# Evaluation of the Multiple Benefits of Nitrogen Management Practices in Walnuts

Parry Klassen
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# Study Overview

- *Walnut Orchard located east of Ceres (Stanislaus County)*
- *2-year study*
  - *2016-2017 crop years*

*Project Technical Consultant*

- MLJ Environmental, Davis
- Performed lysimeter installation, data gathering and analysis

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# Project Objectives

#1: Identify management practices implemented to reduce nitrogen moving past the root zone in two walnut orchards

#2: Determine the amount and timing of nitrogen moving through the root zone following adequate rain to saturate soils

#3: Identify benefits of implemented management practices

a. Cost savings (reduced water use, reduced fertilizer use)
b. Groundwater protection

#4: Determine if additional practices could be implemented to further reduce nitrogen moving past the root zone

#5: Disseminate results to growers of walnuts

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# Efficient Nitrogen Management
## ***Applying the 4 R's Principles***

- Apply at the *Right Time*
- Apply the *Right Rate*
- Use the *Right Source*
- Apply in the *Right Place*

# Study parameters, analyses, and measurements

| Parameter | Analyses | Distribution | Collection depth | Frequency |
|---|---|---|---|---|
| Pore water | Nitrate as N | 15 locations per block | 4 feet (2016, 2017), 10 feet (2017) | 1 rain event, 6 irrigation events |
| Irrigation water | Nitrate as N | Groundwater and surface water | NA | As needed to characterize nitrate applied. |
| Soil cores | Nitrate as N, C:N ratio, % moisture | 8 random locations per block | 2 foot intervals to 10 feet (5 samples per 10-foot core) | 2 in 2016, early season and late season; 1 in 2017, early |
| Solvita Labile Ammino-N (SLAN) | Nitrogen mineralization potential | 8 random locations per block (Sub-sampled from soil cores) | 2-4 foot interval (variable based on results) | 2 in 2016; early season and late season; none in 2017 |
| Tissue (nut and hull only) | Total nitrogen, % moisture | 10 random locations in east and west block | NA; samples collected from multiple trees within the grid square | Annually, just prior to harvest. |
| Soil volumetric water content | % VWC | 5 random locations per block | 2 feet, 4 feet | Continuous logging; 15-minute interval |

# Walnut Orchard

- Located in Stanislaus County near Ceres
- Chandler walnut cultivar on black walnut rootstock
- 20 yrs old with replanting as needed for losses from disease (bacterial canker)
- East block (4.09 acres)
  - 170 trees/acre
  - Each tree irrigated with one 10.3 gal/hr microsprinkler
- Center block (3.50 acres)
  - 108 trees/acre
  - Each tree irrigated with one 19.6 gal/hr microsprinkler
- West block (2.34 acres)
  - 108 trees/acre
  - Each tree irrigated with one 19.6 gal/hr microsprinkler

# Treatments

- 2016
  - 2 blocks: West and East
  - 4 ft. lysimeters only
- 2017
  - 3 blocks: West, Center and East
    - An improved understanding of the irrigation system resulted in sub-dividing the West Block into the West and Center Blocks
  - 4 ft. and 10 ft. lysimeters sampled
  - Locations of tissue sample collection, and moisture sensors remained the same

# East Block: 4.09 acres

West Block: 2.34 acres  Center Block: 3.50 acres (blue outline)

# Soil Cores

- Collected in May and November 2016, March 2017
- Five 10 ft cores from each block
  - Divided into 2 ft sections
- Characterized for texture by section
- Measured concentration of $NO_3$-N

# Walnut orchard - soils

- Hanford fine sandy loam
- Tujunga loamy sand
- Sand lens of more compacted material approximately 10 cm thick is found between 150 and 300 cm below ground surface across some of both blocks
- Depth to groundwater is 40 m

# Irrigation Water Analysis Report for Nitrate

| Sample ID | Nitrate ($NO_3$) ppm |
|---|---|
| I | 63 |
| II | 48 |
| III | 2 |
| IV | 38 |
| V | 63 |

# 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

# Walnut orchard – irrigation and fertilizer 2016

- Combination of microsprinkler using groundwater and flood irrigation using surface water
- Fertilizer – 150 lbs/acre in three 50 lb/acre applications
  - Urea-ammonium nitrate solution fertilizer (UAN 32) used for all fertilizations
  - Combination of fertigation and banded applications
  - Fertigation combined with normal irrigation events
    - Concentration of $NO_3$ during fertigation events – 515 mg/L $NO_3$-N
  - Banded applications prior to flood irrigation
  - Tissue testing in early July indicated no need for additional applications

# Walnut orchard – irrigation and fertilizer 2017

- Fertilizer applications by fertigation only
- Flood irrigation during non-fertilization events
- Fertilizer - 150 lbs/acre in three 50 lb/acre applications
  - Urea-ammonium nitrate solution fertilizer (UAN 32) used for all fertilizations
  - Fertigation combined with normal irrigation events
    - Concentration of $NO_3$ during fertigation events – 515 mg/L $NO_3$-N
  - Tissue testing in early July indicated no need for additional applications

# Results 2016 - soils

Non-detects as missing data
GLM ANOVA results:
No significant difference between grids
No significant difference between months
No significant interaction

| Date | $NO_3$-N (mg/kg), West Block | $NO_3$-N (mg/kg), East Block |
|---|---|---|
| May | 2.818 | 5.387 |
| November | 4.210 | 4.818 |

Non-detects as 0 mg/kg
GLM ANOVA results:
No significant difference between grids
No significant difference between months
No significant interaction

| Date | $NO_3$-N (mg/kg), West Block | $NO_3$-N (mg/kg), East Block |
|---|---|---|
| May | 2. 325 | 4.175 |
| November | 3.928 | 2.650 |

# Soils

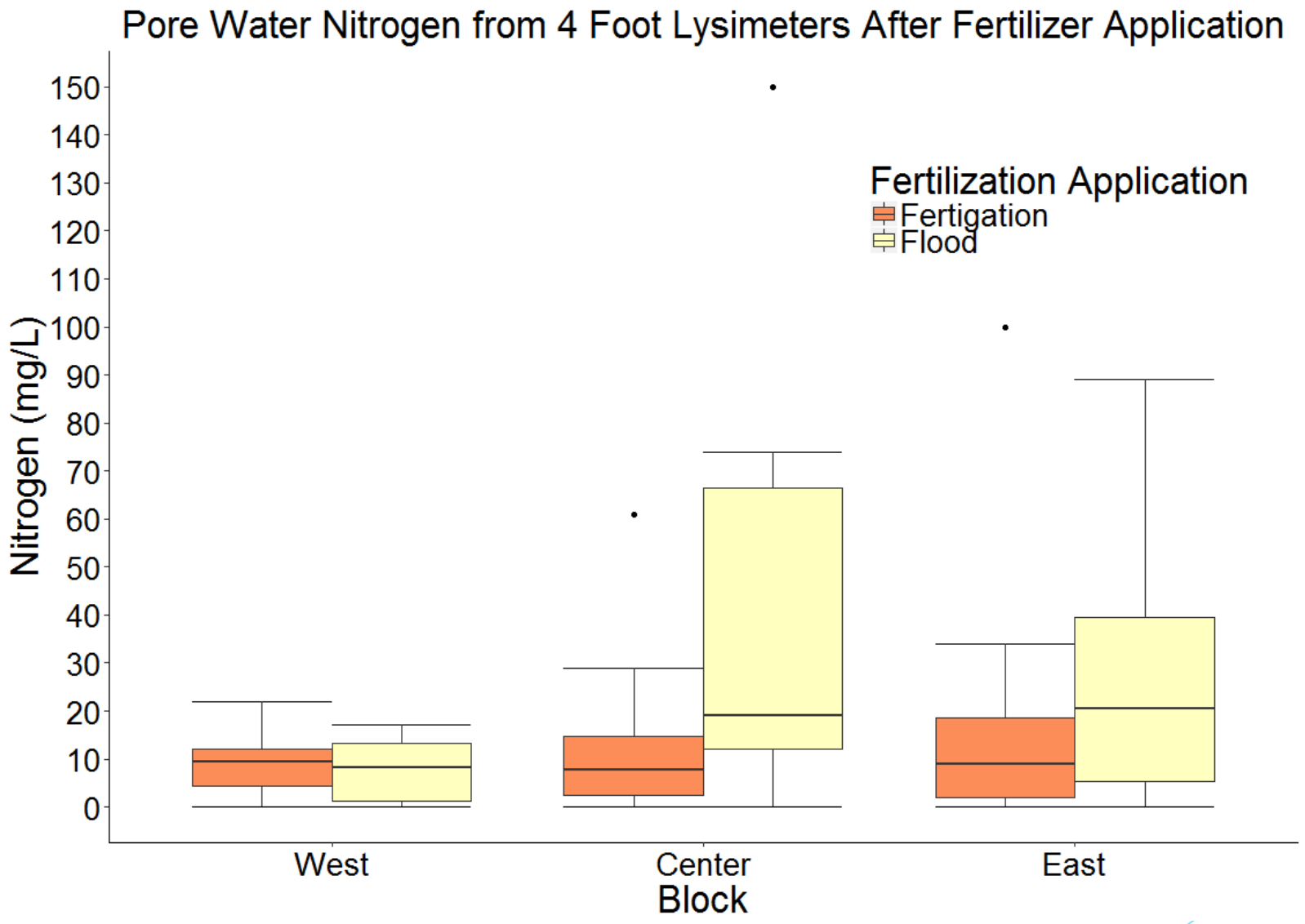
- Paired t-test indicates no differences between May and November concentrations of nitrate from same grid cells
- Non-detects treated as missing

| Mean NO3-N (mg/kg) May | Mean NO3-N (mg/kg) November | Wilcoxon Signed-Ranks |
|---|---|---|
| 4.625 | 5.000 | t = -0.384, p = 0.70 |

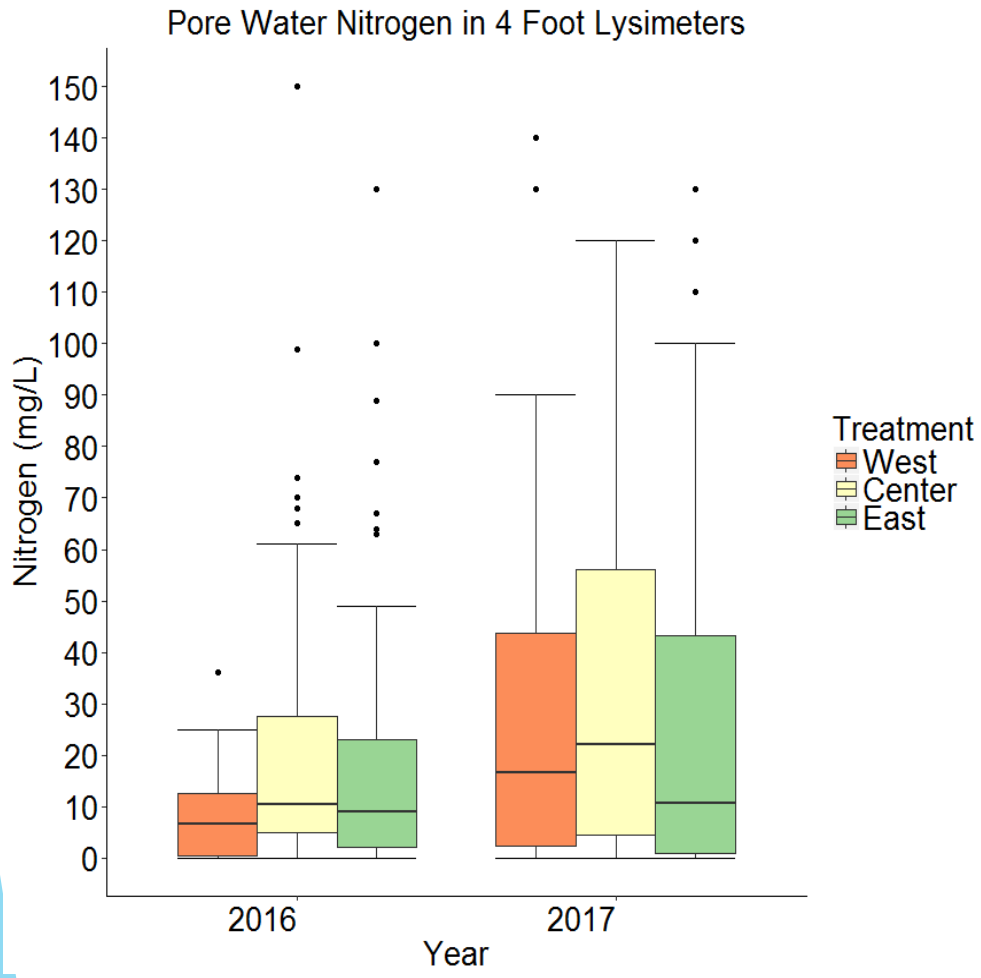
- Non-detects treated as 0 mg/kg

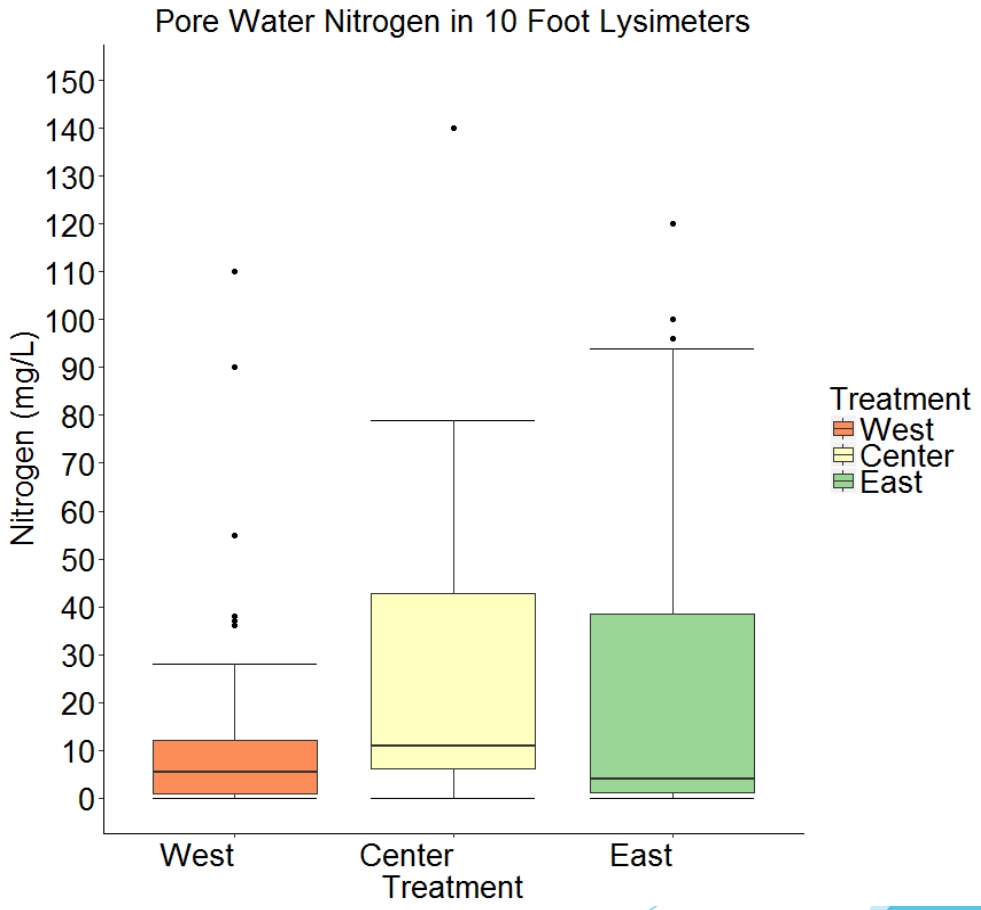
| Mean NO3-N (mg/kg) May | Mean NO3-N (mg/kg) November | Wilcoxon Signed-Ranks |
|---|---|---|
| 3.25 | 2.33 | t = 1.597, p = 0.11 |

# Year 1 Results (2016)



# Year 2 Results (2017)



# Summary of Findings

- Flood irrigations moved applied nitrogen beyond the root zone
  - Sprinkler irrigations levels were less dramatic (but still resulted in nitrate detections above 10 mg/l N mcl)
- Split applications of N were not significant improvement
  - May have been caused by injecting N at beginning of irriga
    set

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Parry Klassen

Executive Director 559-288-8125 klassenparry@gmail.com