Assessing the Impact of Nitrogen Fertilizer Amounts and Sources on Strawberry Yield and Shelf Life

Andre Biscaro,
Irrigation and Water Resources Advisor
University of California Cooperative Extension, Ventura County

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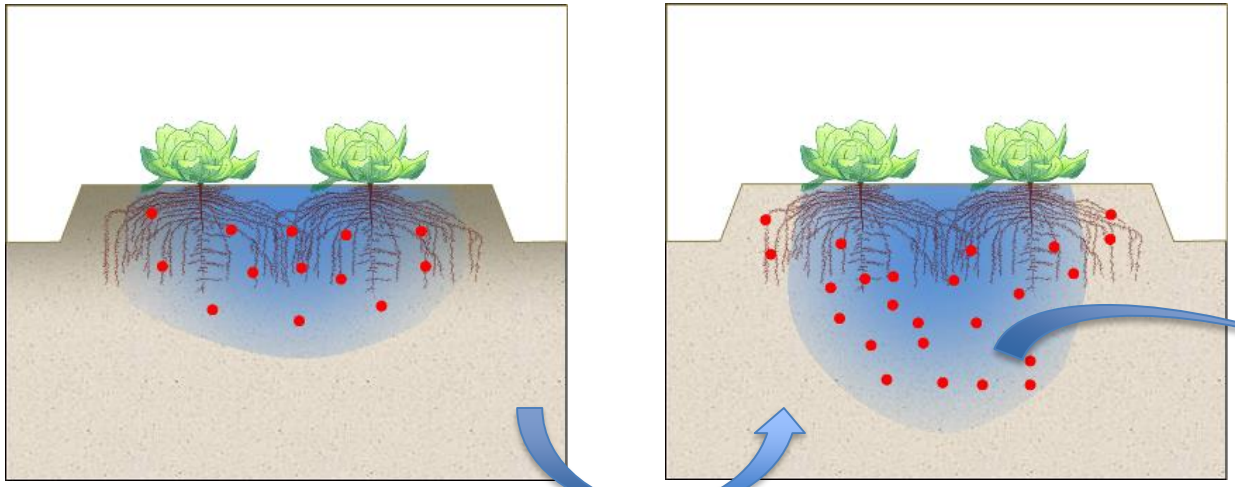
Context of Nitrogen Management for Strawberry production in Ventura County:

- Concerns with environmental contamination and regulations; NMP requirement
- Concerns with fruit quality and shelf life
- NO_3^- vs NH_4^+ -based fertilizers
- Concerns that N-induced excessive vegetative growth can reduce yields
- Crops are often under-fertilized and yields reduced to avoid excessive vegetative growth and shelf life issues
- Limited N uptake information in Ventura County (restricted funds availability)
- Cultivars may respond differently to varying N amounts
- Long season (approx. 9 months), variable rainfall

Strawberries in general:

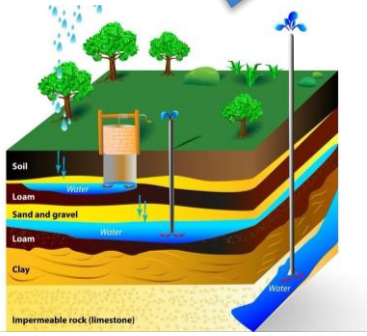
- ✓ Sensitive to mild water stress (increased irrigation frequency)
- ✓ Shallow, or relatively shallow root system
- ✓ Usually grown on well-drained soils
- ✓ High-value crop; small yield losses can cause significant impact on returns



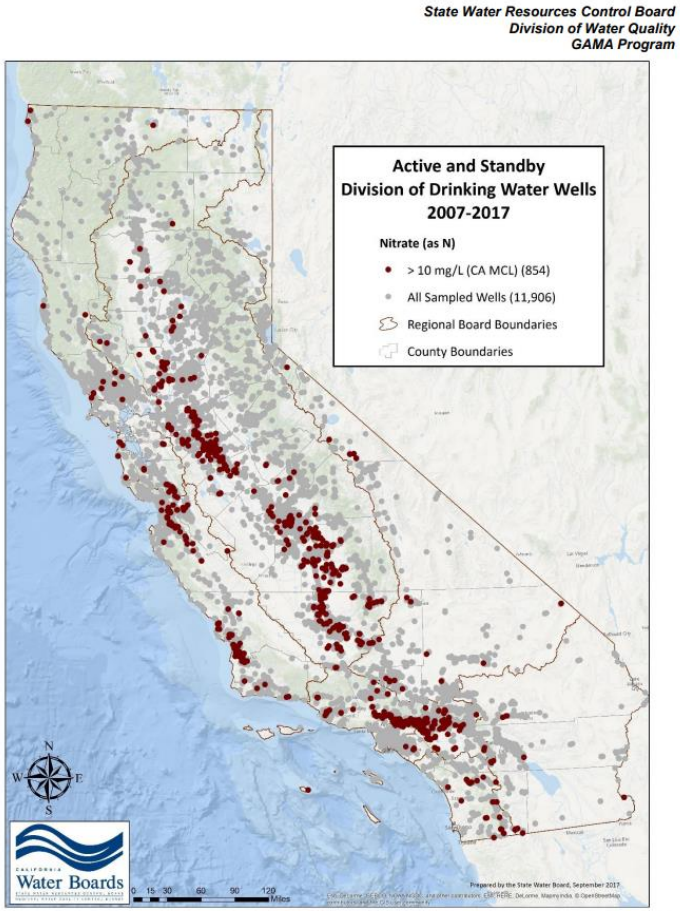
Typical number of irrigation events: 50-60

https://apps1.cdfa.ca.gov/fertilizerresearch/docs/Nitrate_Tool.html

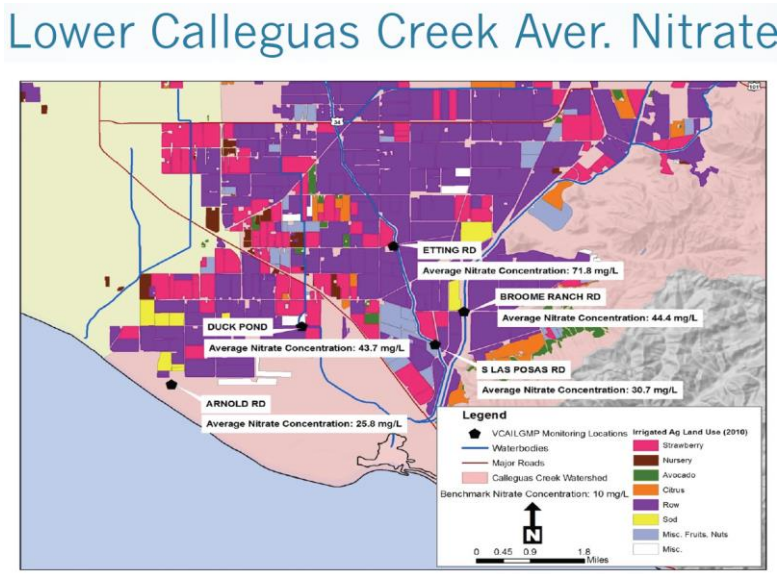
- ✓ Most soil N is in the form of nitrate
- ✓ Nitrate is very soluble in water
- ✓ Nitrate is weekly held in the soil CEC



A majority of agriculture wells on the Central Coast are contaminated with nitrate



Active and standby public drinking water wells that had at least one detection of nitrate (as N) above the MCL, 2007-2017, 854 wells. *(Source: Public Well Data using GeoTracker GAMA).*



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Nitrogen Use Reporting

NITROGEN MANAGEMENT PLAN WORKSHEET

1. Crop Year (Harvested): _____

2. Member ID# _____

3. Name:

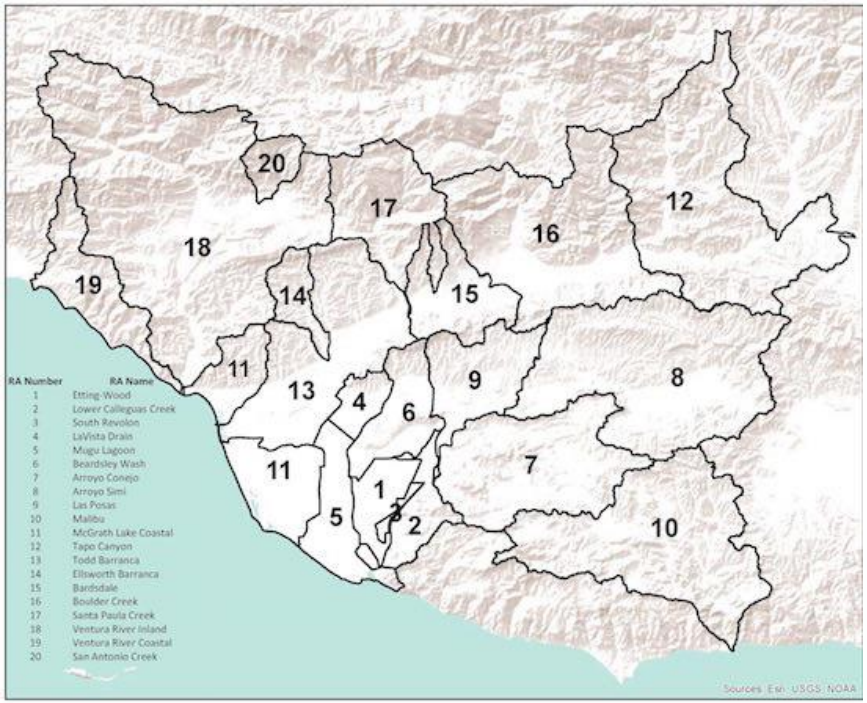
4. APN(s):	5. Field(s) ID	

CROP NITROGEN MANAGEMENT PLANNING		N APPLICATIONS/CREDITS	26. Recommended/ Planned N	27. Actual N
6. Crop		**15. Nitrogen Fertilizers**		
7. Production Units		16. Dry/Liquid (lbs/ac)		
8. Projected Yield (Units/Acre)		17. Foliar N (lbs/ac)		
9. N Recommended (lbs/ac)		**18. Organic Material N**		
10. Acres		19. Available N in Manure/Compost (lbs/ac estimate)		
Post Production Actuals		**20. Total Available N Applied** (lbs per acre)		
11. Actual Yield (Units/Acre)		**21. Nitrogen Credits (est)**		
12. Total N Applied (lbs/ac)		22. Available N carryover in soil; (annualized lbs/acre)		
13. ** N Removed (lbs N/ac)		23. N in Irrigation water (annualized, lbs/ac)		
14. Notes:		**24. Total N Credits** (lbs per acre)		
		25. Total N Applied & Available		

PLAN CERTIFICATION		
28. CERTIFIED BY:	**29. CERTIFICATION METHOD**	**X**
	30. Low Vulnerability Area, No Certification Needed	
	31. Self-Certified, approved training program attended	
DATE:	32. Self-Certified, UC or NRCS site recommendation	
	33. Nitrogen Management Plan Specialist	

** Your Coalition will provide the method to be used to estimate N Removed.

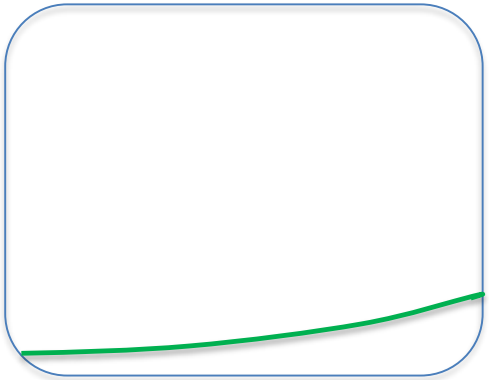
Responsibility Areas



[Farm Bureau of Ventura County: http://www.farmbureauvc.com/issues/water-issues/water-quality/management](http://www.farmbureauvc.com/issues/water-issues/water-quality/management)

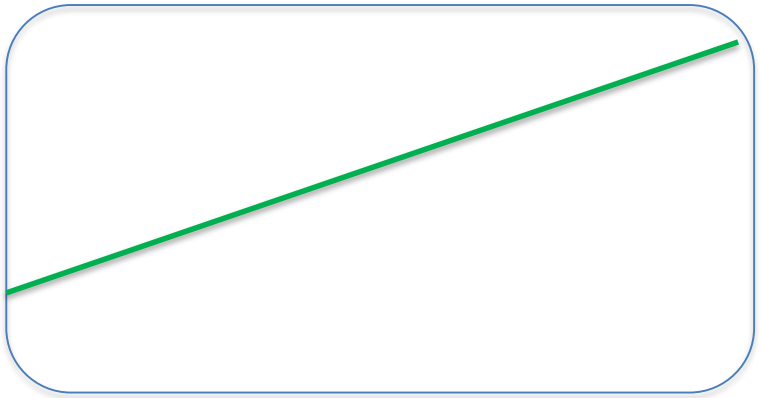
✓ Right Rate
✓ Right Time

Establishment,
up to 1/3 of crop cycle



- Very little N uptake
- Little water demand, but high susceptibility to water stress
- Shallow root system

Remaining 2/3



- Constant N uptake rate (predictable)
- Increasing water demand
- Increasing and deeper root system

Objectives

- Quantify yield and shelf-life responses do distinct N fertilization amounts
- Quantify yield and shelf-life responses do ammonium and nitrate-based fertilizers
- Determine if increased vegetative biomass decreases yield

Material and Methods

- ✓ 6 treatments: 3 rates (low, medium and high), 2 fertilizers (CN9 and AN20)
  CN9 = Calcium nitrate (93.5% NO_3-N, and 6.4% NH_4-N) + 11% Ca
  AN20 = Ammonium nitrate (50% NO_3-N and 50% NH_4-N)
- ✓ Treatments were fertigated on average every 17 days
- ✓ Cultivars: Fronteras and Proprietary cv.
- ✓ 64 in bed, two high-flow tapes, planted on October 8, 2018
- ✓ No pre-plant fertilizer applied
- ✓ Soil NO_3-N before planting: 2.4 ppm at 0-12 in depth
- ✓ Soil Ca:17.3 meq/100g
- ✓ Soil: Hueneme sandy loam

Material and Methods

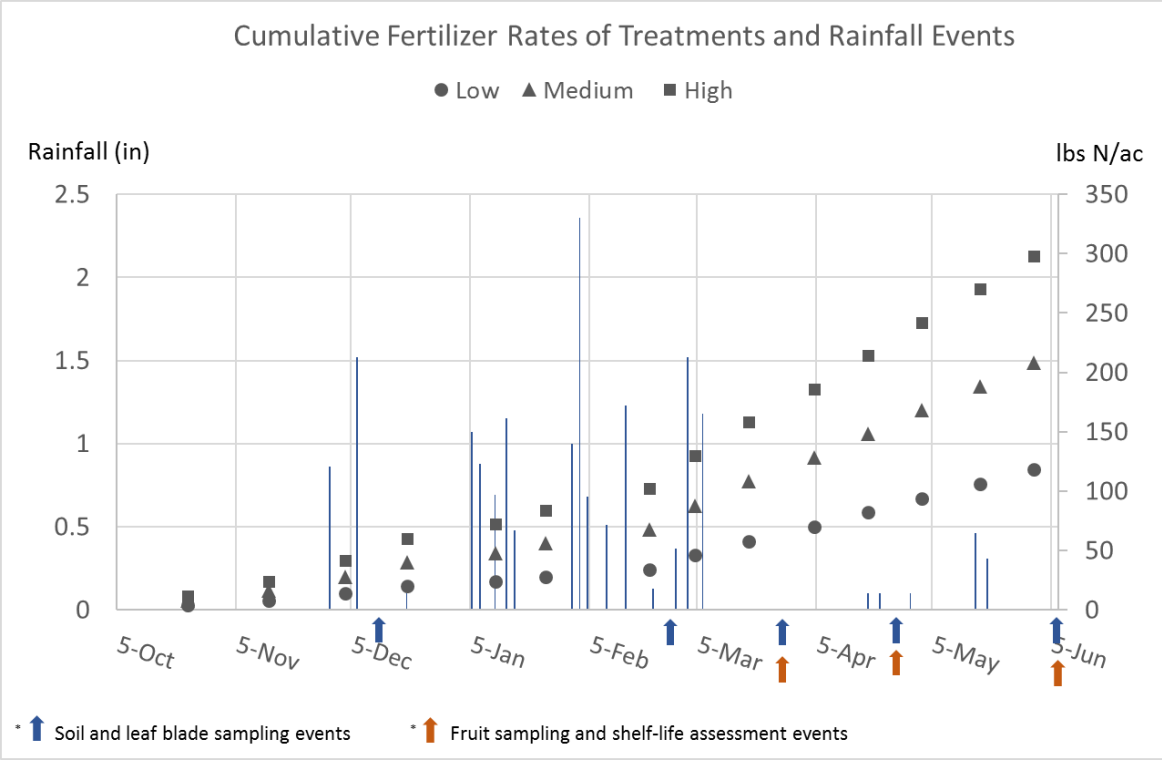
- ✓ Experimental design: randomized complete block, replicated four times; 30 ft long and 1 bed wide plots
- ✓ Soil, leaf blades and fruits were sampled periodically (5 times) and analyzed for total N and Ca concentrations
- ✓ Total drip-applied water: 14.0 in; total precipitation: 16.8 in;
- ✓ Canopy cover and vegetative biomass
- ✓ 42 harvest events: marketable and unmarketable yield and berry weight
- ✓ Shelf life: fruit firmness, weight loss, mold, leakage at 0, 4, 8 and 12 days (St Francis Cooler, Oxnard). March, April and June
- ✓ Cooler Temperature: 33F, Relative humidity: 86%

Treatments

	Low	Medium	High
	----- lbs N/ac/week -----		
Early season (Oct-Feb)	2	4	6
Late season (Mar-May)	6	10	14
	------- lbs N/ac -------		
Total applied (Oct 8-May 31)	118	208	298

Applied as CN9 and as AN20

Treatments

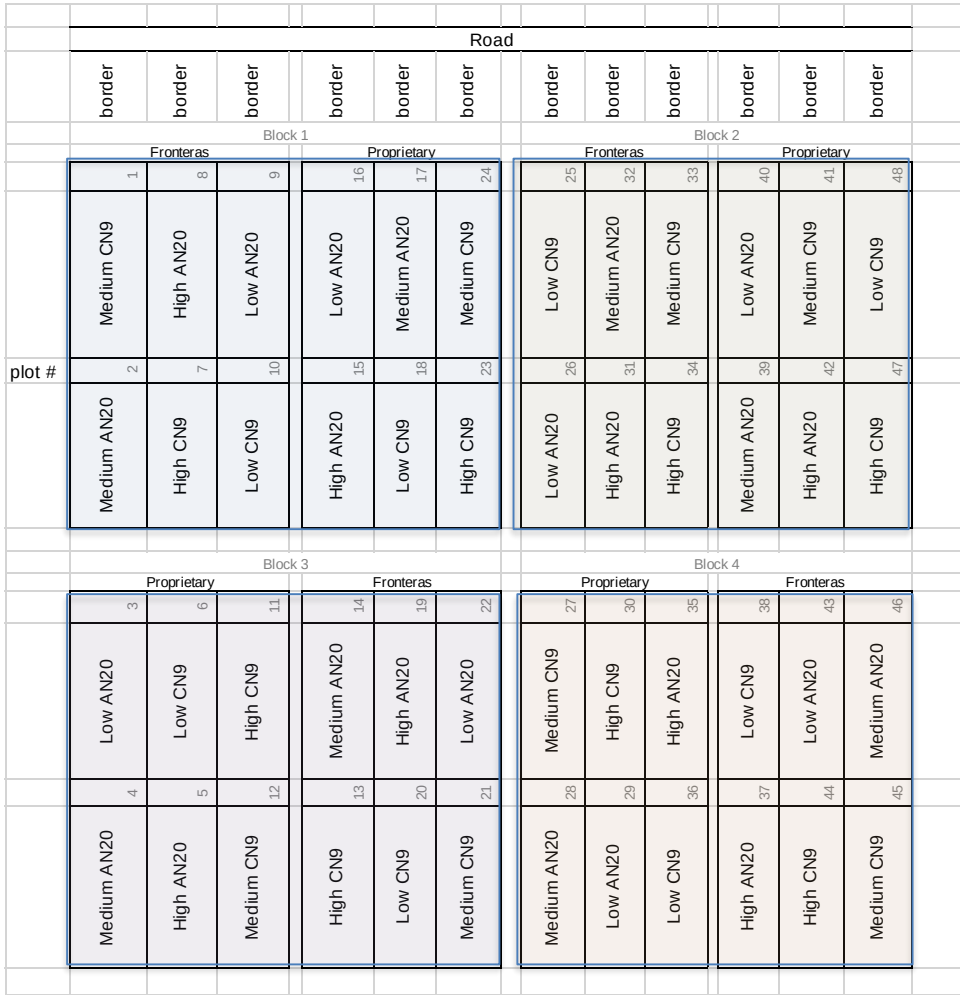

Cumulative Fertilizer Rates of Treatments and Rainfall Events
Low
Medium
High
Rainfall (in)
lbs N/ac
2.5
2
1.5
1
0.5
0
350
300
250
200
150
100
50
0
5-Oct
5-Nov
5-Dec
5-Jan
5-Feb
5-Mar
5-Apr
5-May
5-Jun
* Soil and leaf blade sampling events
* Fruit sampling and shelf-life assessment events

Treatments Application

Early season, lower rates

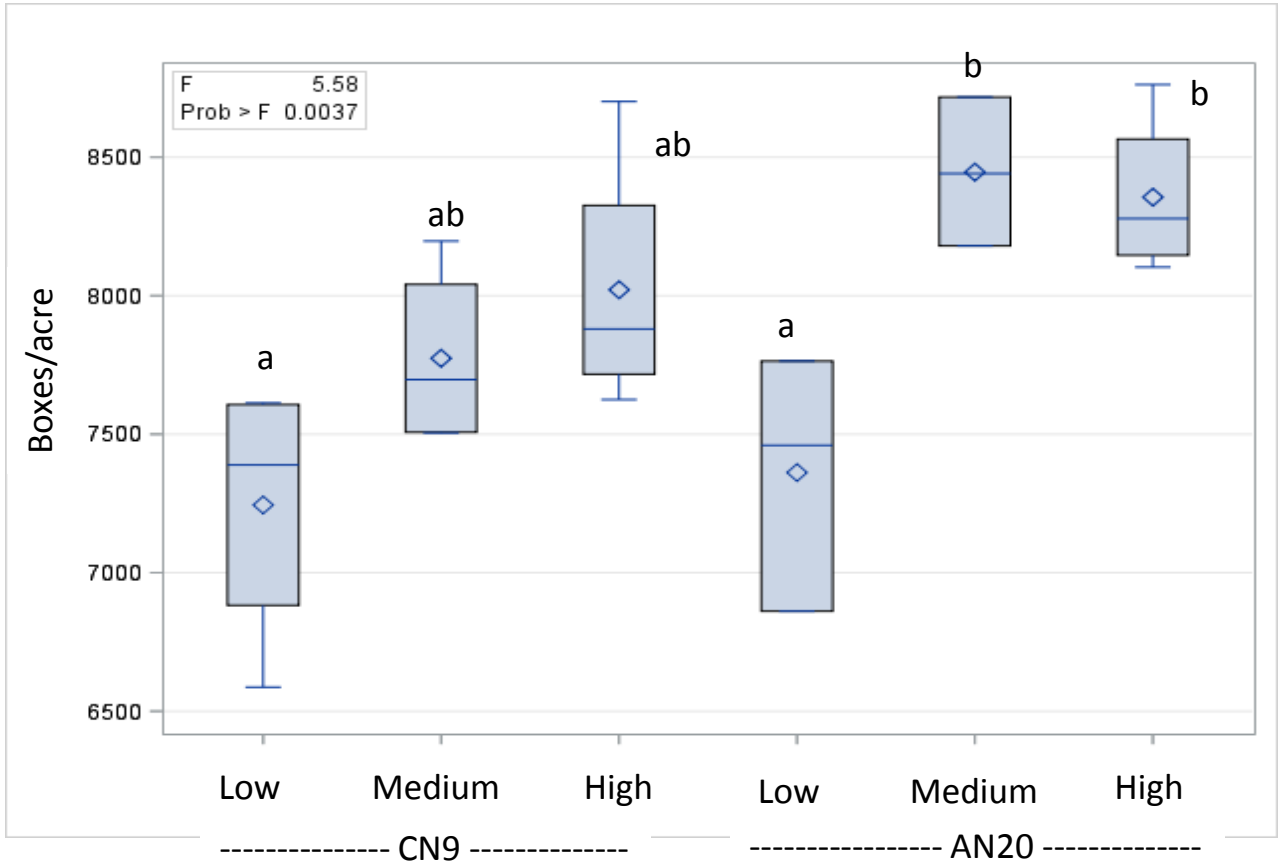
Mid-late season, higher rates

Plot map:

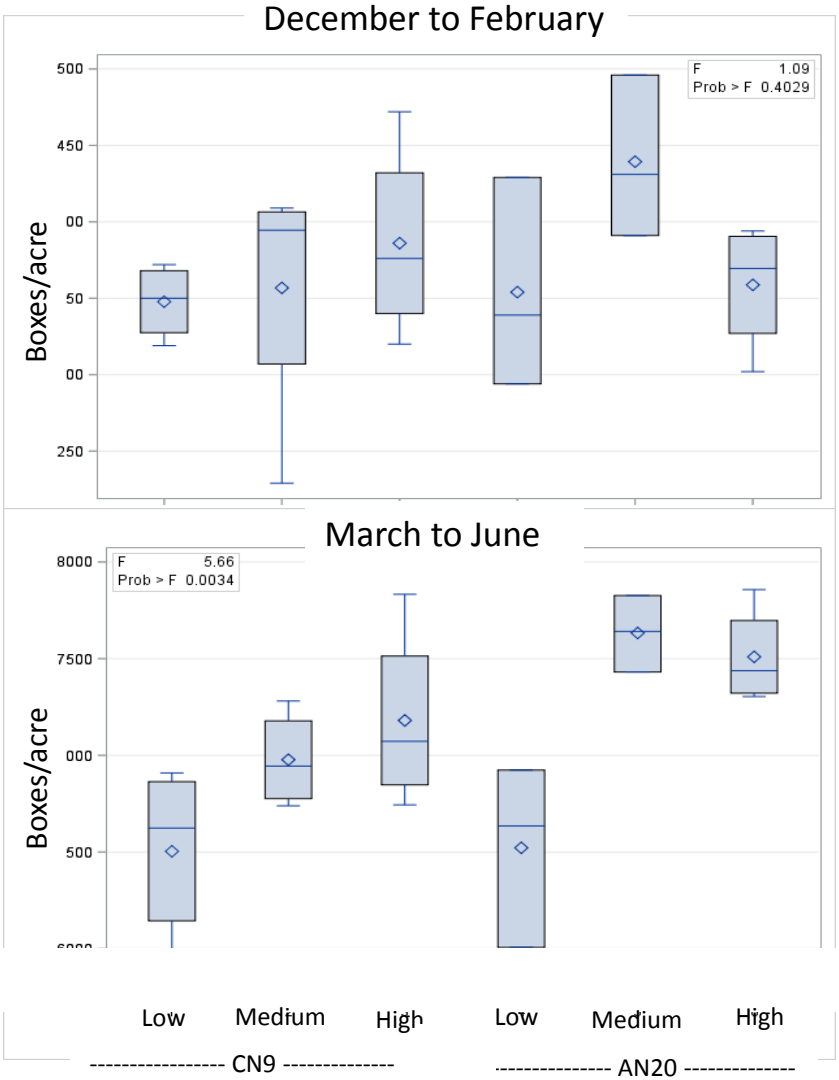

Road
border
Block 1
Fronteras
Proprietary
Block 2
Fronteras
Proprietary
plot #
1 Medium CN9
8 High AN20
9 Low AN20
16 Low AN20
17 Medium AN20
24 Medium CN9
25 Low CN9
32 Medium AN20
33 Medium CN9
40 Low AN20
41 Medium CN9
48 Low CN9
2 Medium AN20
7 High CN9
10 Low CN9
15 High AN20
18 Low CN9
23 High CN9
26 Low AN20
31 High AN20
34 High CN9
39 Medium AN20
42 High AN20
47 High CN9
Block 3
Proprietary
Fronteras
Block 4
Proprietary
Fronteras
3 Low AN20
6 Low CN9
11 High CN9
14 Medium AN20
19 High AN20
22 Low AN20
27 Medium CN9
30 High CN9
35 High AN20
38 Low CN9
43 Low AN20
46 Medium AN20
4 Medium AN20
5 High AN20
12 Medium CN9
13 High CN9
20 Low CN9
21 Medium CN9
28 Medium AN20
29 Low AN20
36 Low CN9
37 High AN20
44 High CN9
45 Medium CN9

Results

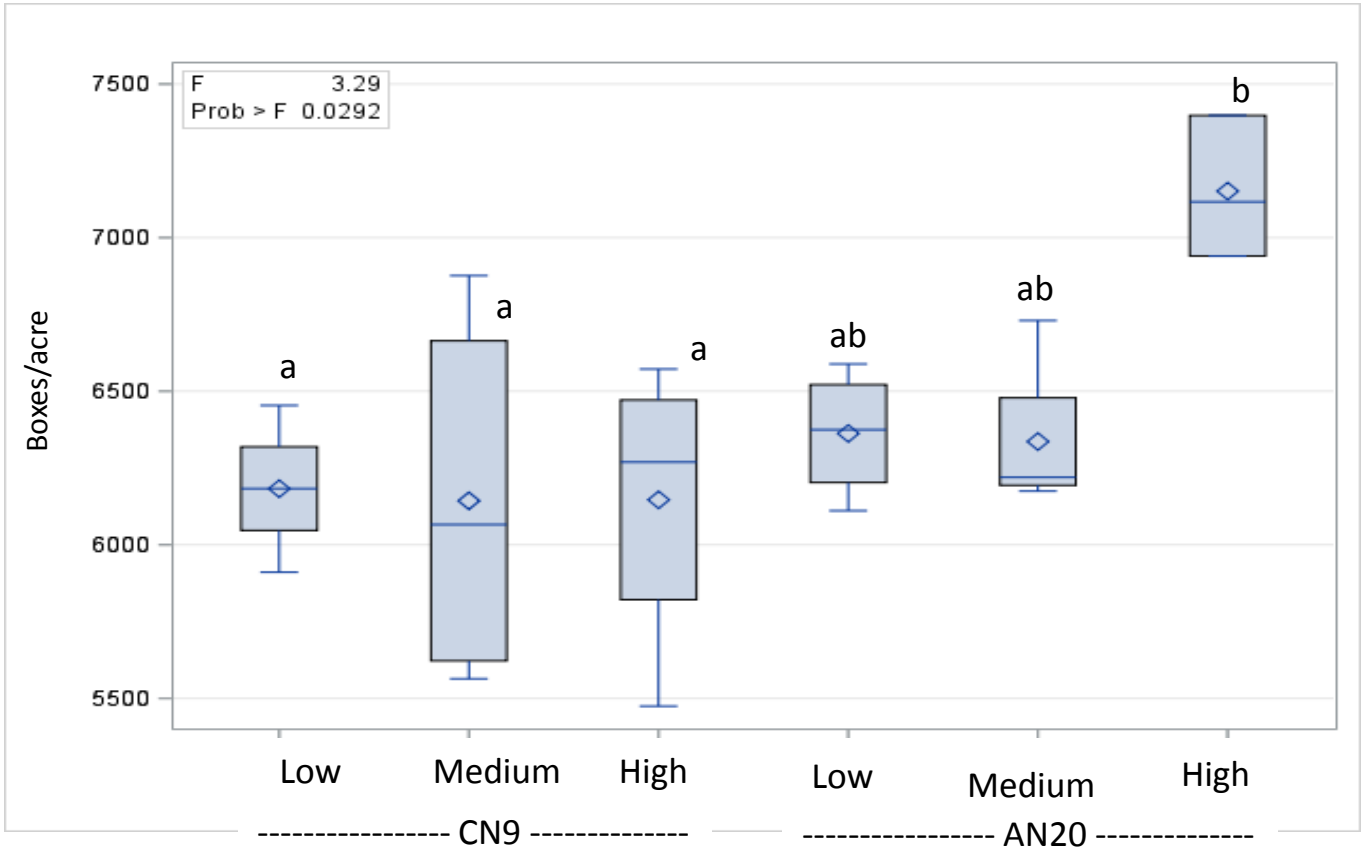
Total Marketable Yield, Fronteras

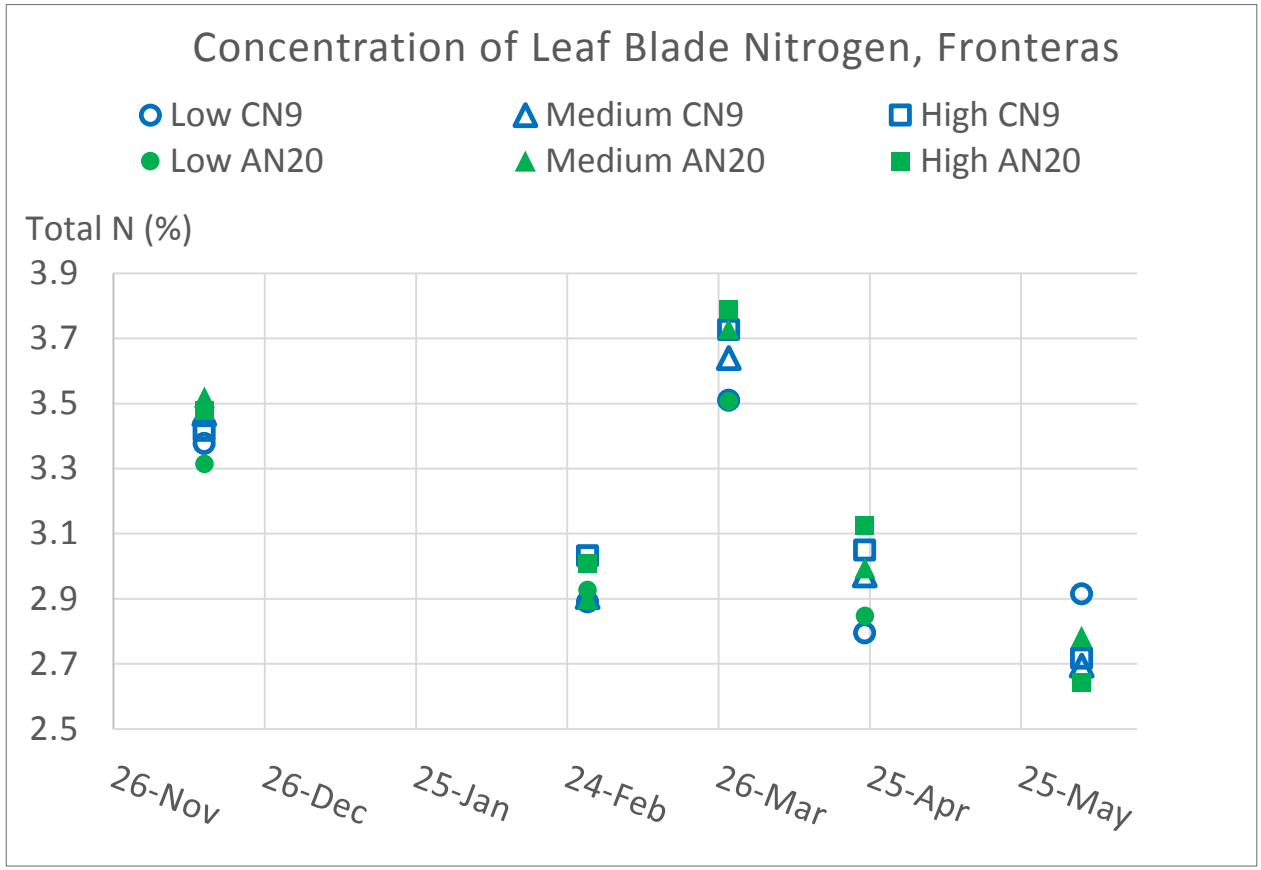


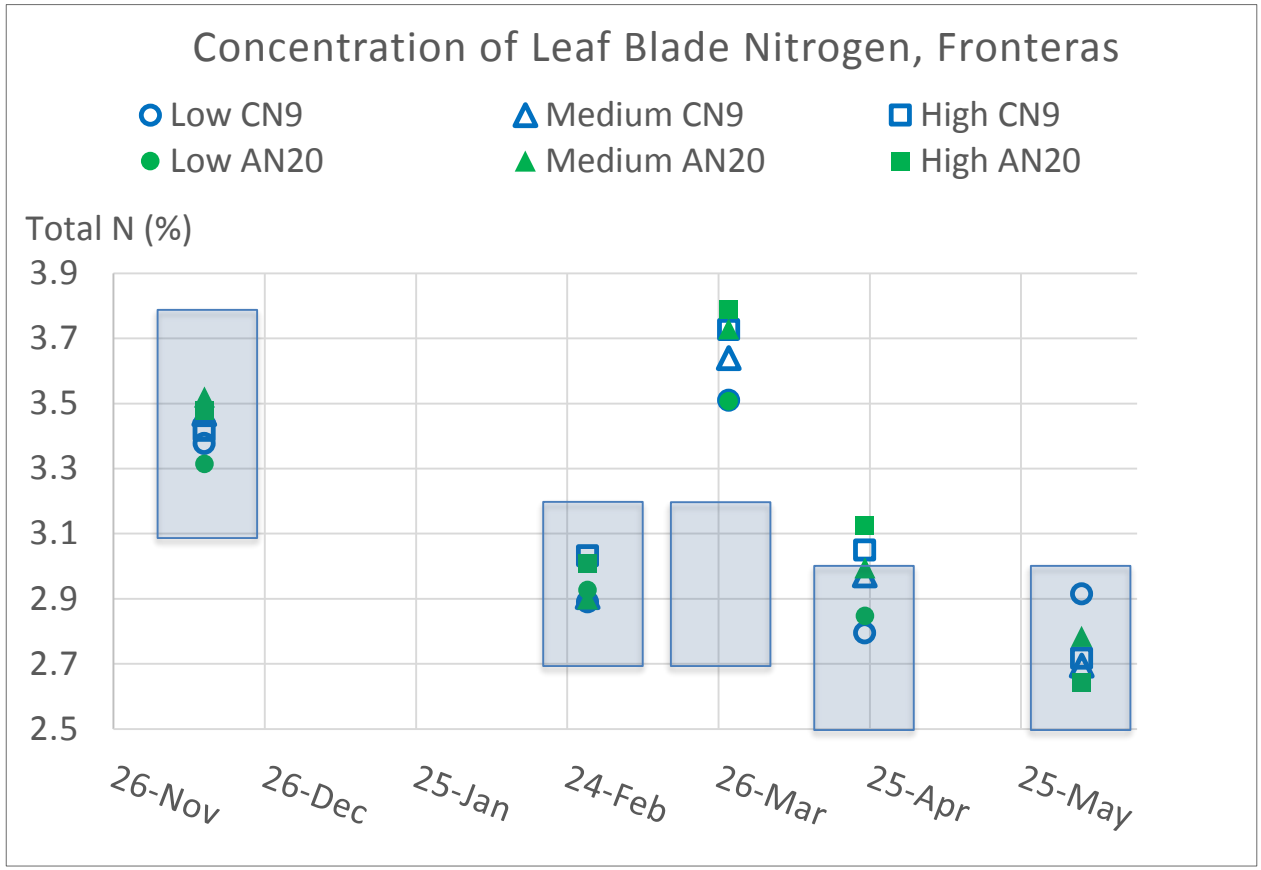
Marketable Yield, Fronteras



Total Marketable Yield, Proprietary cv.




Concentration of Leaf Blade Nitrogen, Fronteras
Low CN9
Medium CN9
High CN9
Low AN20
Medium AN20
High AN20
Total N (%)
3.9
3.7
3.5
3.3
3.1
2.9
2.7
2.5
26-Nov
26-Dec
25-Jan
24-Feb
26-Mar
25-Apr
25-May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Total N (%)
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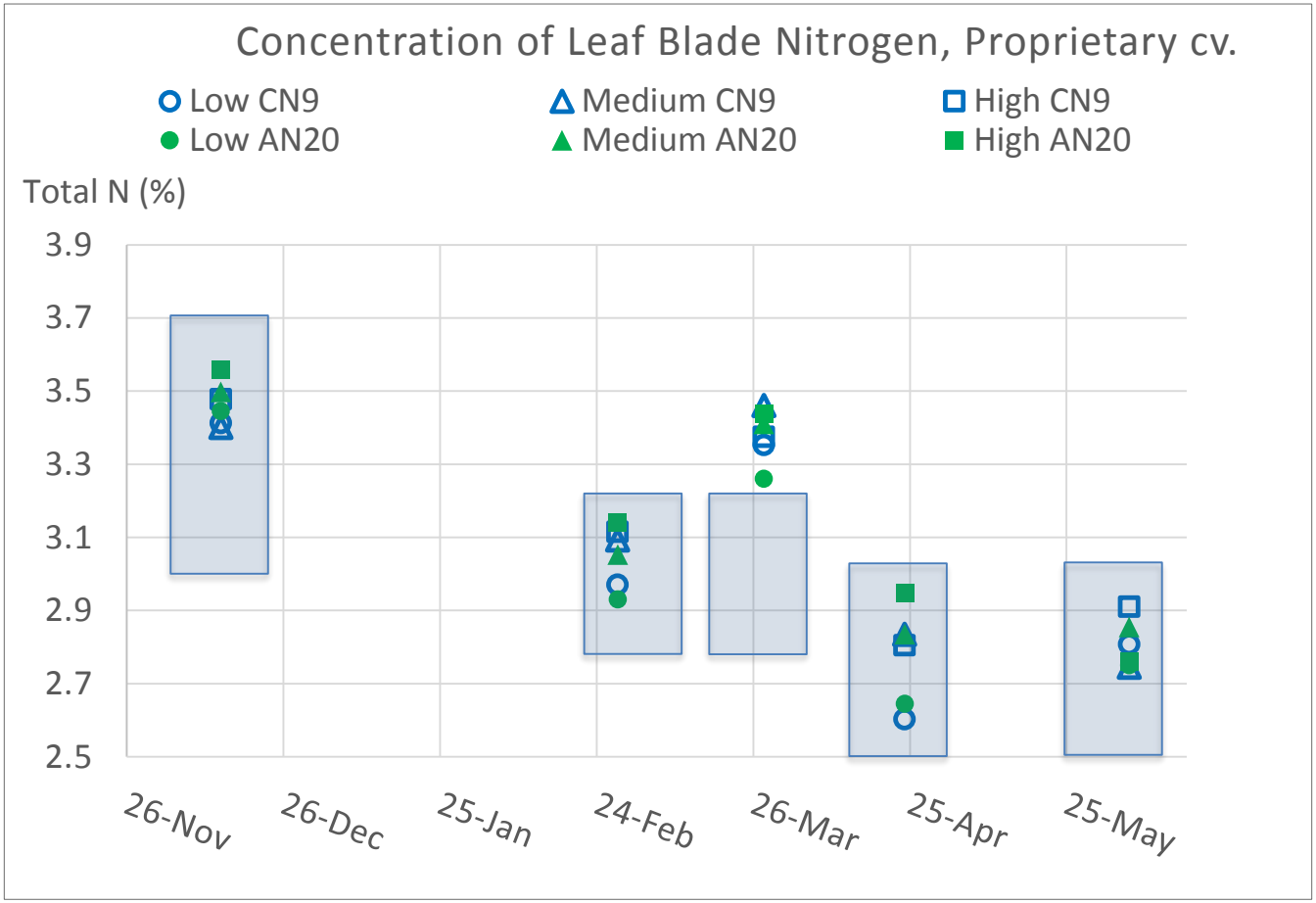
3.1
2.9
2.7
2.5
26-Nov
26-Dec
25-Jan
24-Feb
26-Mar
25-Apr
25-May


Concentration of Leaf Blade Nitrogen, Proprietary cv.
Low CN9
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Low AN20
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Total N (%)
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3.7
3.5
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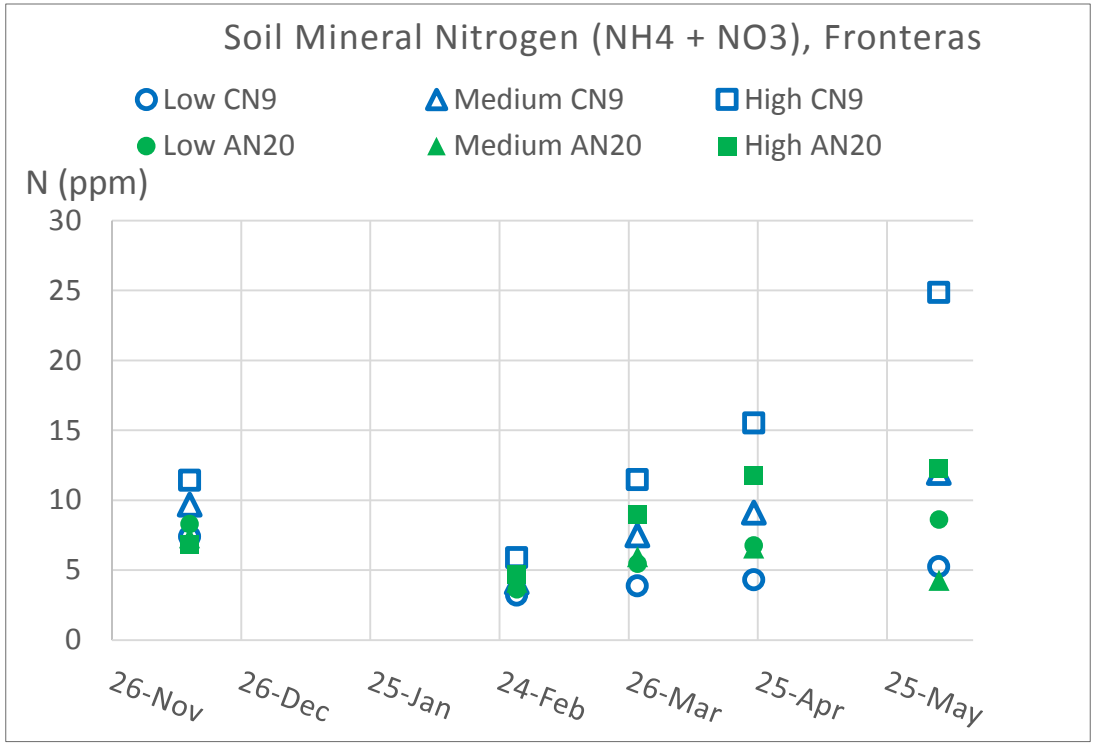
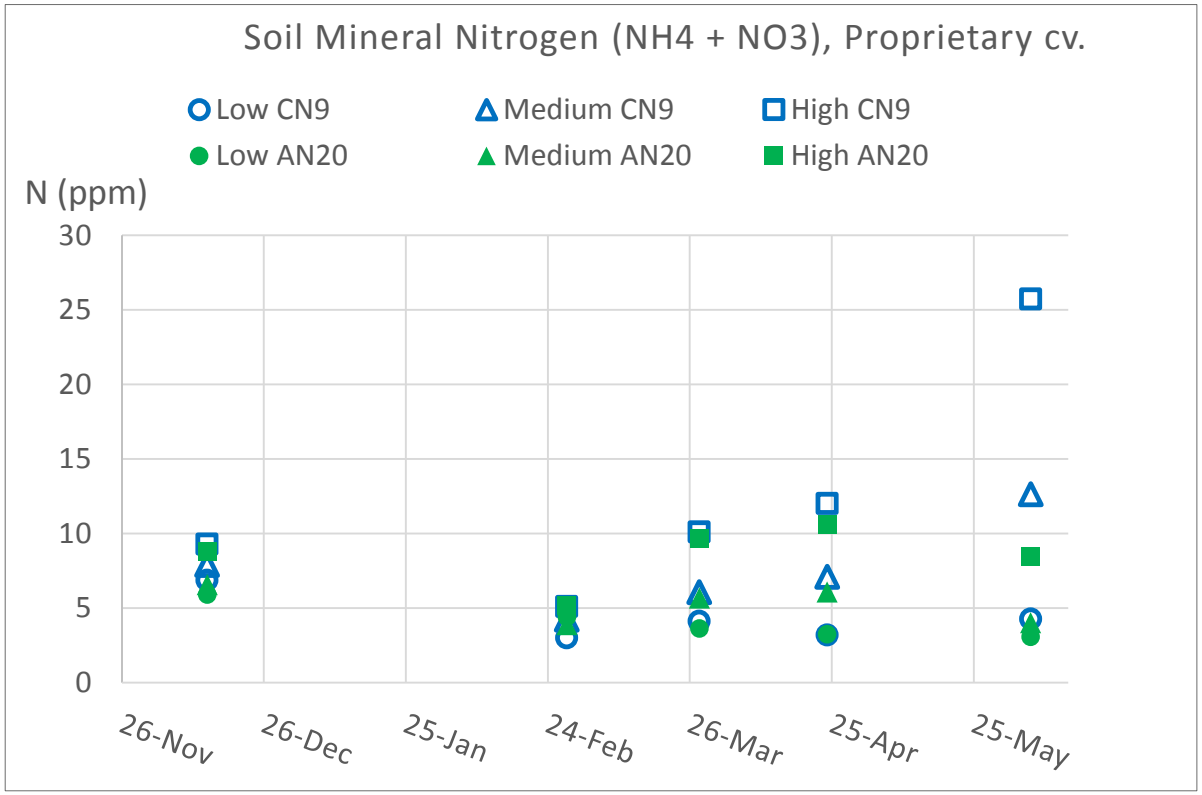
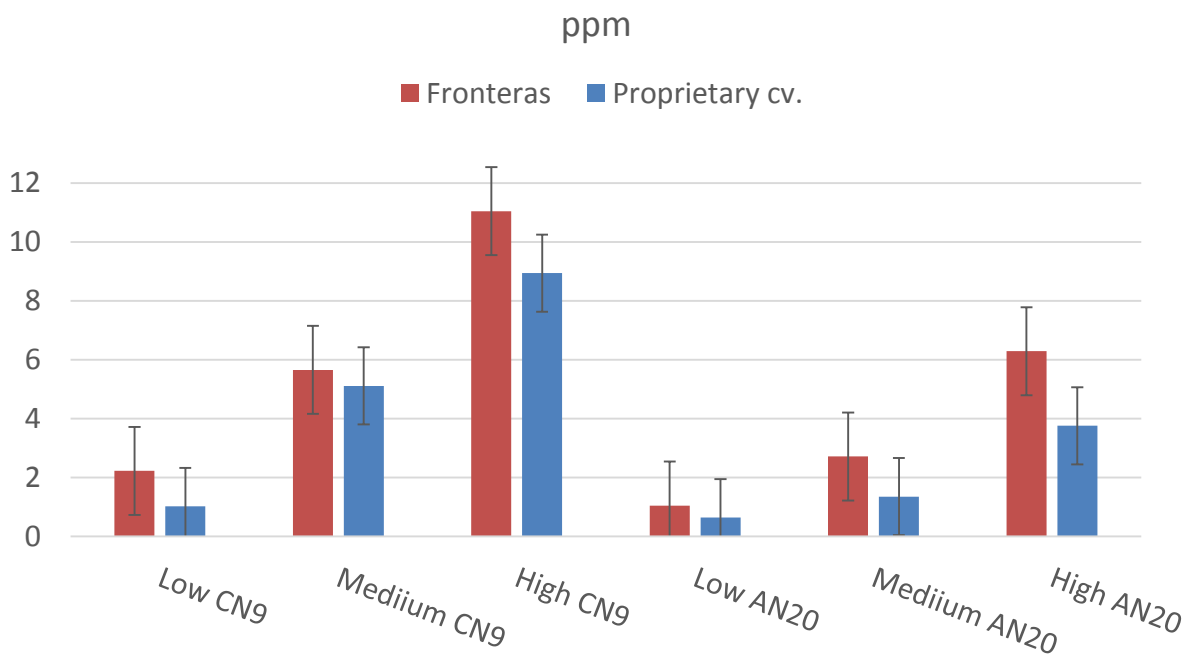
25-Apr
25-May

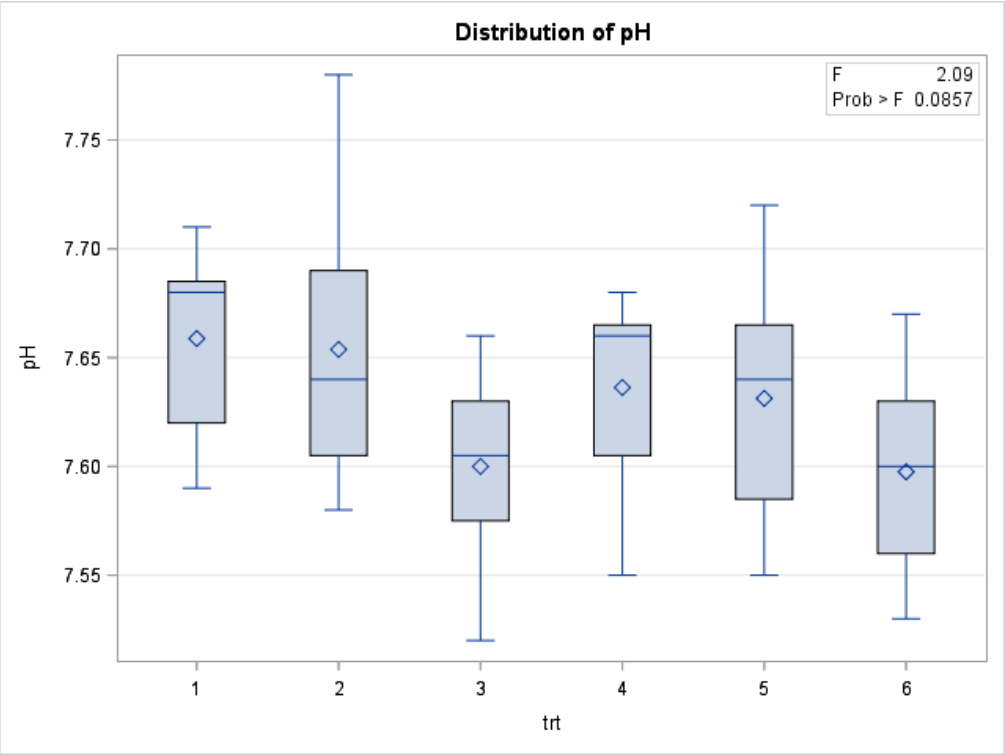

Soil Mineral Nitrogen (NH4 + NO3), Fronteras
Low CN9
Medium CN9
High CN9
Low AN20
Medium AN20
High AN20
N (ppm)
30
25
20
15
10
5
0
26-Nov
26-Dec
25-Jan
24-Feb
26-Mar
25-Apr
25-May


Soil Mineral Nitrogen (NH4 + NO3), Proprietary cv.
Low CN9
Medium CN9
High CN9
Low AN20
Medium AN20
High AN20
N (ppm)
30
25
20
15
10
5
0
26-Nov
26-Dec
25-Jan
24-Feb
26-Mar
25-Apr
25-May

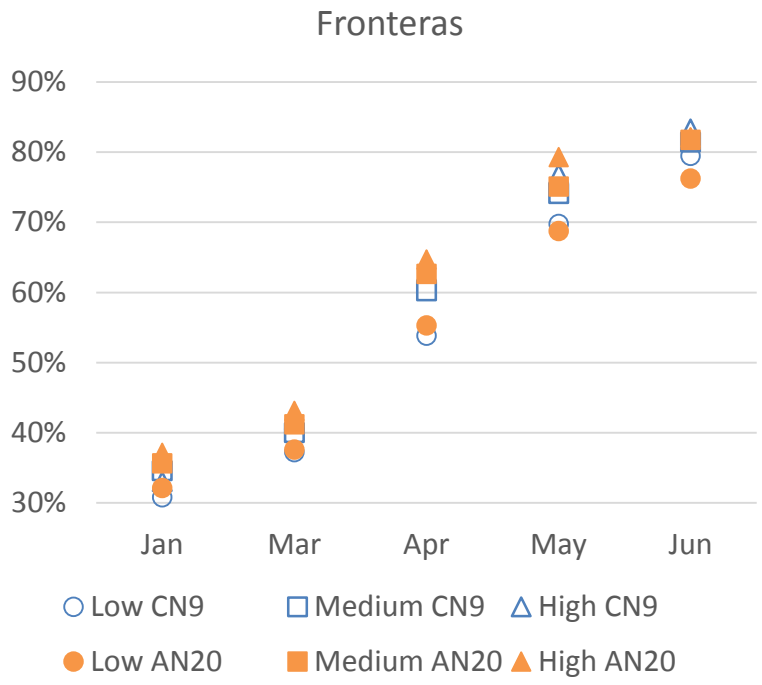
NO_3-N at 12-24 in depth

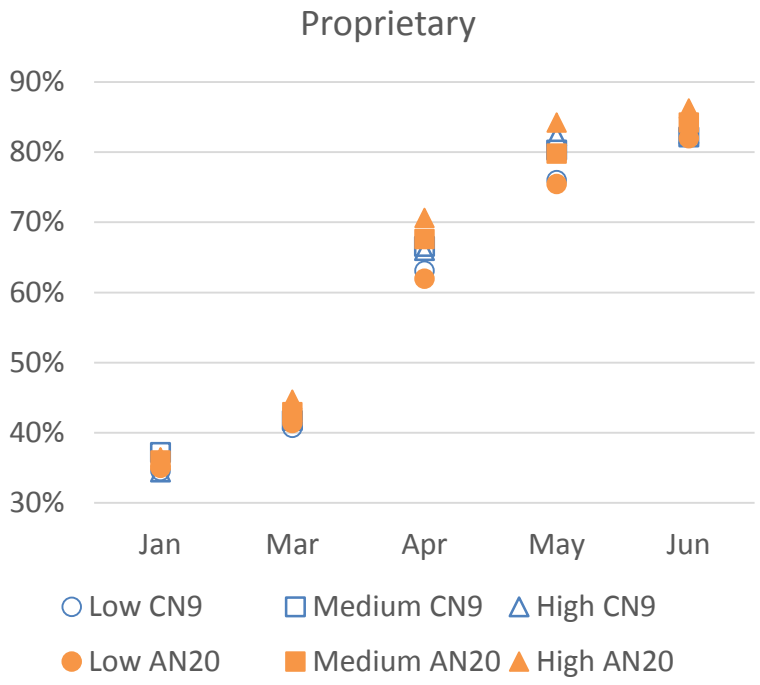


All cultivars soil pH, 0-12in depth

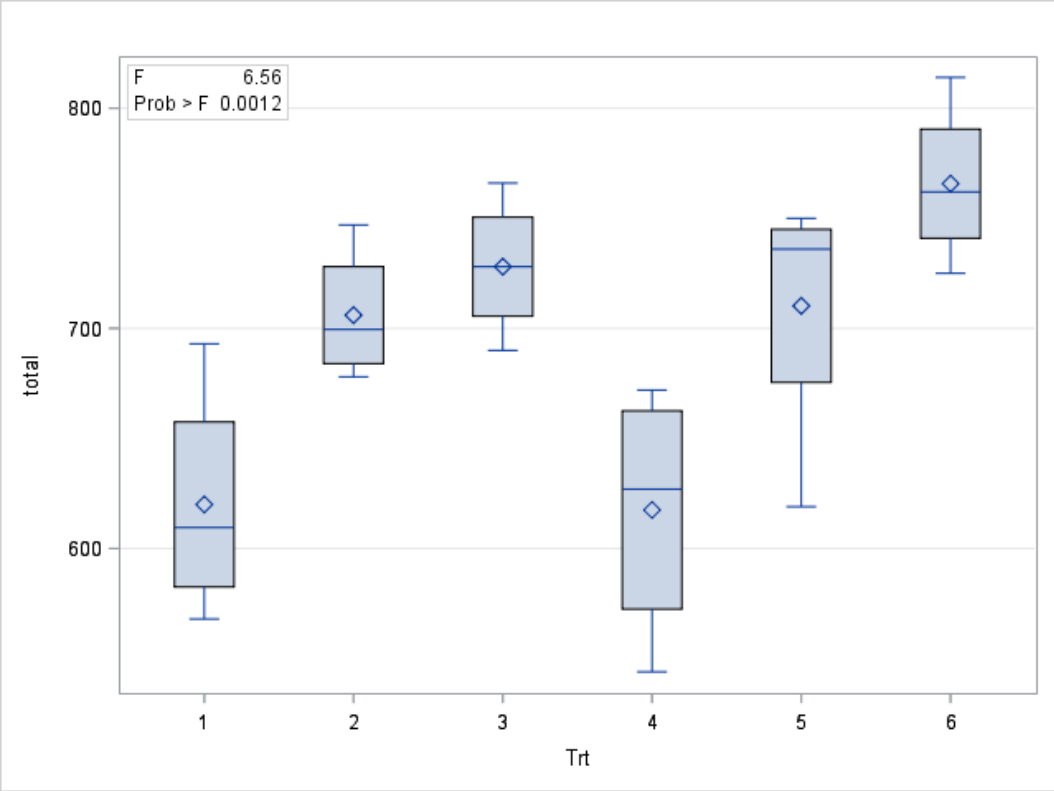


Canopy Coverage

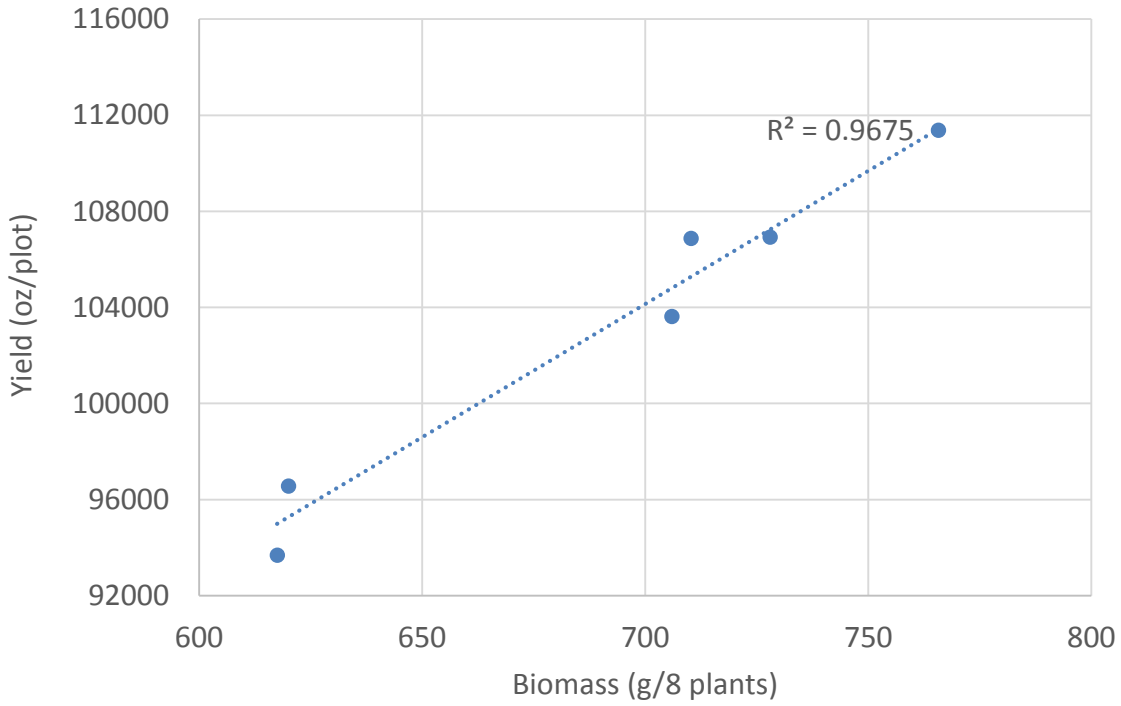




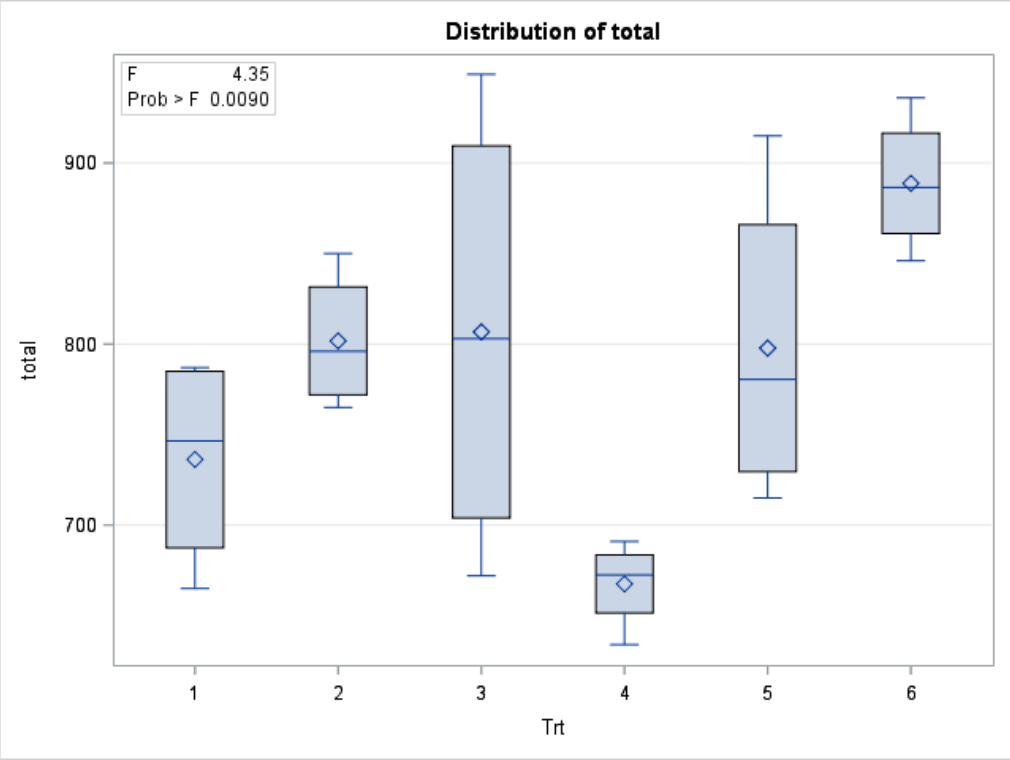
Fronteras, Dry Aboveground Biomass (grams/8 plants)



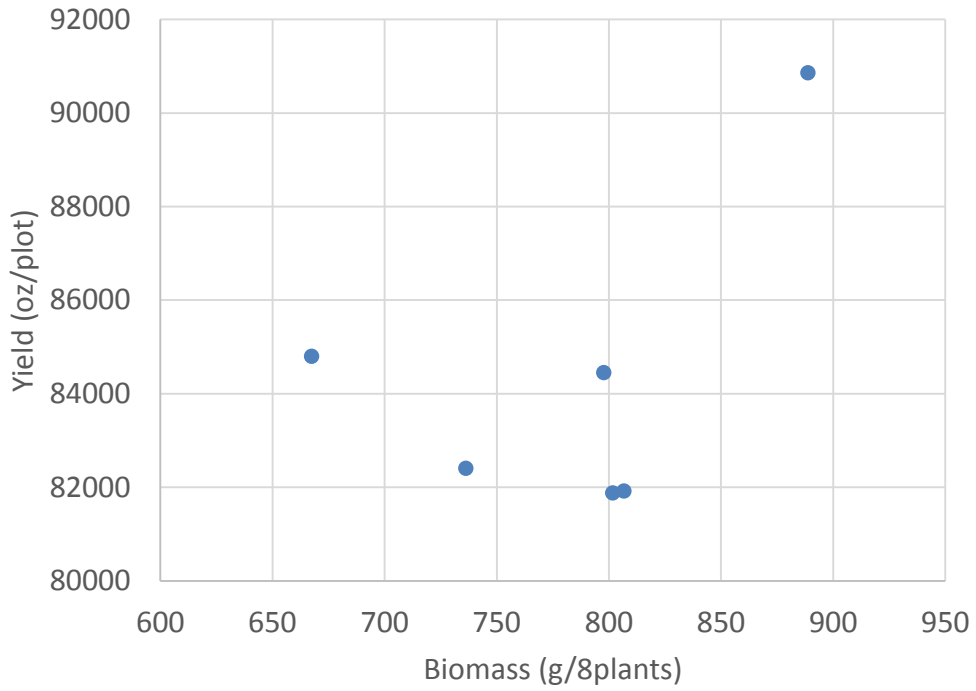
Yield vs Vegetative Biomass, Fronteras



Proprietary cv., Dry Aboveground Biomass (grams/8 plants)



Yield vs Vegetative Biomass, Proprietary cv.



Shelf Life Results

- ✓ Treatments did not affect fruit firmness, mold, leakage and berry weight; no trends observed
- ✓ Leakage and mold were observed in June at 8 and 12 days, but data is inconclusive

Summary

- ✓ Fronteras yield for Medium and High AN20 was very similar and significantly greater than Low CN9 and Low AN20. All other differences were not statistically significant
- ✓ Cull rate and shelf life were not affected by fertilizer rates and sources
- ✓ Significantly high precipitation amounts were atypical and most likely influenced results
- ✓ Fronteras yield was clearly correlated with vegetative biomass; proprietary cv. was not

Summary

- ✓ Nitrogen and Calcium content in whole fruits was not affected by fertilizer rates and sources; calcium content in leaf blades was not affected by treatments in both cultivars
- ✓ Concentration of leaf blade N was significantly affected by treatments in March, April and June samplings
- ✓ There were significant differences in cultivar response to treatments. Research is needed for other cultivars

Other observations:

- ✓ Ca in the leaf blades and fruits were very similar and didn't present a trend between fertilizer types (CN9 vs. AN20)
- ✓ Overall leaf blades nutrient content in June were greater for AN20; Mn was significantly ($P<0.05$) greater for AN20 than CN9 for both cultivars
- ✓ Soil pH differences between fertilizer types and rates at crop termination were minimal (<0.02) and not statistically significant

Acknowledgements:

- Crisalida Berry Farms: David Murray, Matt Conroy, Raul Coronado, Constancio Garcia and Chino
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- St. Francis Cooler

Questions/comments?

Field Day, June 2019