
   ***Status*: Outreach material such as videos, model protocols, press release, and field days are under development and will be released during 2018.**

Example of deliveries

Model development



IPNC, Denmark, 2017



Prediction of Summer Leaf Nitrogen Concentration from Early Season Samples to Better Manage Nitrogen Inputs at the Right Time in Walnuts, Prunes, and Pears

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UCDAVIS

Overview: Walnuts, prunes, and pears are important crops in California. Each of these crops uses significant amounts of nitrogen to maintain high yields. While these crops have high N demands, application of N in excess of need is prevalent. This is, in part due to a lack of tools to correctly monitor tree nitrogen status early in the season. This project uses data from two years in 120 orchards to build and validate a model for early leaf sampling in spring to predict N content in summer, thereby allowing growers to make more well-informed N fertilization decisions earlier in the season.

Introduction

With increasing awareness of the environmental impact of excess N and new N regulations, growers need tools to make precise fertilization decisions. Leaf nutrient analysis is the most widely used monitoring tool to track tree N status. To do this growers collect leaf samples in summer and then send leaves for lab analysis to compare their values against standard critical values. However, sampling in summer is too late in the season to adjust current season N management. In 2012 UC Davis researchers achieved the goal of developing an early season sampling protocol for almonds and pistachios. The almond and walnut industries began implementing these results in 2013 and there has been a significant improvement of N management in these crops. This project builds on these results by working to achieve the following three objectives:
1.Develop a leaf nitrogen prediction model to better manage walnut, prune, and pear orchards in California.
2.Create an online interface to help end users design nutrient plans based on early season leaf samples for walnuts, prunes, pears, pistachios and almonds.
3.Promote the use of this tool, and an understanding of these models, to better manage N inputs at the right time.

Acknowledgments

This project is made possible by funding from UCD-A Fertilizer Research and Education Program. Thanks to the California Dried Plum Board, California Walnut Board, California Pear Advisory Board, Fruit Growers Laboratory for their support.

Methods

Data collected to build the leaf nitrogen prediction model were:

Season 1

- Spring and Summer leaf nutrient concentration from 90 orchards (prunes, walnuts, pears) representative of main CA growing regions. Soil nutrient concentration of each of the 90 orchards.
- Growing degree from leaf-out to the sampling date in spring for each site by using the Integrated model provided in UC Davis Fruit & Nut Research Information website (http://fruitsandnuts.ucdavis.edu).
- Historical yield, current nutrient management, tree age, tree space and expected yield for each site.

Season 2

- 30 orchards (10 per cultivar) sampled in 2017 to perform a cross validation of the selected models.

Statistical Modeling:

- Combinations of nutrient values, their equivalent weight, and nutrient interactions were tested throughout the study. During model development, sites were treated as random variables. Leaf nutrient analyses and their ratios (i.e. N/P) were treated as fixed effects. The best model to predict nitrogen was selected by starting with all first and second degree nutrient combinations and interactions, and then by only keeping the effects that were statistically significant. Random effects with no significant likelihood test were removed. Modeling selection followed the procedures described in the LMERConvenienceFunctions package (Tremblay, 2013) and Pinheiro and Bates (2000) book.

Results & Conclusions

Among the different models, a partial least squares model was selected by cross-validation using the root mean square of prediction error (RMSEP). The model included all soil and leaf variables measured in spring, as well as crop, species and the interactions. The best models project from twelve 1-to-11 components, each being a linear combination of all effects in the full model. The model with a single component was stable across validation sets and also had the lowest RMSEP.

Predictions are within 0.28 percent of the true value with 90% confidence for individual orchards and within 0.04 for the population mean. 2017 data will be used to fully validate this model, and others.

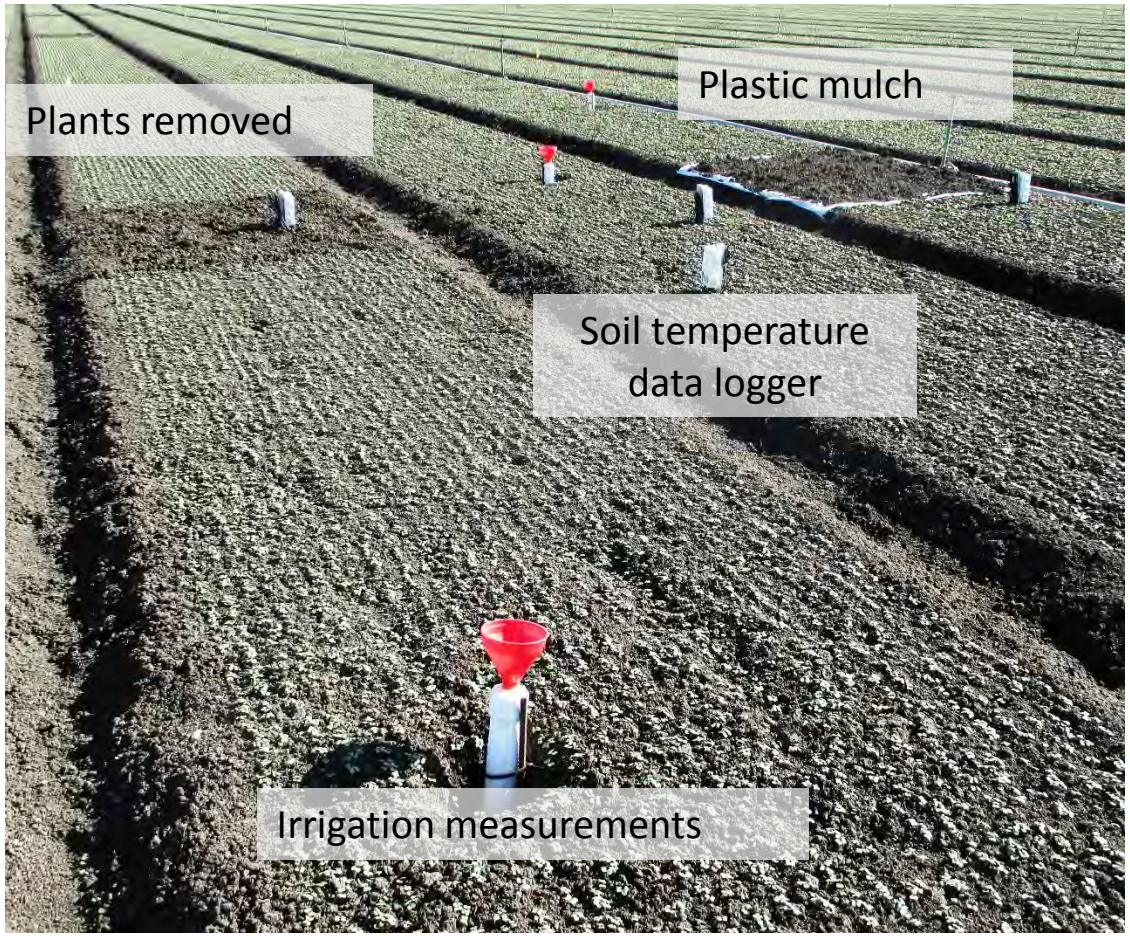
- A simple regression of spring against summer N concentrations is not sufficient to develop a early predictive model.
- The same issue was observed in Almonds and Peaches as.
- This is solved by using multiple linear regressions and other modeling techniques (next slide).
- Note that these results also imply that we should not rely in single element interpretation for spring analysis.

Video clips

Evaluation and demonstration of nitrogen management of organic vegetable production in leafy green vegetables on the Central Coast

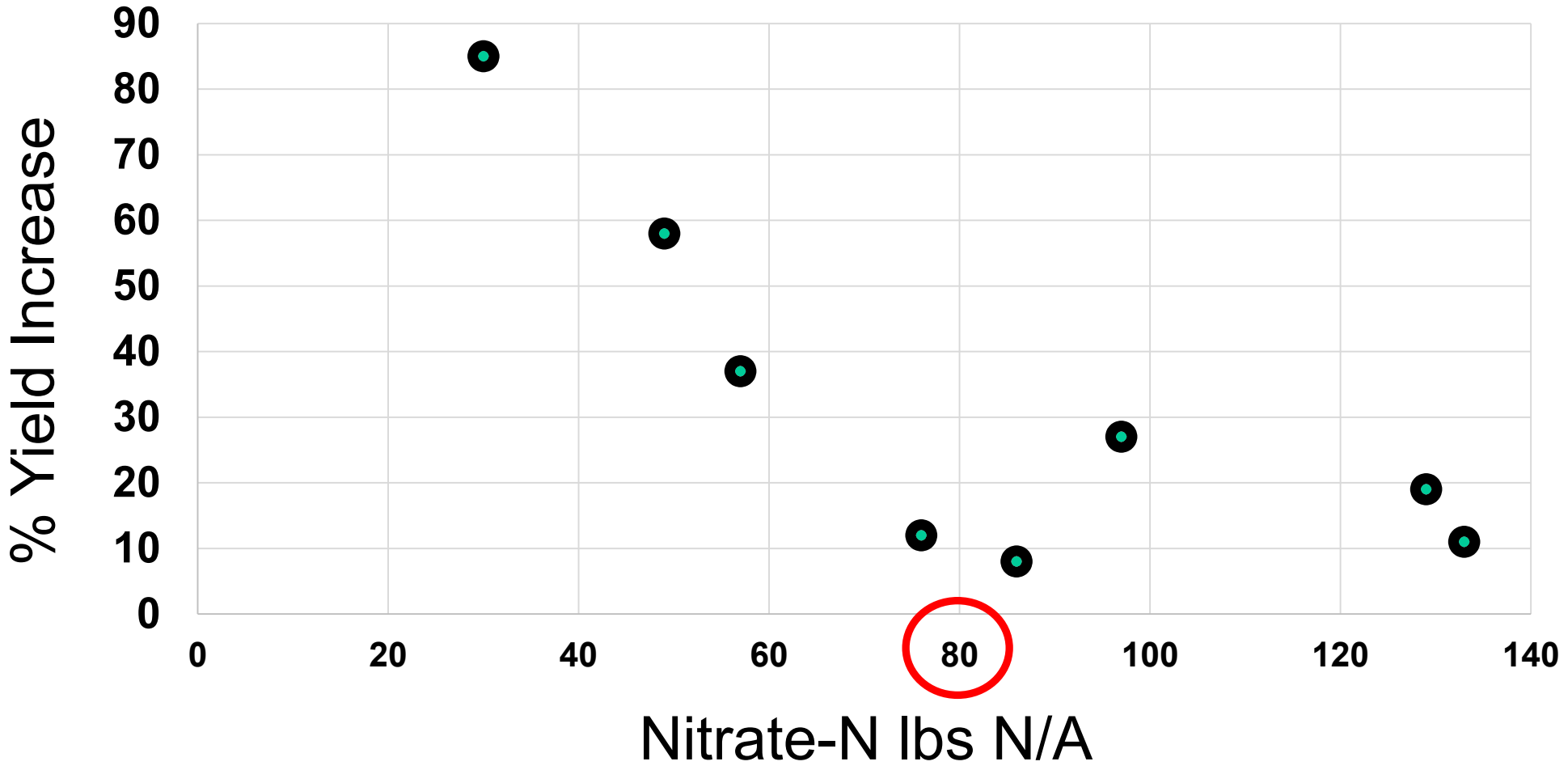
Richard Smith, Michael Cahn, Tim Hartz and Daniel Geisseler
University of California Cooperative Extension
Monterey County and UCD

In-field Soil Organic Matter Mineralization Evaluations

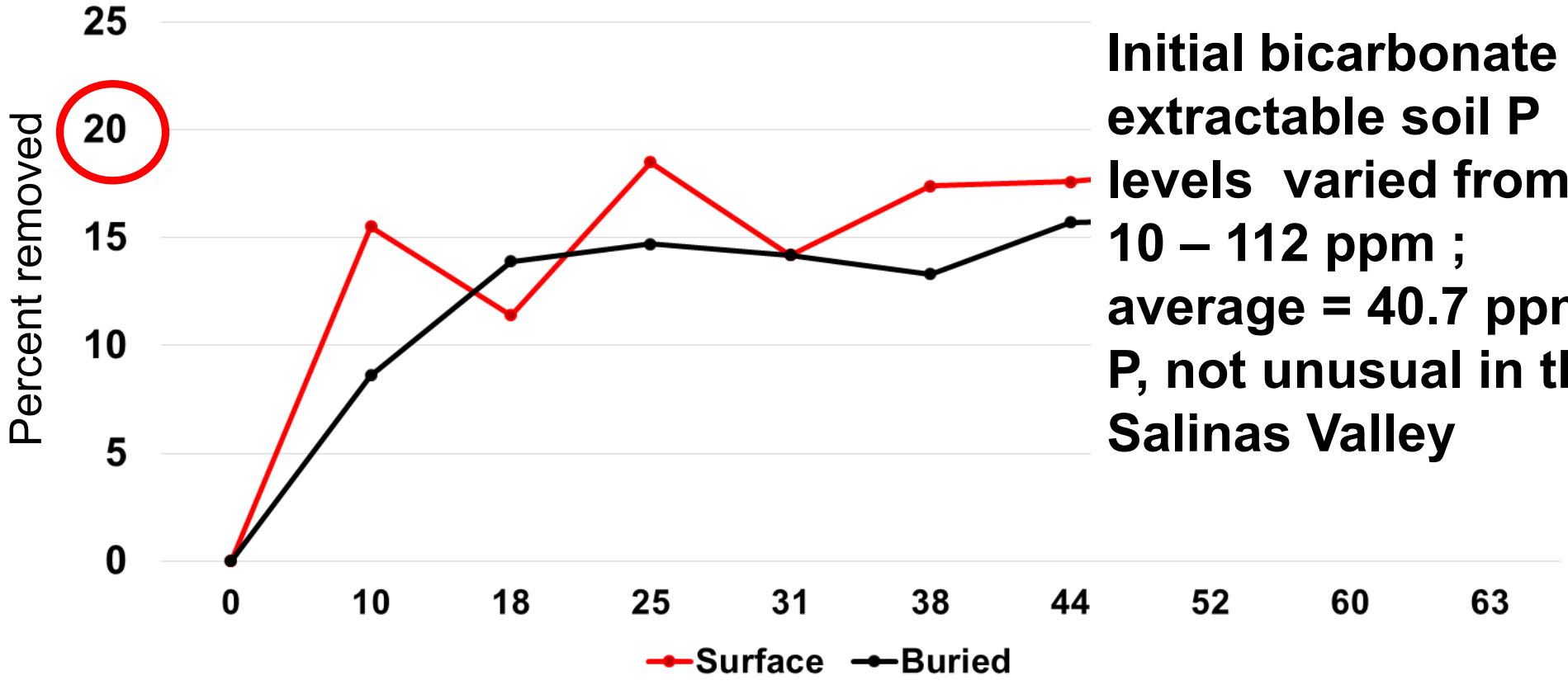


- **The use of plots with and without plants, and with plastic mulch were used to estimate the quantity of nitrate mineralized from the soil over the course of the cropping cycle**
- **Evaluations indicated that from 0.6 to 3.3 lbs N/A/day were mineralized**
- **The amount mineralized was loosely correlated with %N in the soil**

Initial Nitrate-N and Percent Yield Increase with Fertilization



4-4-2
Percent Phosphorus Released to Soil
Buried vs Surface



Initial bicarbonate extractable soil P levels varied from 10 – 112 ppm ; average = 40.7 ppm P, not unusual in the Salinas Valley

Days after Planting

Summary

- Evaluations of the impact of soil mineralization are still on-going
- Fast maturing baby lettuce and spinach need a preplant soil evaluation because there is no time to react later in the cycle
- A nitrate quick test following the germ water may be the best tool for getting an understanding of N available for the crop
- Most of the P in 4-4-2 is not soluble at the pH's of SV soils (probably from bone meal)

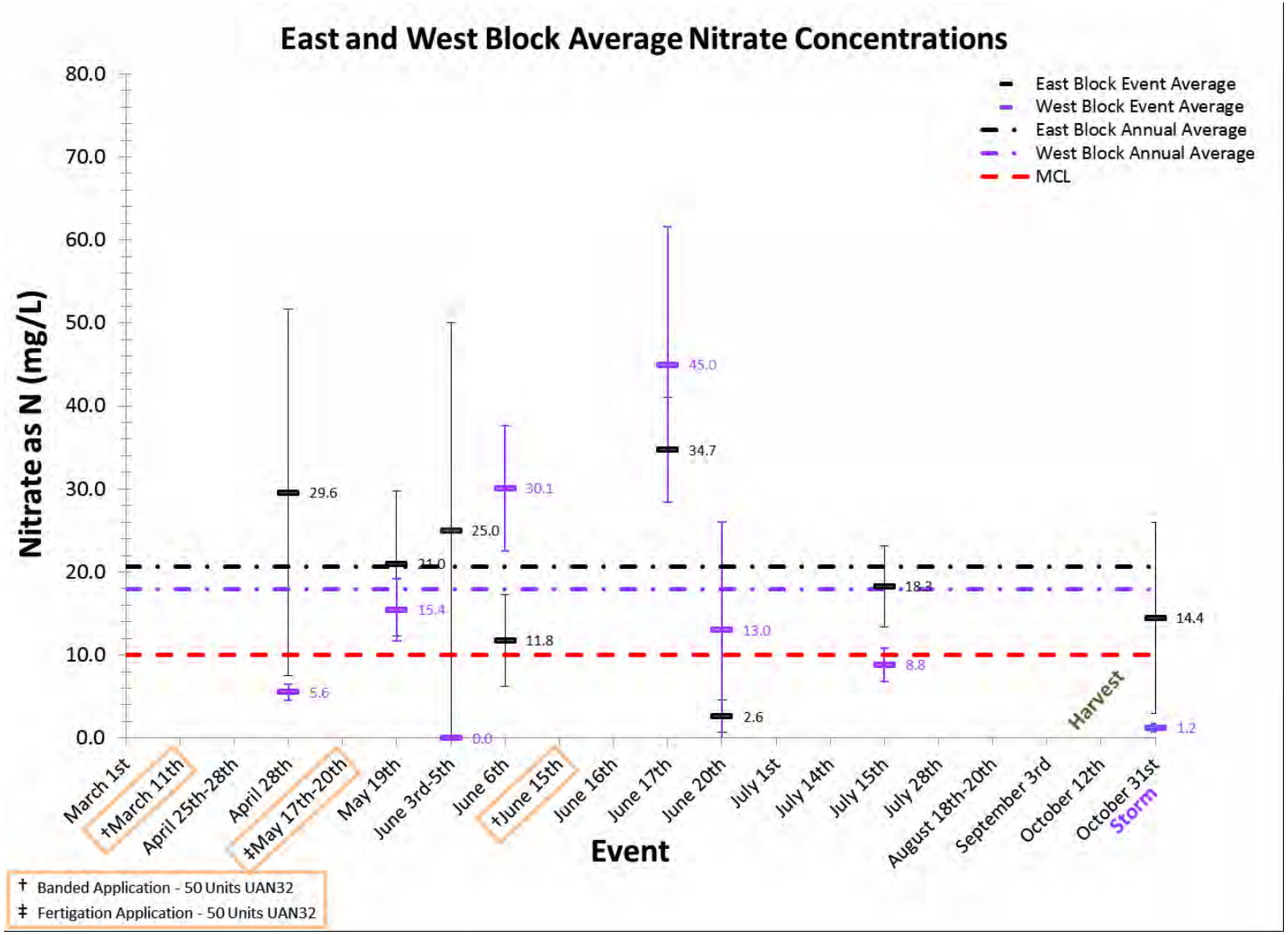
Evaluation of the Multiple Benefits of Nitrogen Management Practices in Walnuts

Parry Klassen
Coalition for Rural Urban Environmental Stewardship (CURES)
www.curesworks.org

Project Objectives

- Identify management practices implemented to reduce nitrogen moving past the root zone in two walnut orchards
- Determine the amount and timing of nitrogen moving through the root zone
- Identify benefits of implemented management practices
  - Cost savings (reduced water use, reduced fertilizer use)
  - Groundwater protection
- Determine if additional practices could be implemented to further reduce nitrogen moving past the root zone
- Disseminate results to growers of walnuts

Year 1 Results (2016)



Observations From 2016
Changes Made in 2017

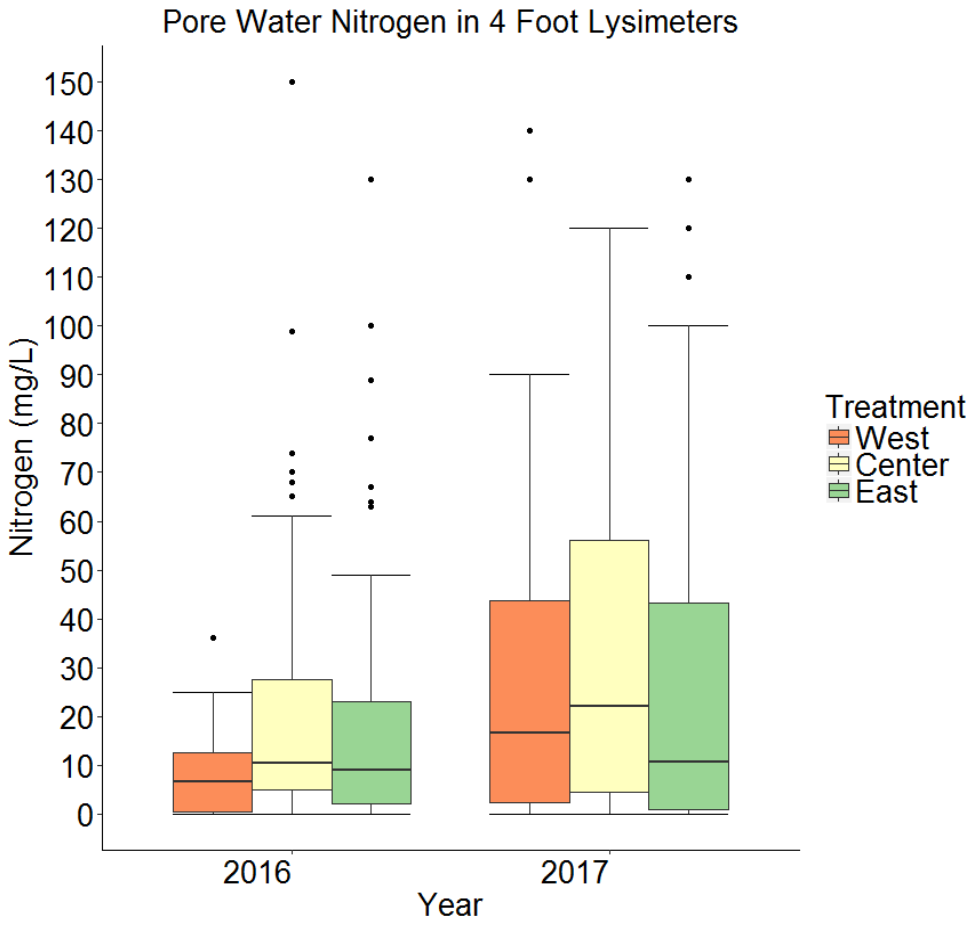
2016 Observations

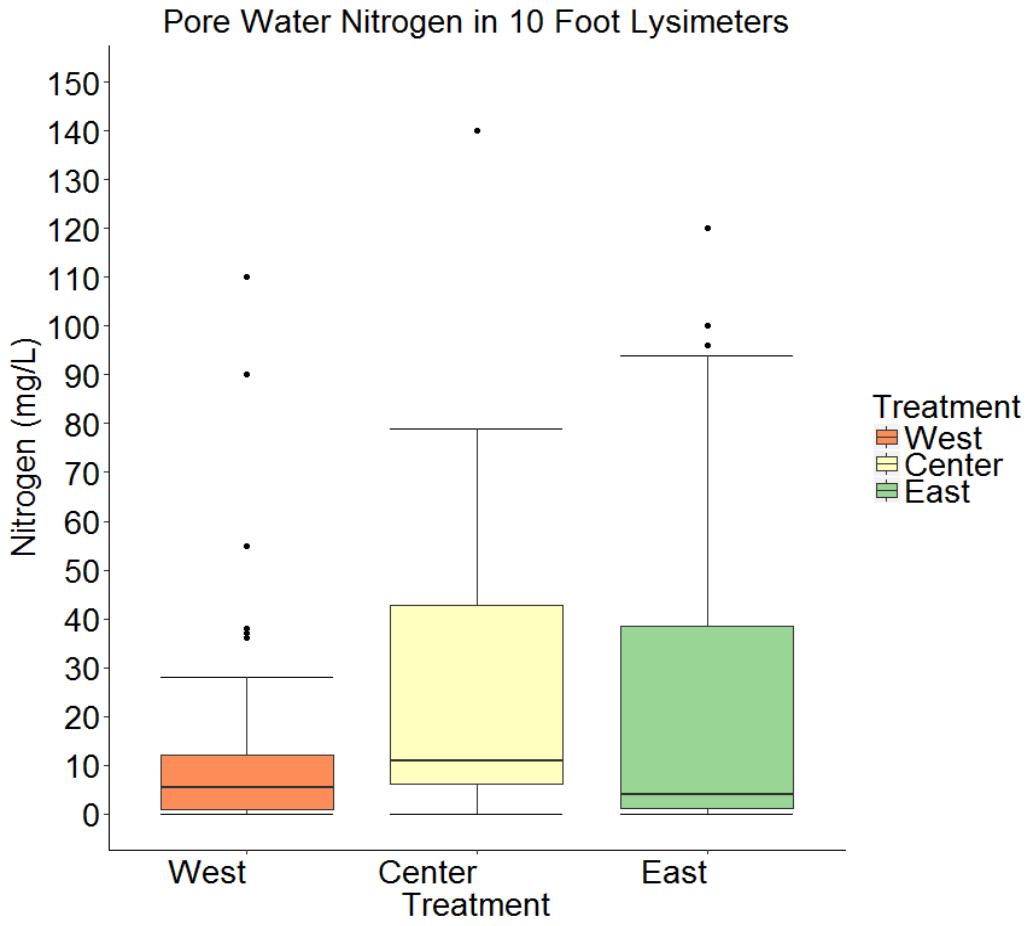
- Fertilization by banded applications followed by flood irrigation
- Flood irrigation events were causing considerable nitrate movement to four feet: was it from just previous nitrogen application or the combination of all previous applications?
- Grower wondered what was going on below our 4 ft lysimeters

2017 Changes

- Grower agreed to delay flood irrigation until after fertilization was complete
  - Fertilizer applied by sprinkler fertigation
- Added 10’ deep lysimeters to measure nitrate movement below active root systems
- Grower decided to split two blocks into three blocks to minimize the piping needed for fertigation and irrigation

Year 2 Results (2017)





Quantifying N_2O Emissions under Different On-farm Irrigation and Nutrient Management BMPs that Reduce Groundwater Nitrate Loading and Applied Water

California State University, Monterey Bay

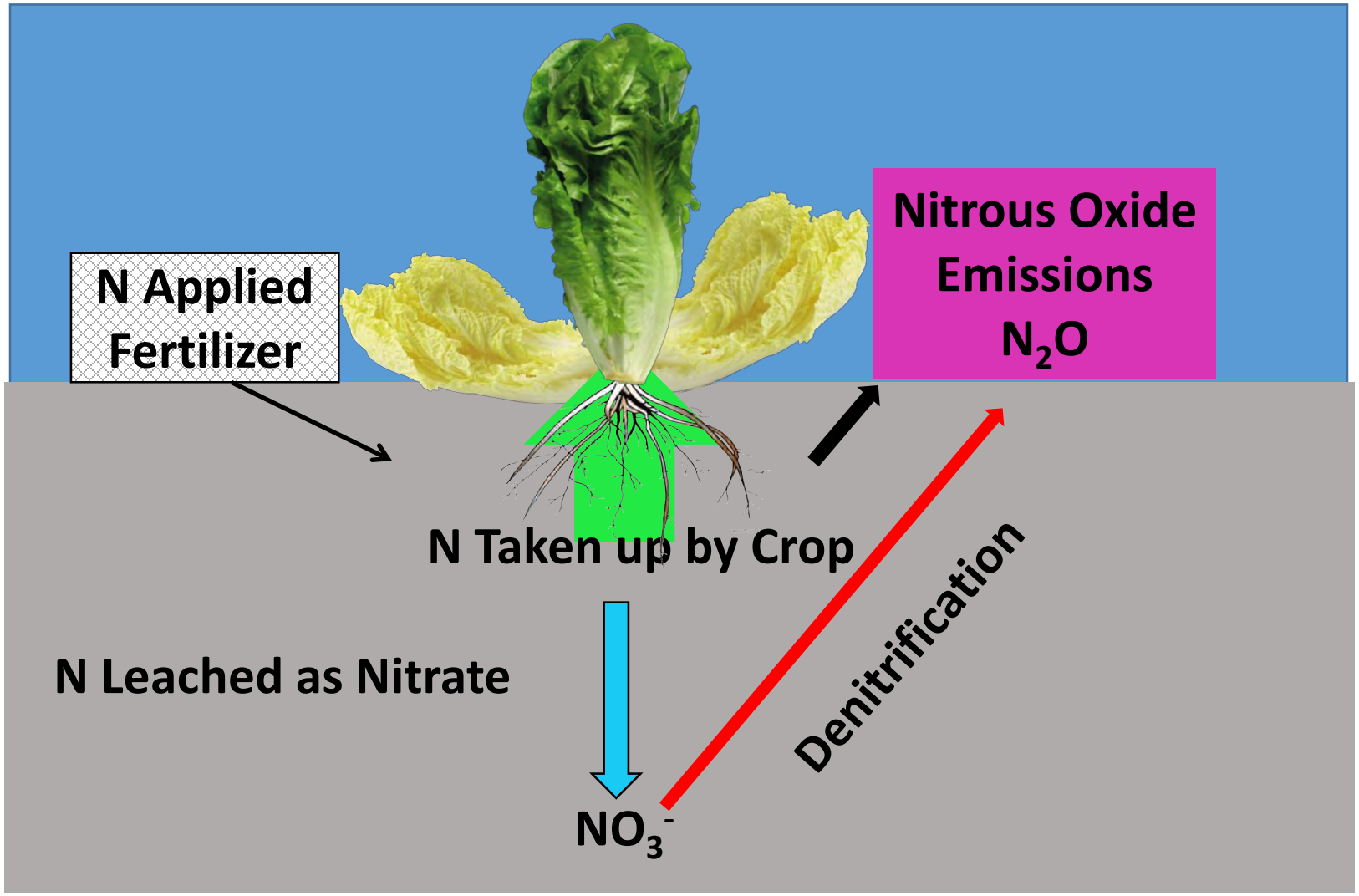
NASA ARC-CREST

UC Cooperative Extension

UC Davis

D'Arrigo Brothers

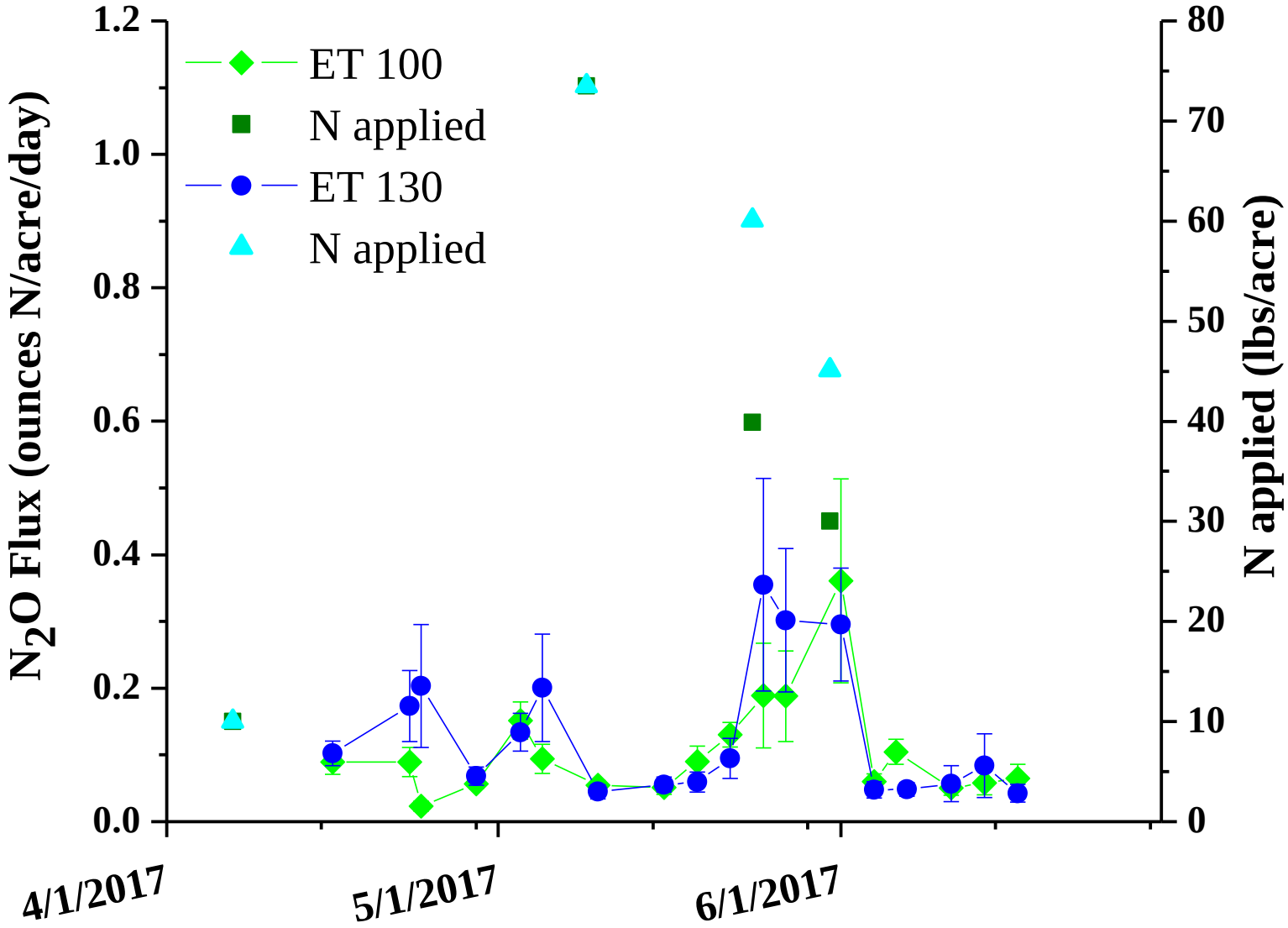
Huntington Farms



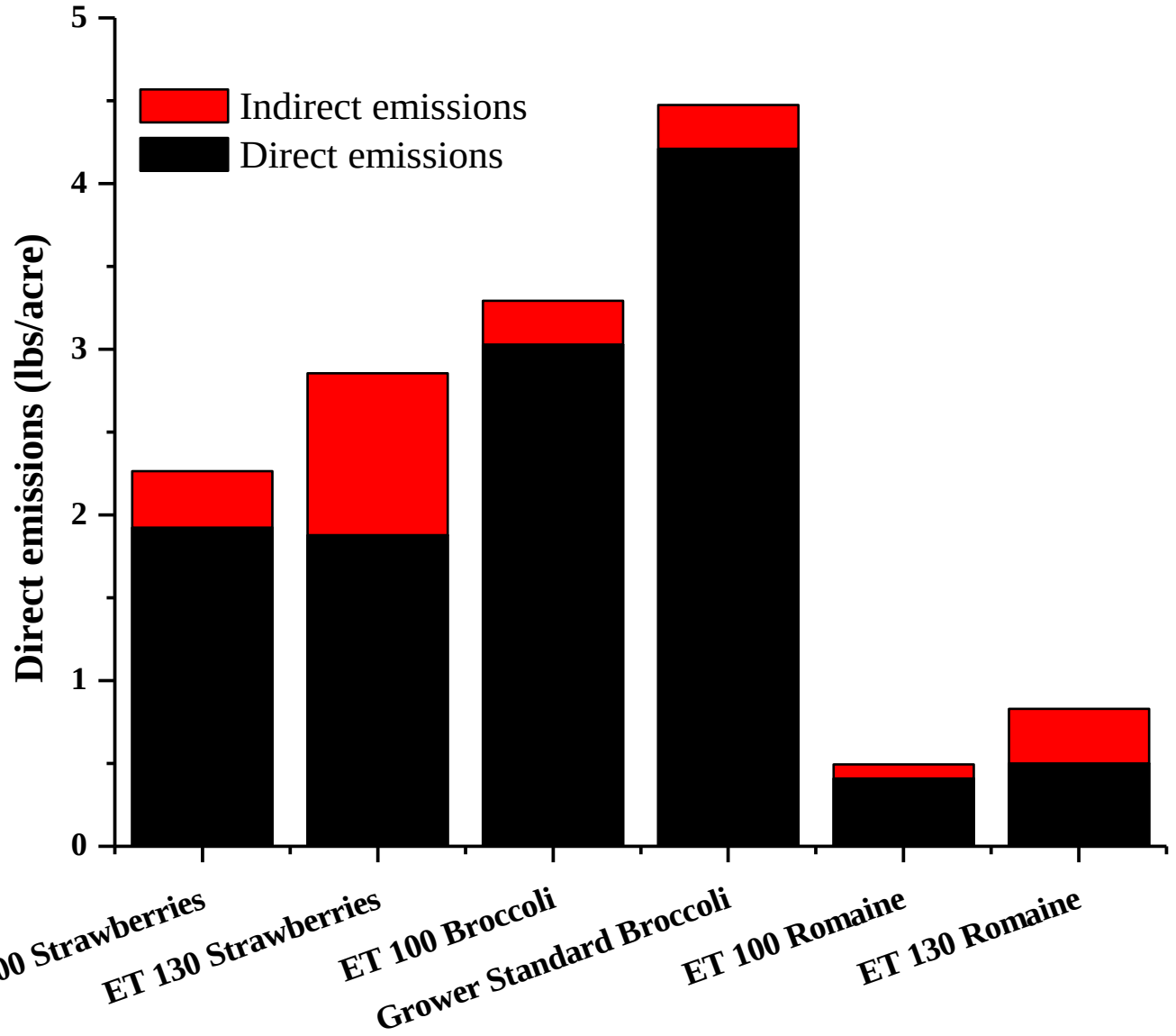
Nitrate Data is still Preliminary

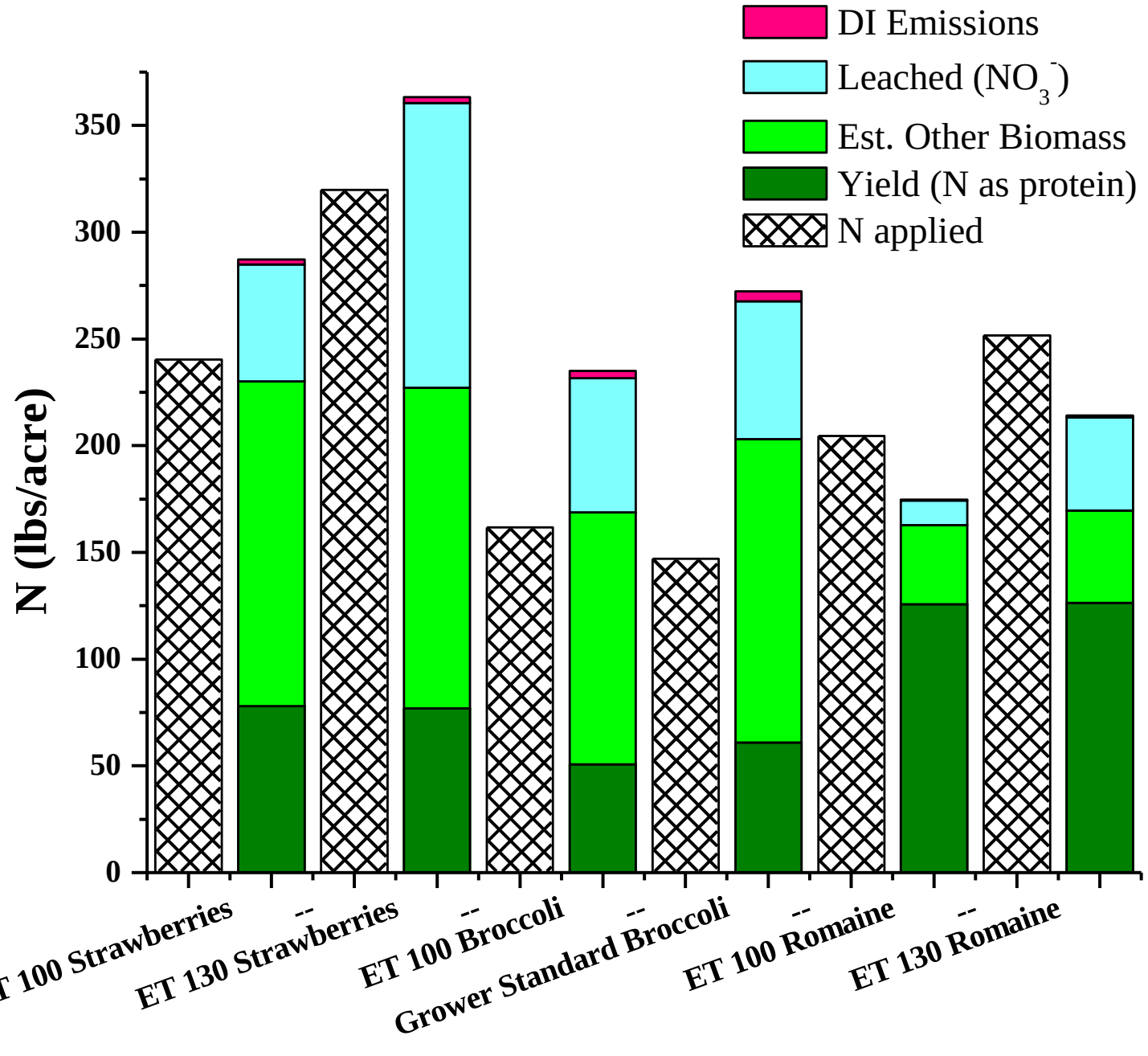
Pending data includes Residual N in soil at the time of planting

Romaine Lettuce



Nitrous Oxide Gas Emissions




DI Emissions
Leached (NO_3^-)
Est. Other Biomass
Yield (N as protein)
N applied
N (lbs/acre)
0
50
100
150
200
250
300
350
ET 100 Strawberries
--
ET 130 Strawberries
--
ET 100 Broccoli
--
Grower Standard Broccoli
--
ET 100 Romaine
--
ET 130 Romaine
Treatment