Irrigation and Nitrogen Management of Ventura County Berry and Vegetable Crops

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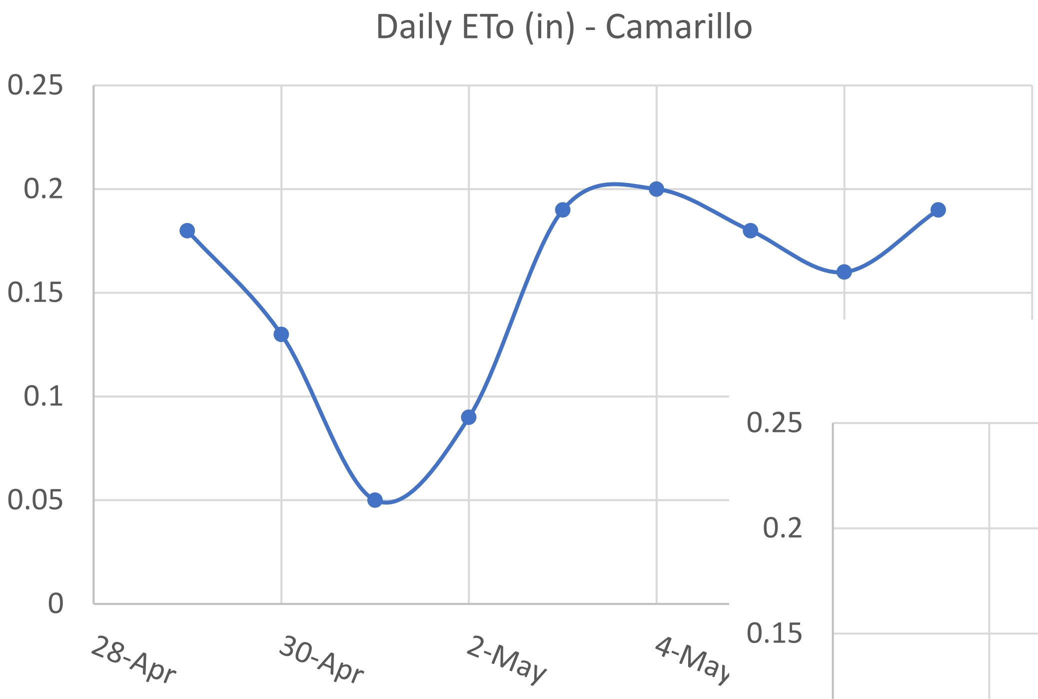
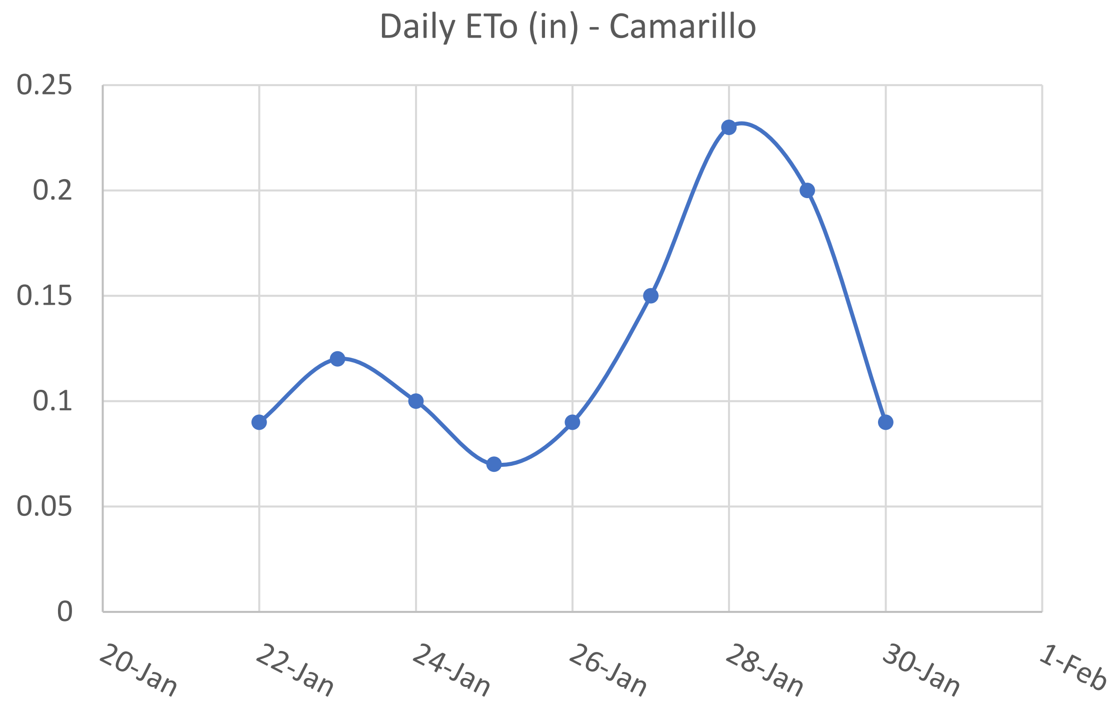
Presentation file:
https://ucanr.edu/sites/INM/files/372149.pdf

Outline

- Irrigation management concepts and tools
- N regulations in California
- N uptake curves
- N removal project
- Summary

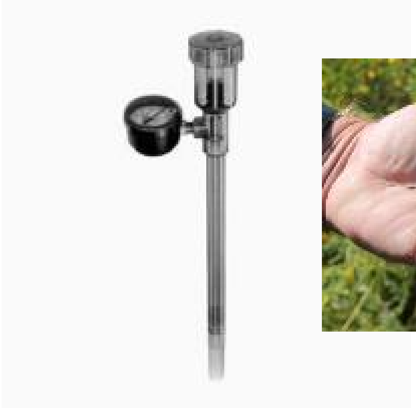
Why is irrigation scheduling challenging?



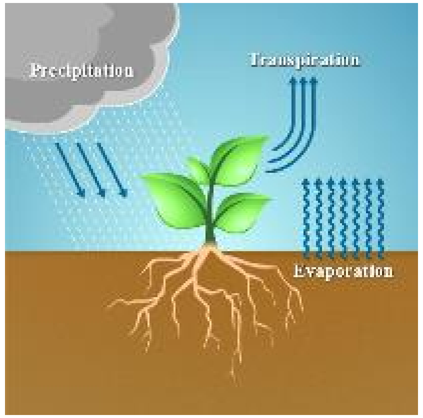


Irrigation Scheduling

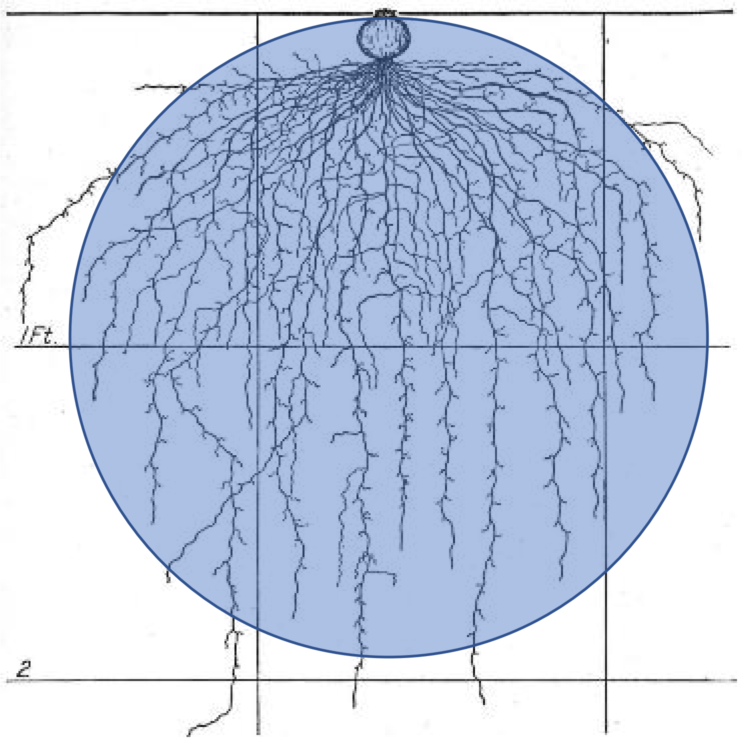
1. Deciding when to irrigate



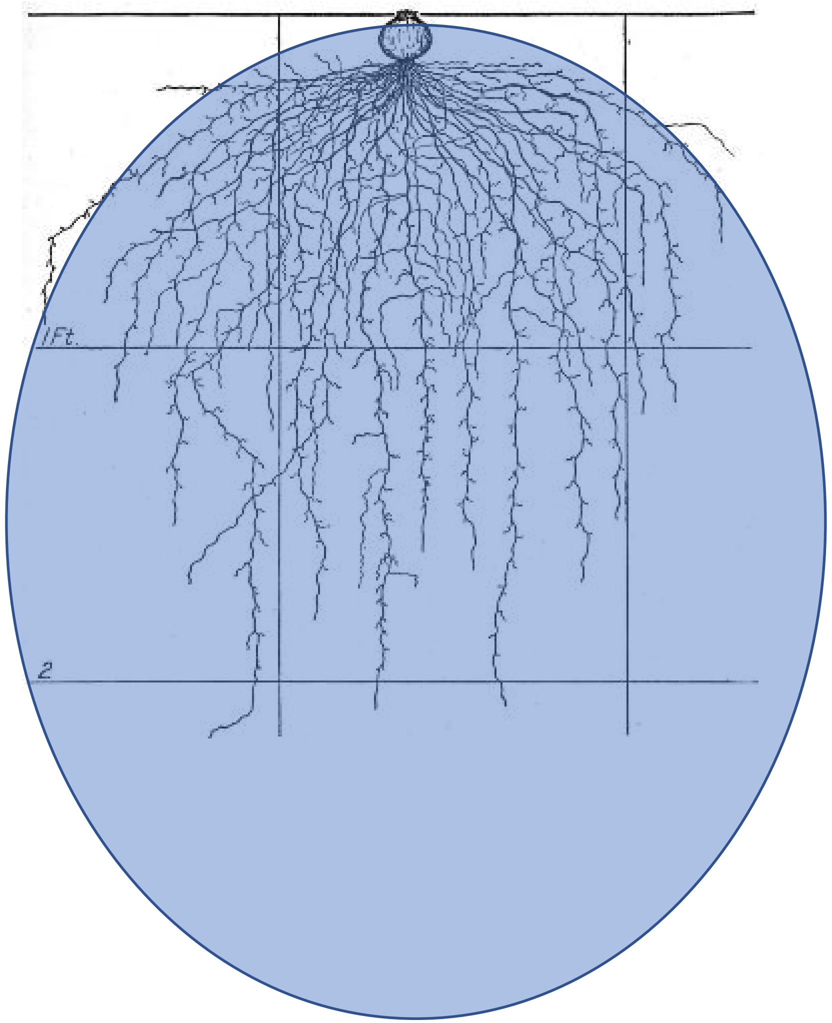
2. Deciding how much to irrigate

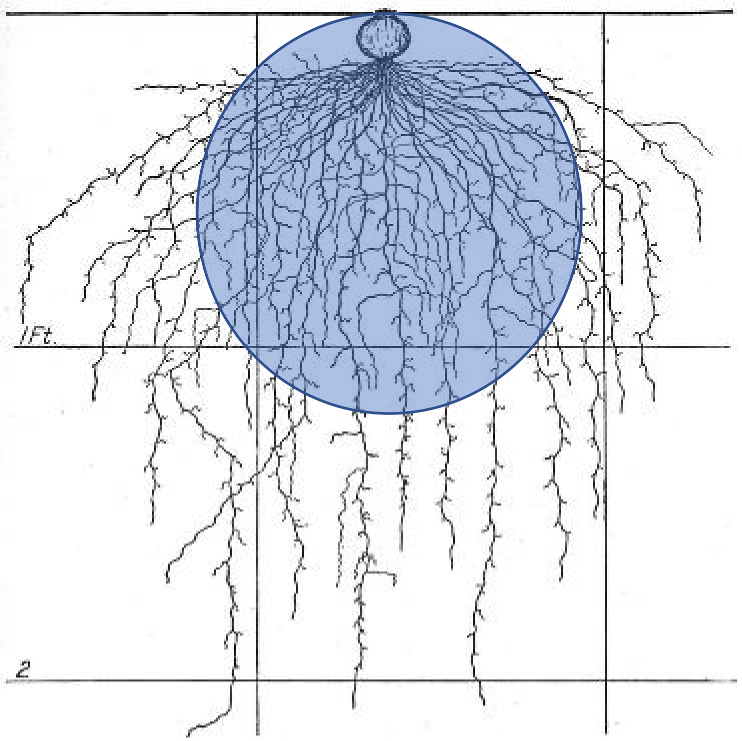


Ideal irrigation scenario



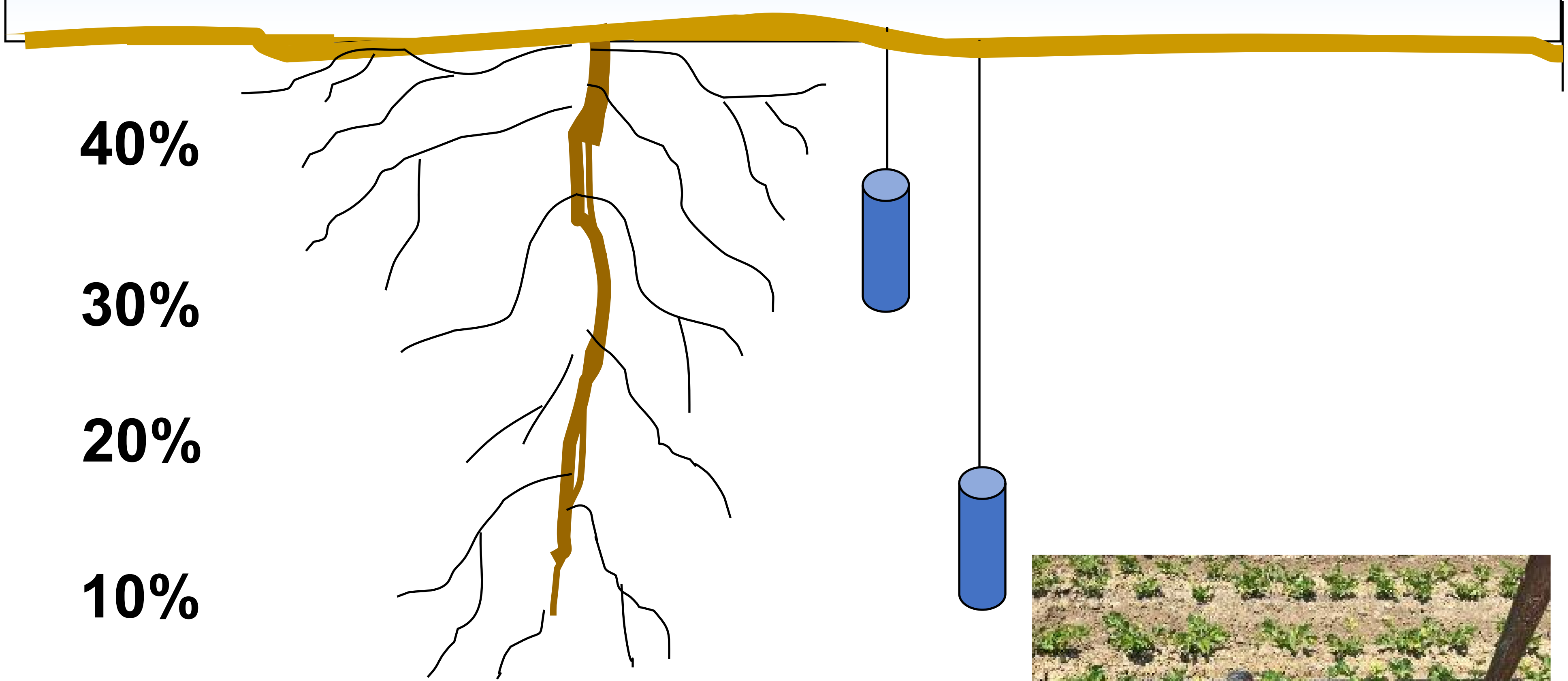
Inefficient irrigation scenarios



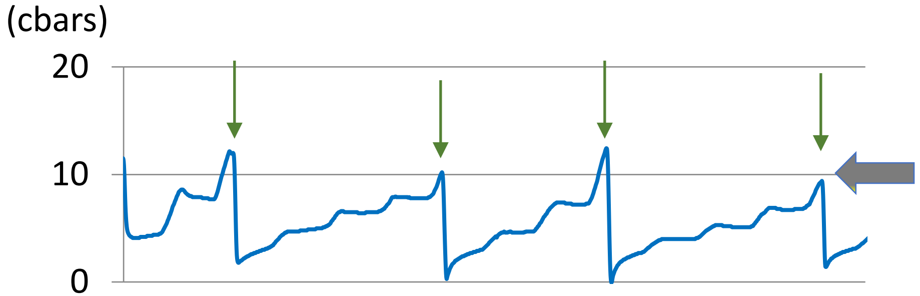


Soil Moisture Monitoring

Sensor Depth and Installation are Key



Soil Moisture Thresholds

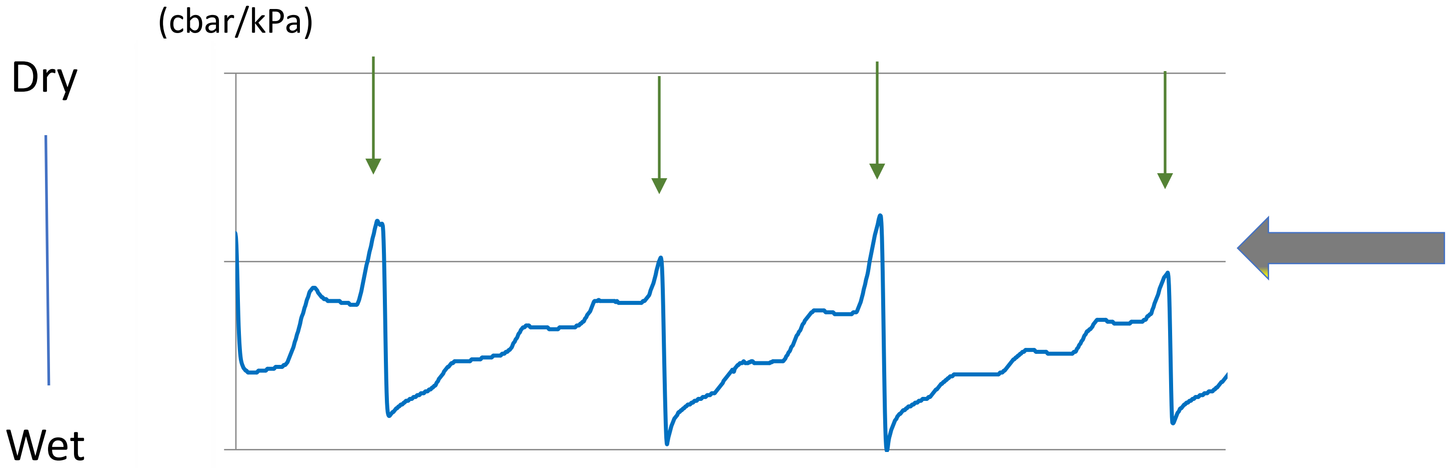


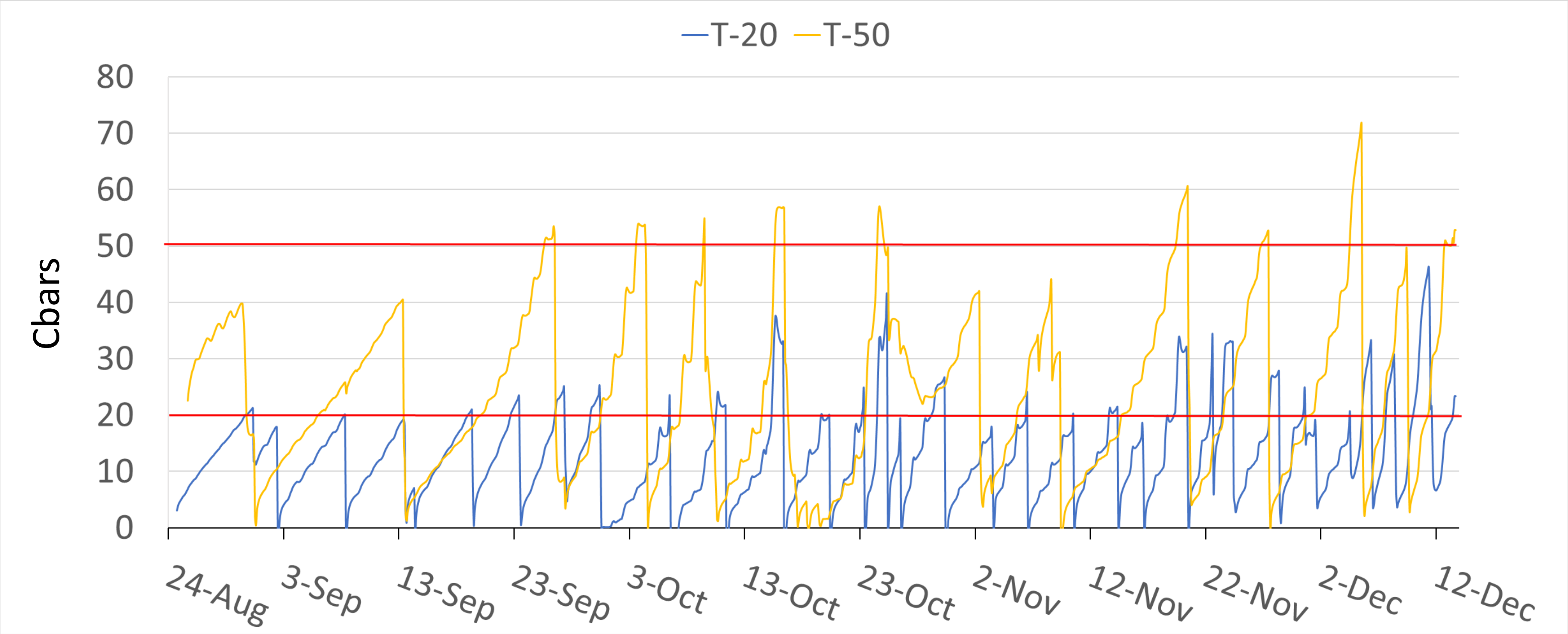
Celery Soil Moisture Threshold Study

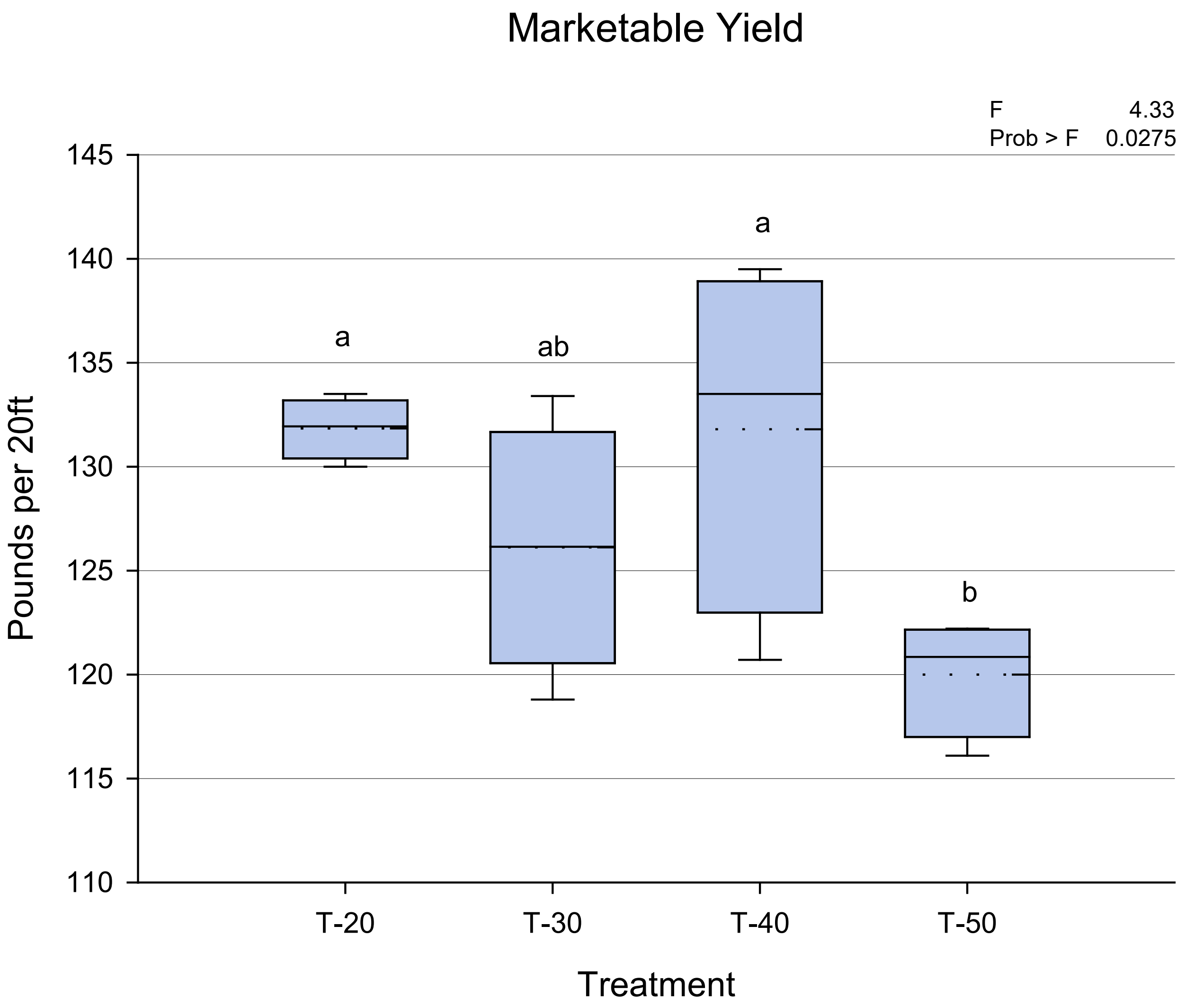
Treatments:

T-20 = 20 cbar
T-30 = 30 cbar
T-40 = 40 cbar
T-50 = 50 cbar

at 8in depth




T-20
T-50
Cbars
80
70
60
50
40
30
20
10
0
24-Aug
3-Sep
13-Sep
23-Sep
3-Oct
13-Oct
23-Oct
2-Nov
12-Nov
22-Nov
2-Dec
12-Dec


Marketable Yield
F 4.33
Prob > F 0.0275
145
140
135
130
125
120
115
110
Pounds per 20ft
a
ab
a
b
T-20
T-30
T-40
T-50
Treatment

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Matric potential-based irrigation management of field-grown strawberry: Effects on yield and water use efficiency

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ABSTRACT

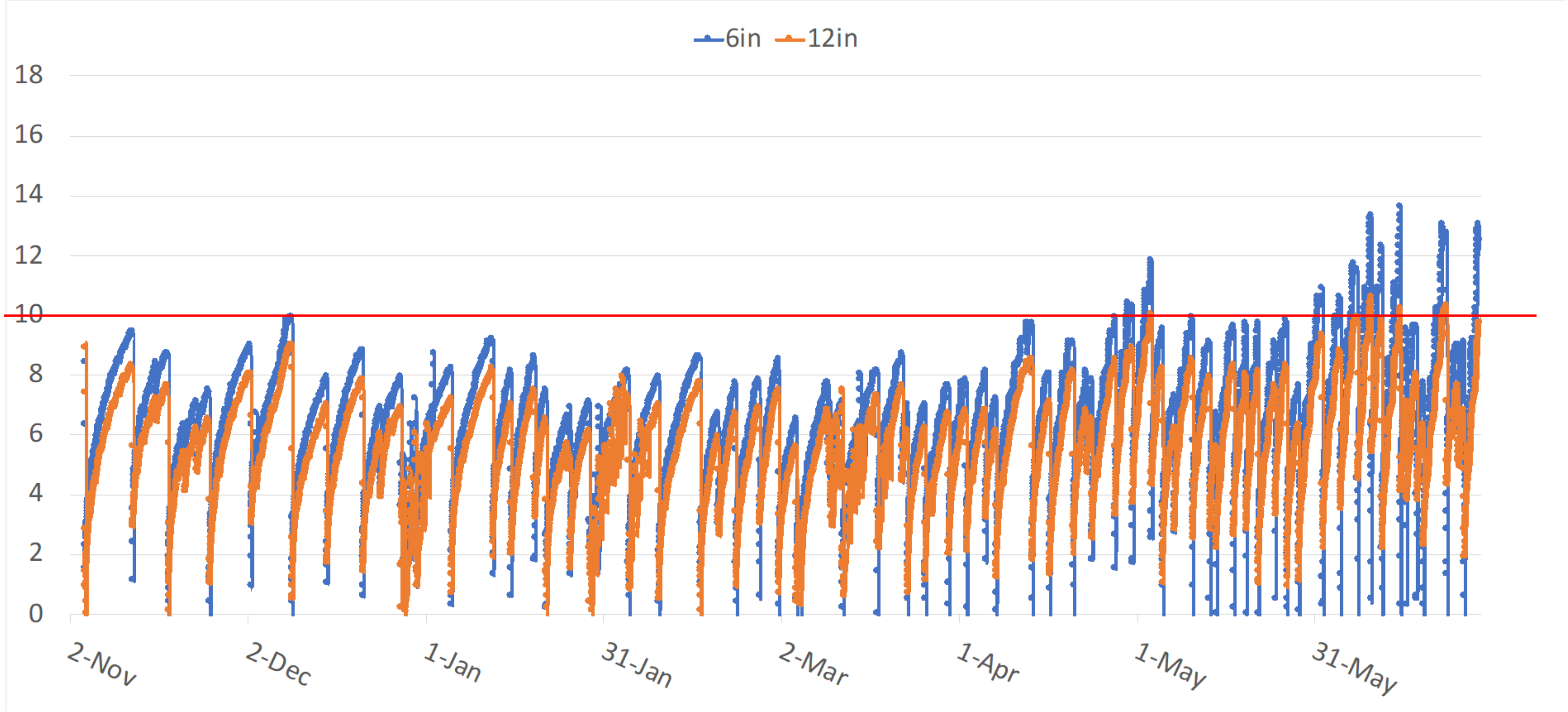
Effective and adapted criteria for irrigation scheduling are required to improve yield and water use efficiency (WUE) and reduce the environmental impacts associated with water and nutrients losses by runoff and leaching. In this study, field-scale experiments were conducted at four commercial strawberry production sites with contrasting soil and climatic conditions. Within each site, the influence of different soil matric potential-based irrigation thresholds (IT) on yield and WUE was evaluated. Matric potential-based irrigation management was also compared with common irrigation practices used by producers in each site's respective areas. At Site 1 (silty clay loam; humid continental (Dfb) climate), an IT of −15 kPa improved yields by 6.2% without any additional use of water relative to common irrigation practices. At Site 2, with similar soil and climatic conditions, the irrigation treatments did not affect yield and the matric potential-based management decreased WUE relative to common practices. However, the results suggested that maintaining the soil matric potential lower than −9 kPa could induce stressing conditions for the plants. At Site 3 (sandy loam; Mediterranean (Cs) climate), the best yield and WUE were obtained with an IT of −8 kPa and suggested that WUE could be further improved by implementing high-frequency irrigation. At Site 4 (clay loam; Mediterranean (Cs) climate), results suggested that an IT between −10 and −15 kPa could optimize yield and WUE, and matric potential-based irrigation considerably reduced leaching under the root zone relative to common practices. Considering the results from all sites, an IT of −10 kPa appears to be adequate as a starting point for further optimizing irrigation under most field conditions.

1. Introduction

Irrigation management is of primary importance for the prof-

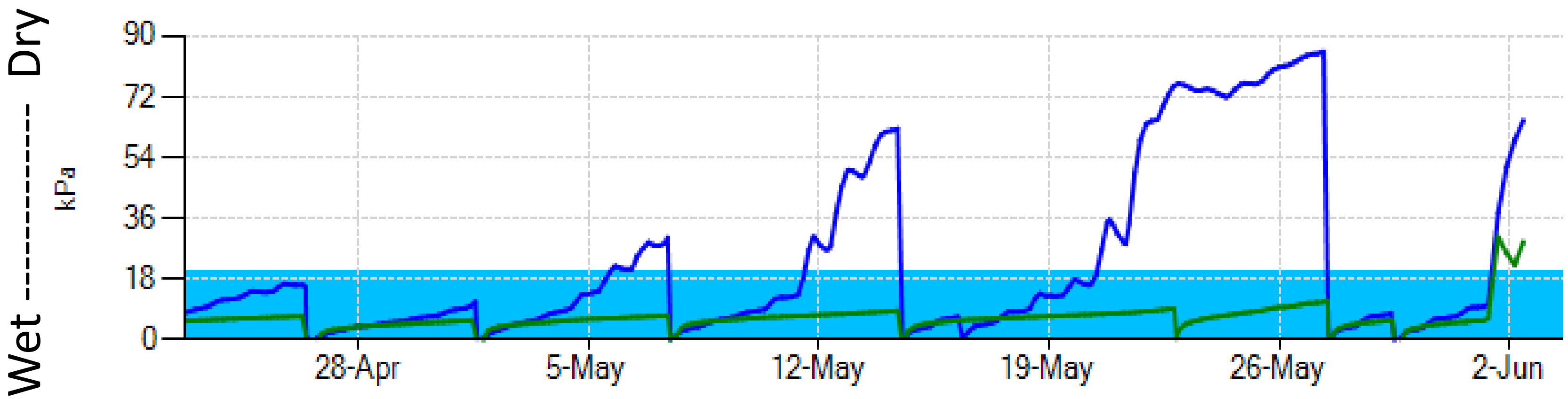
Many studies have shown that evapotranspiration (ET)-based irrigation management could be efficient for strawberry production (Hanson and Bendixon, 2004; Krüger et al., 1999; Yuan, 2004).

Soil Moisture (cbars)

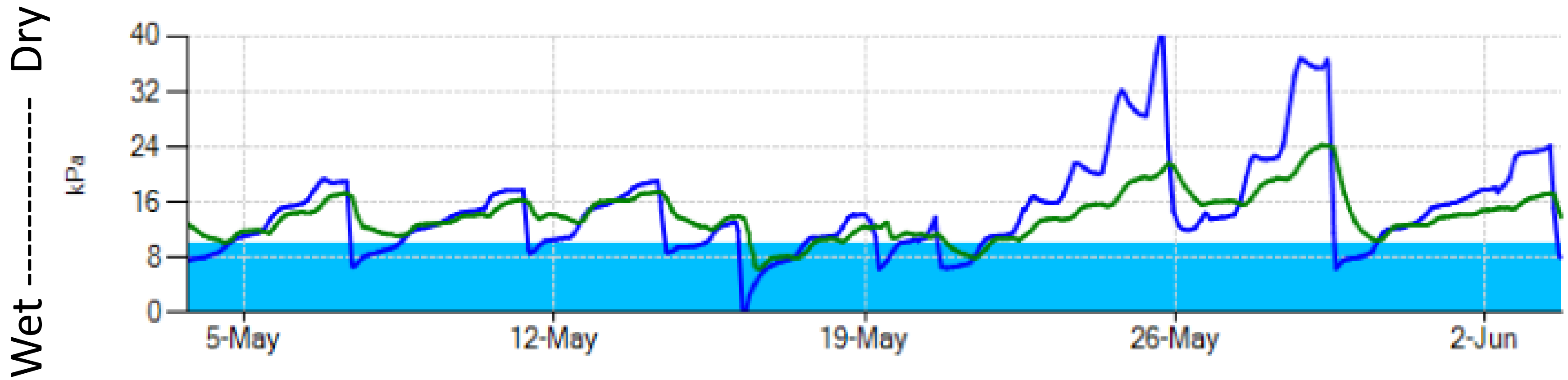


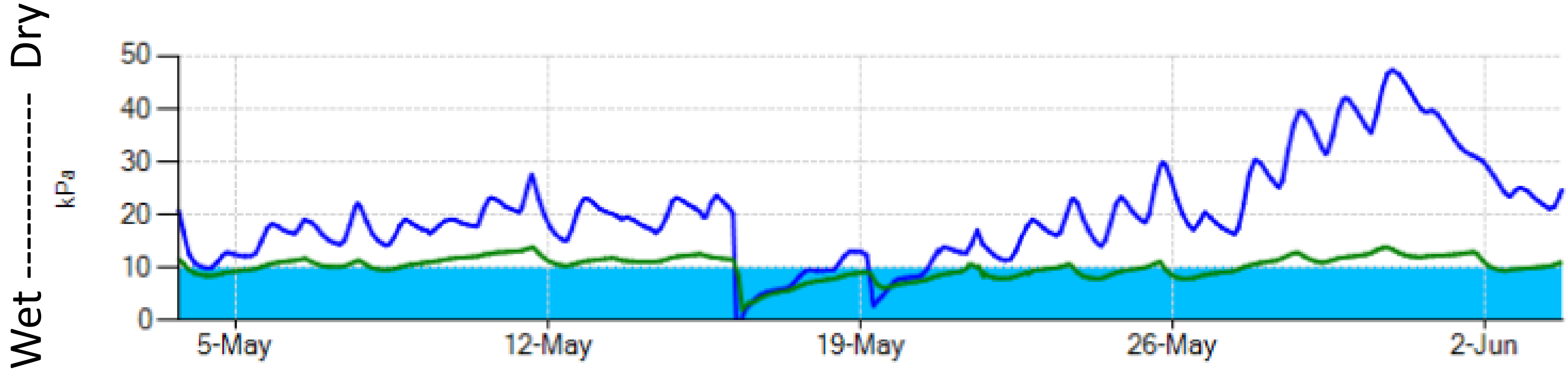
Irrigation Management Context

- Overall, most irrigators over-irrigate early in the season and under-irrigate later
- Why? Mostly lack of information



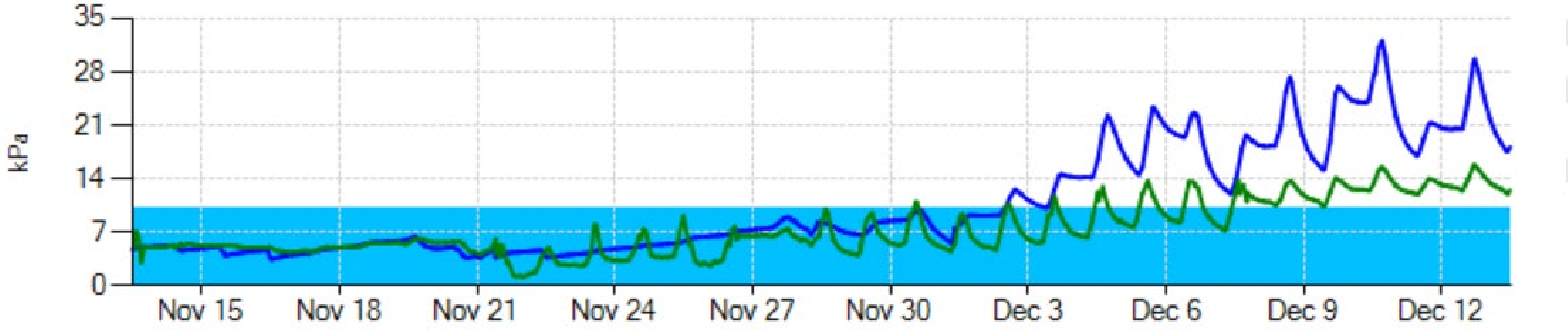
Soil Moisture (Centibars, kPa)



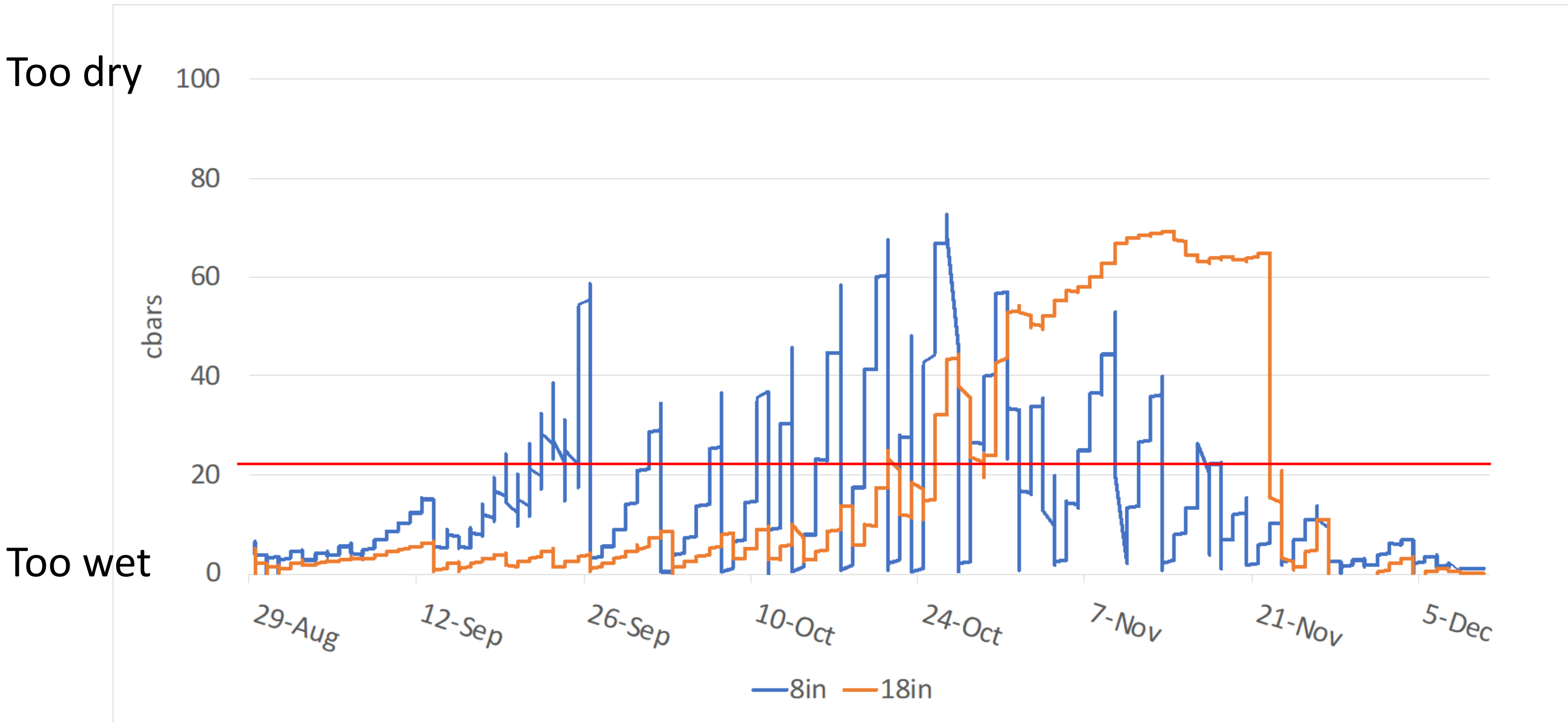


Soil Moisture (Centibars, kPa)

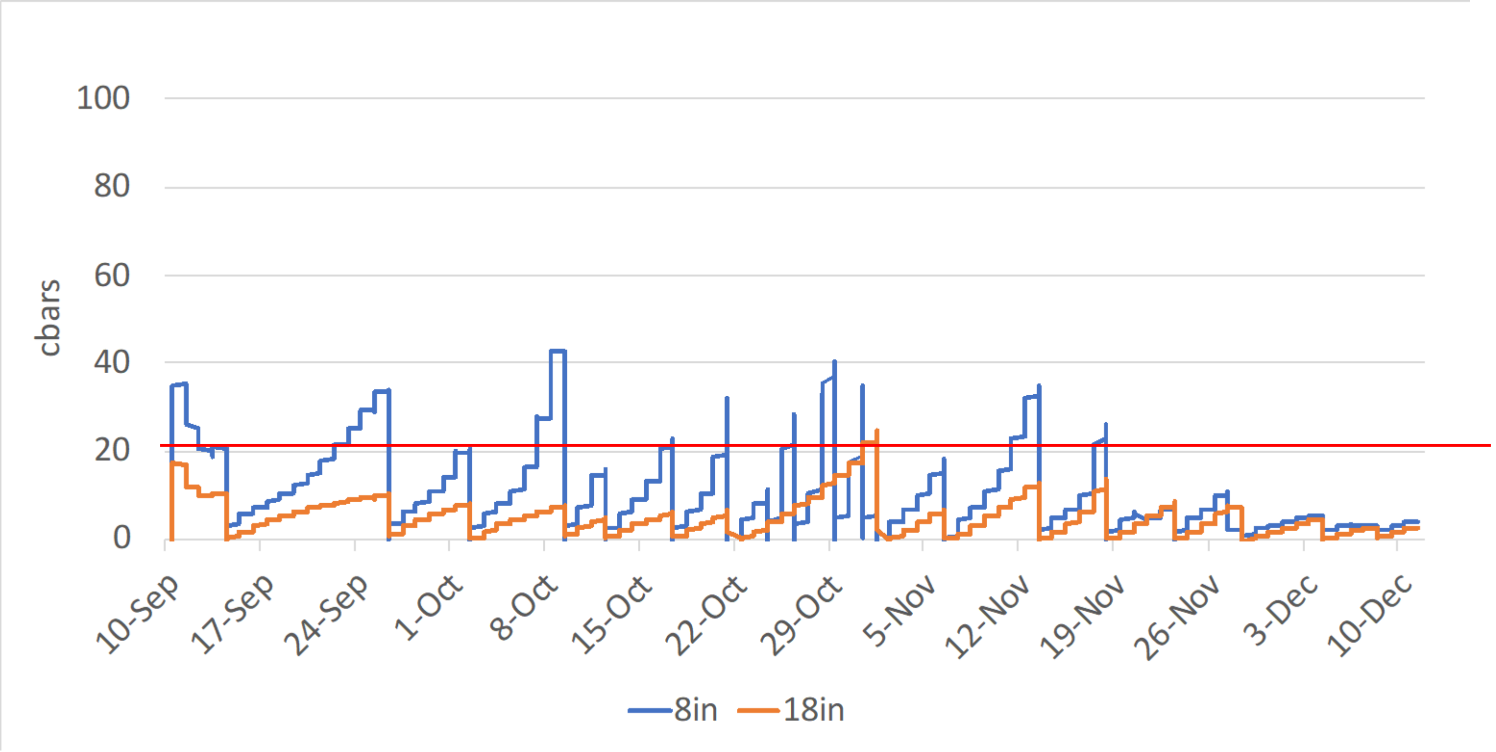
Wet ---------- Dry



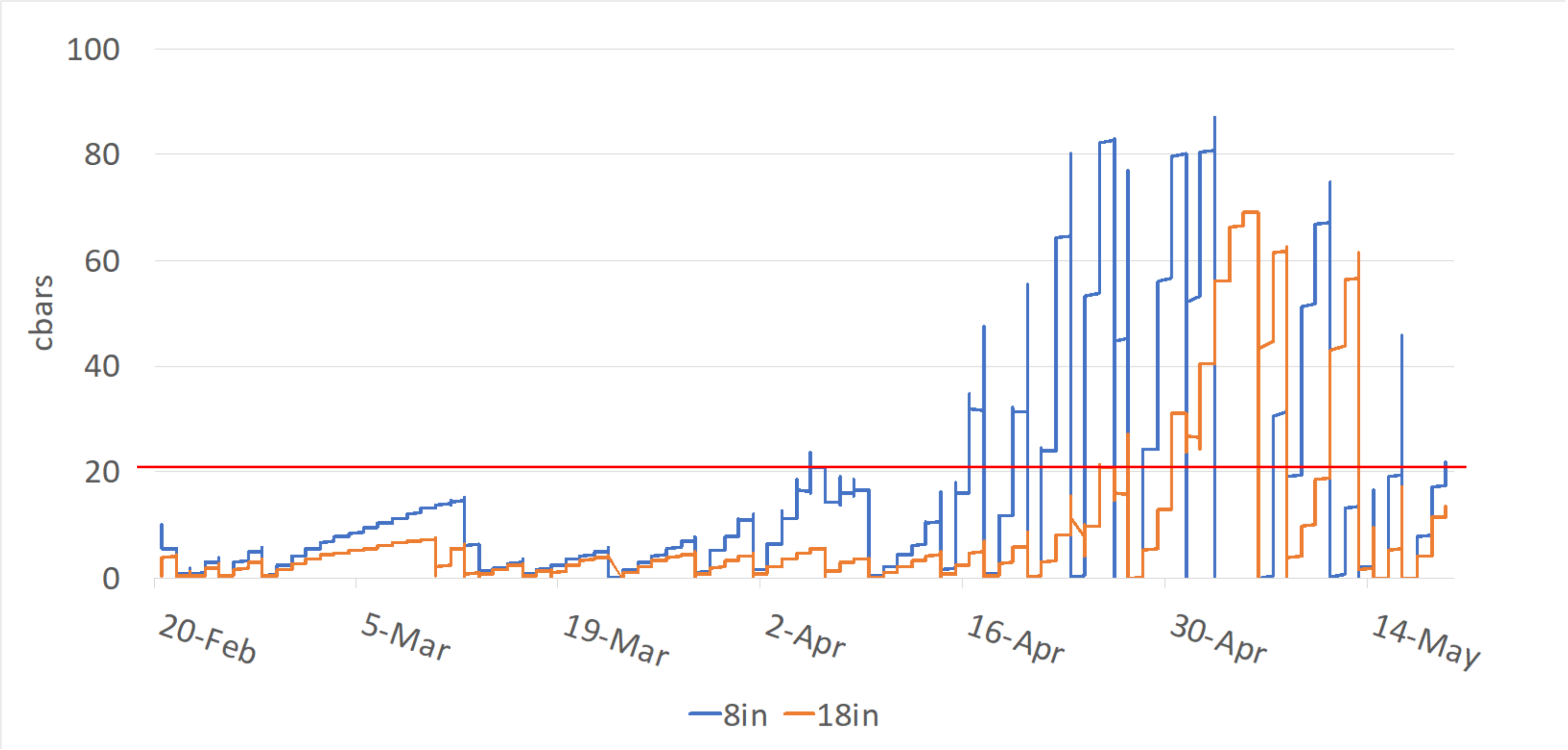
Summer-Planted



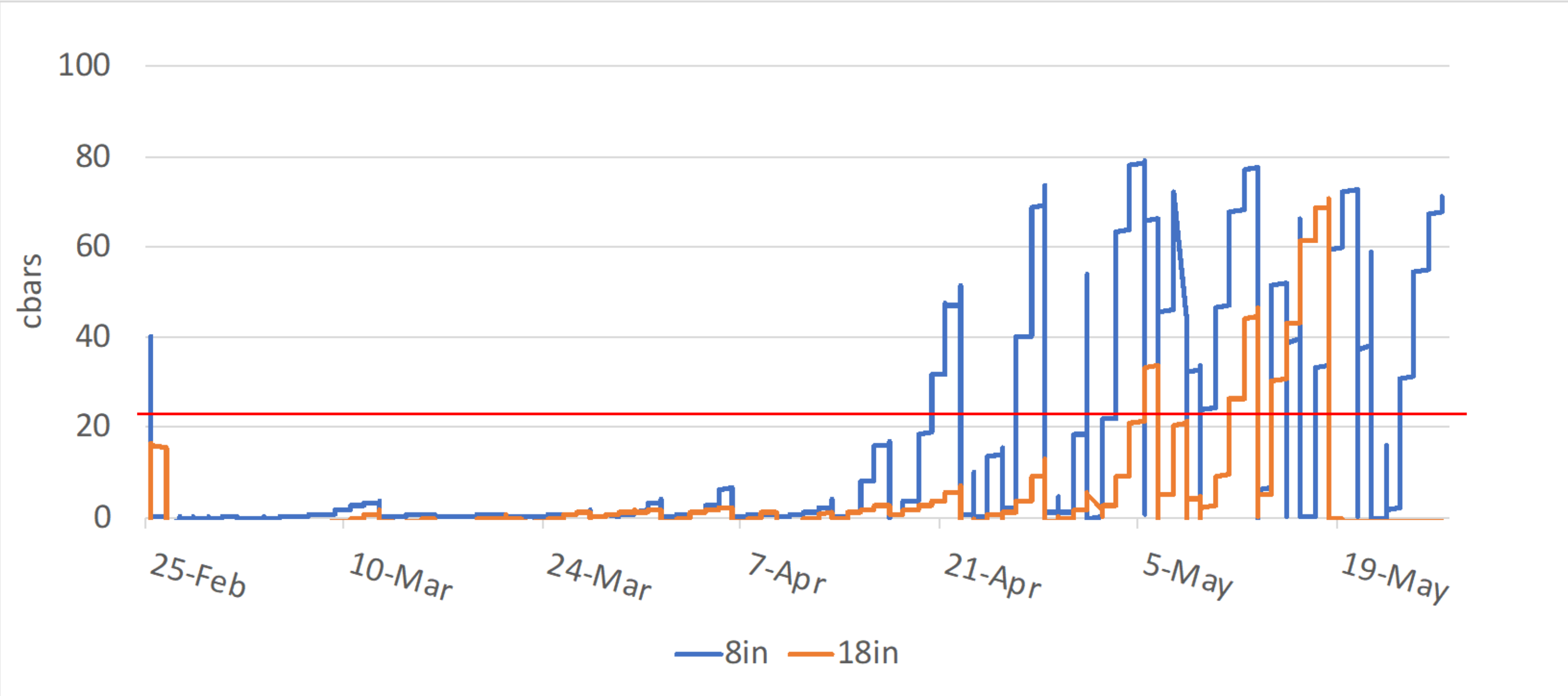
Summer-Planted



Spring-Planted



Spring-Planted



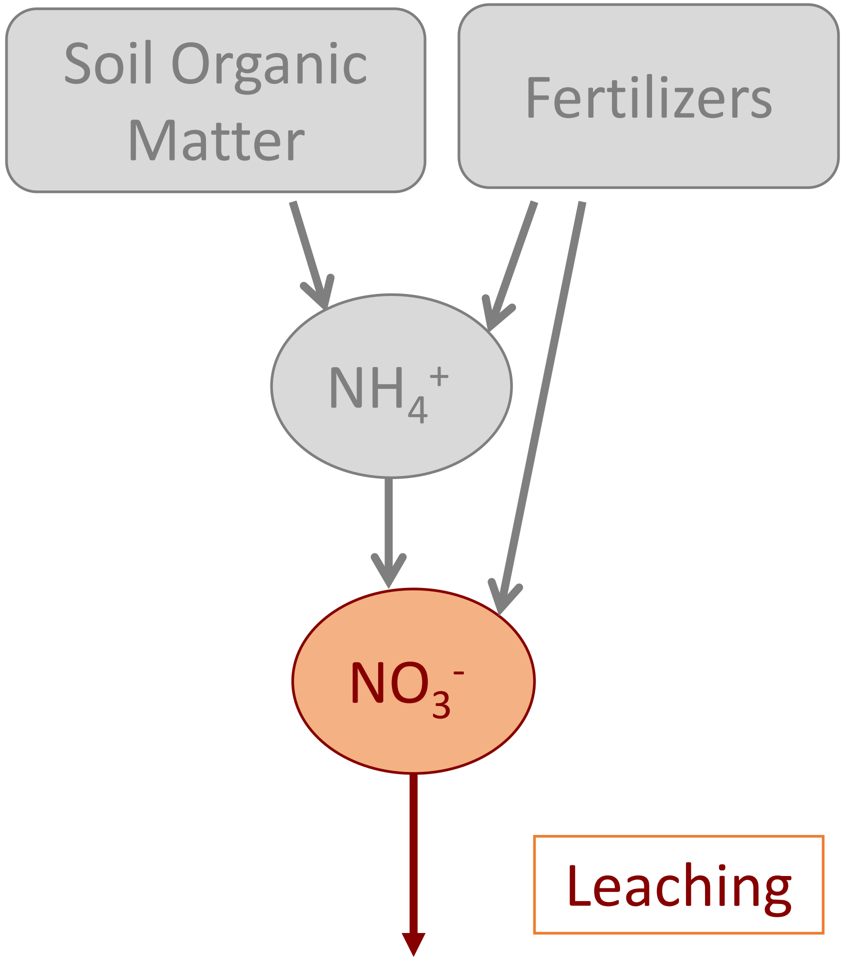
Nitrogen Management

- Among all essential plant nutrients, N is the most unstable in the soil, with significant fluctuation of in-season soil N levels;

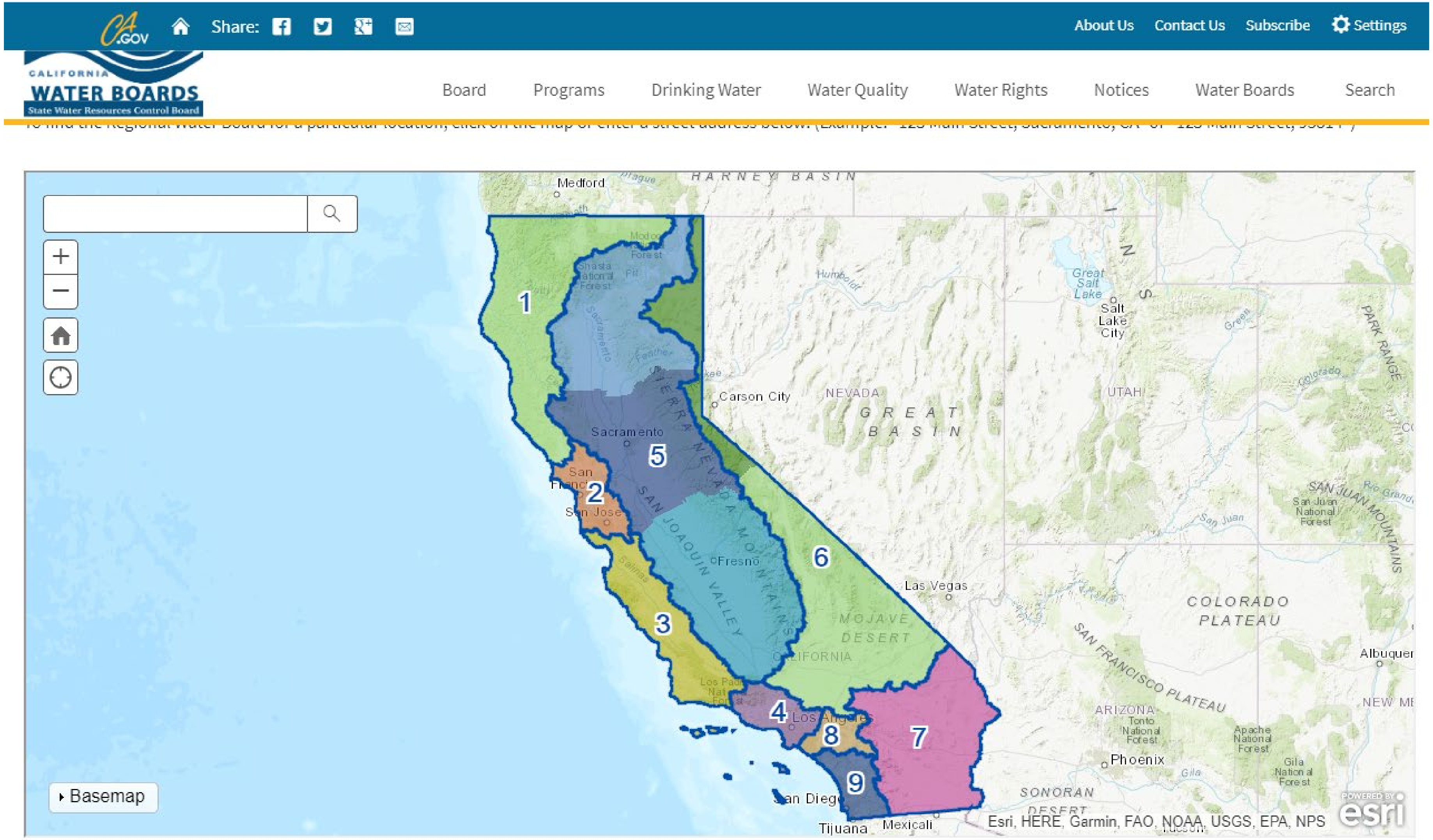
- Reason: combination of factors including numerous biological and chemical processes, variable uptake rates, uneven rainfall pattern, irrigation inefficiency and soil type, among others.

Nitrate Leaching

Loss of nitrate (NO_3^-) from the soil due to irrigation or rain.
Greatest loss potential of nitrogen from the soil.



Regional Water Quality Control Boards



https://www.waterboards.ca.gov/waterboards_map.html

VENTURA COUNTY
Agricultural Irrigated Lands Group

NITROGEN MANAGEMENT PLAN WORKSHEET

NMP Management Unit:

1. Crop Year (Harvested)		4. APN(s):	5. Field(s) ID	Acres
2. VCAILG ID#				
3. Name:				

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

CROP NITROGEN MANAGEMENT PLANNING		
28. CERTIFIED BY:	29. CERTIFICATION METHOD	
	30. Self-Certified, approved training program attended	
	31. Self-Certified, UC or NRCS site recommendation	
DATE:	32. Certified Crop Advisor	

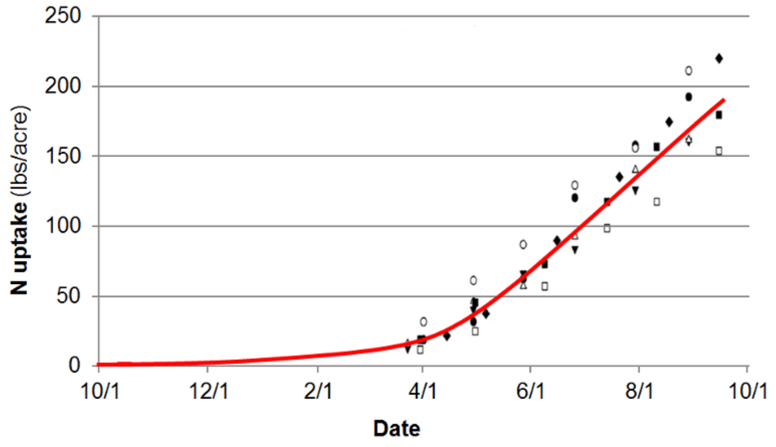
* Note: N Removed is only required if information is available for your crop type. Check for available values at: www.ipni.net/app/calculator/home or https://plants.usda.gov/npk/main

(Region 4)

- Conditional waiver as been extended for another year.

N Uptake vs N Removal

- Uptake: All N used by the crop



- Removal: all N that leaves the field with produce

Recent changes for region 3

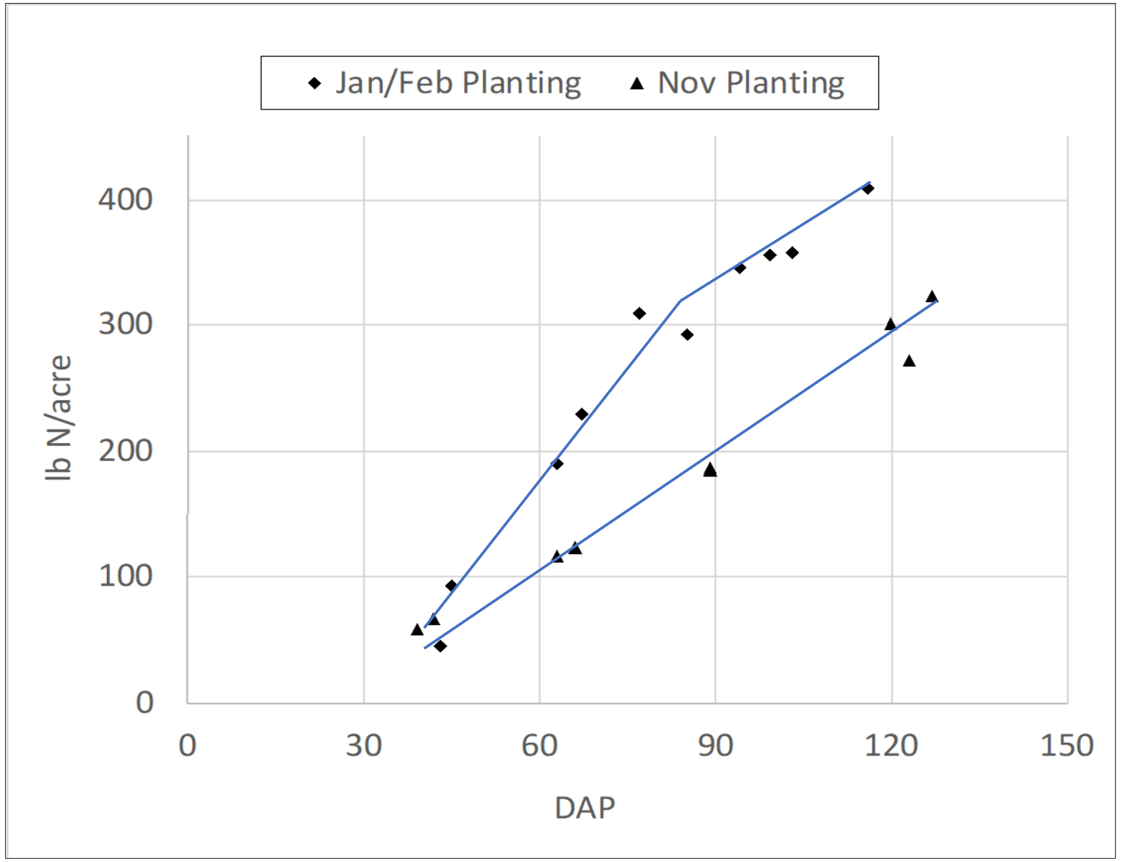
A-R = nitrogen application limits

Limit (lb N/acre/year)	Compliance Date
500 (target)	2023
400 (target)	2025
300	2027
200	2031
150	2036
100	2041
50	2051

Cabbage N Uptake

Starting around 30 DAP:

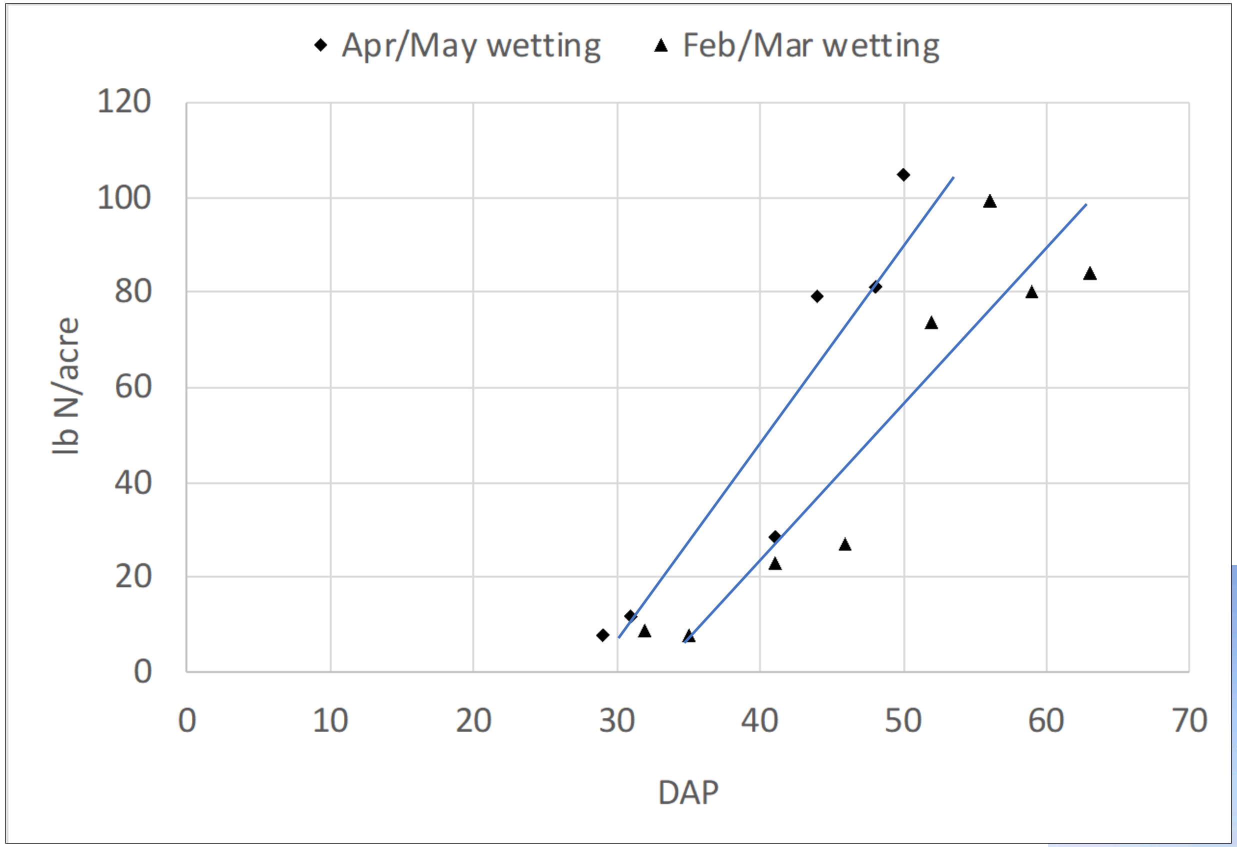
	lb N/acre/day
Nov planting	**2.8**
Jan/Feb planting	**4.8**



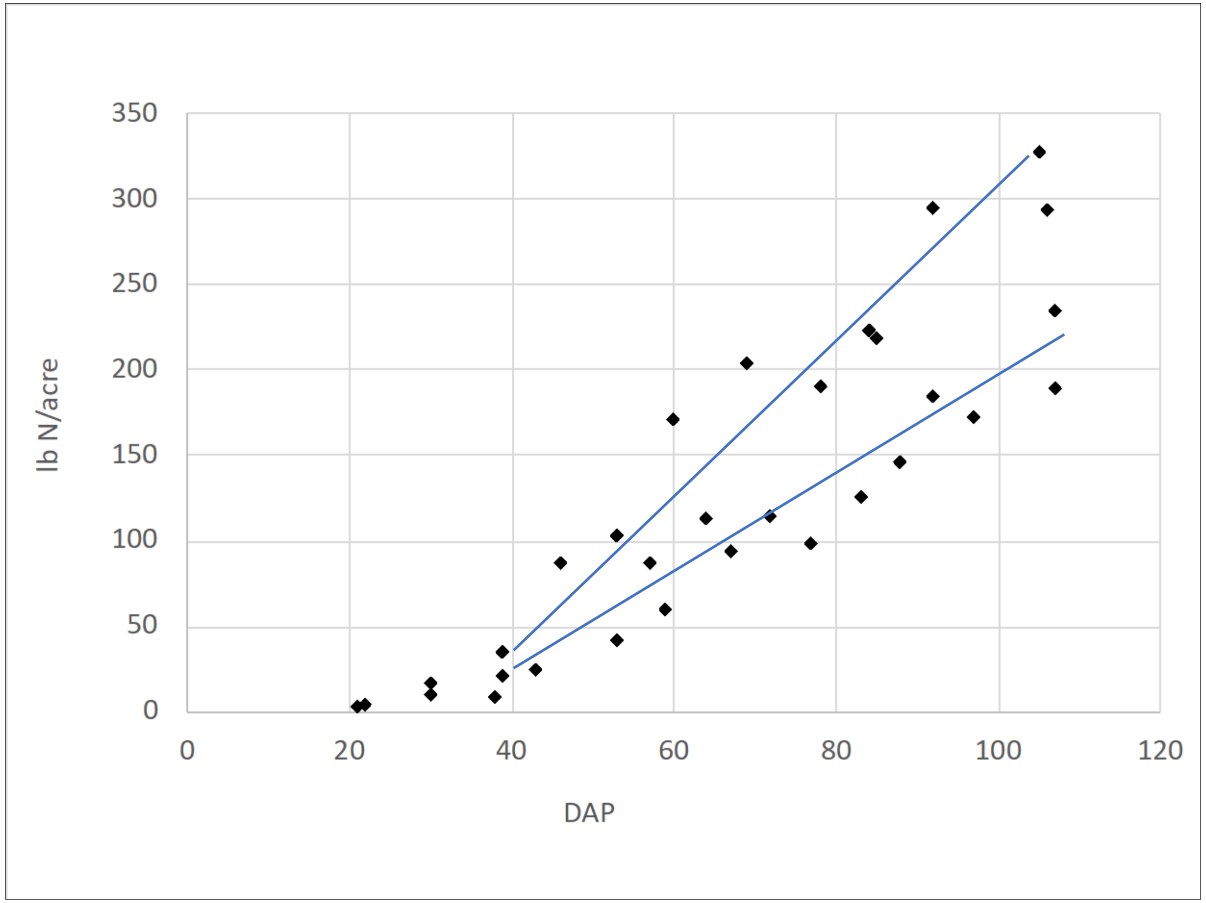
Cilantro N Uptake

Starting around 30 DAP:

	lb N/acre/day
Feb/Mar wetting	3.2
Apr/May wetting	4.4



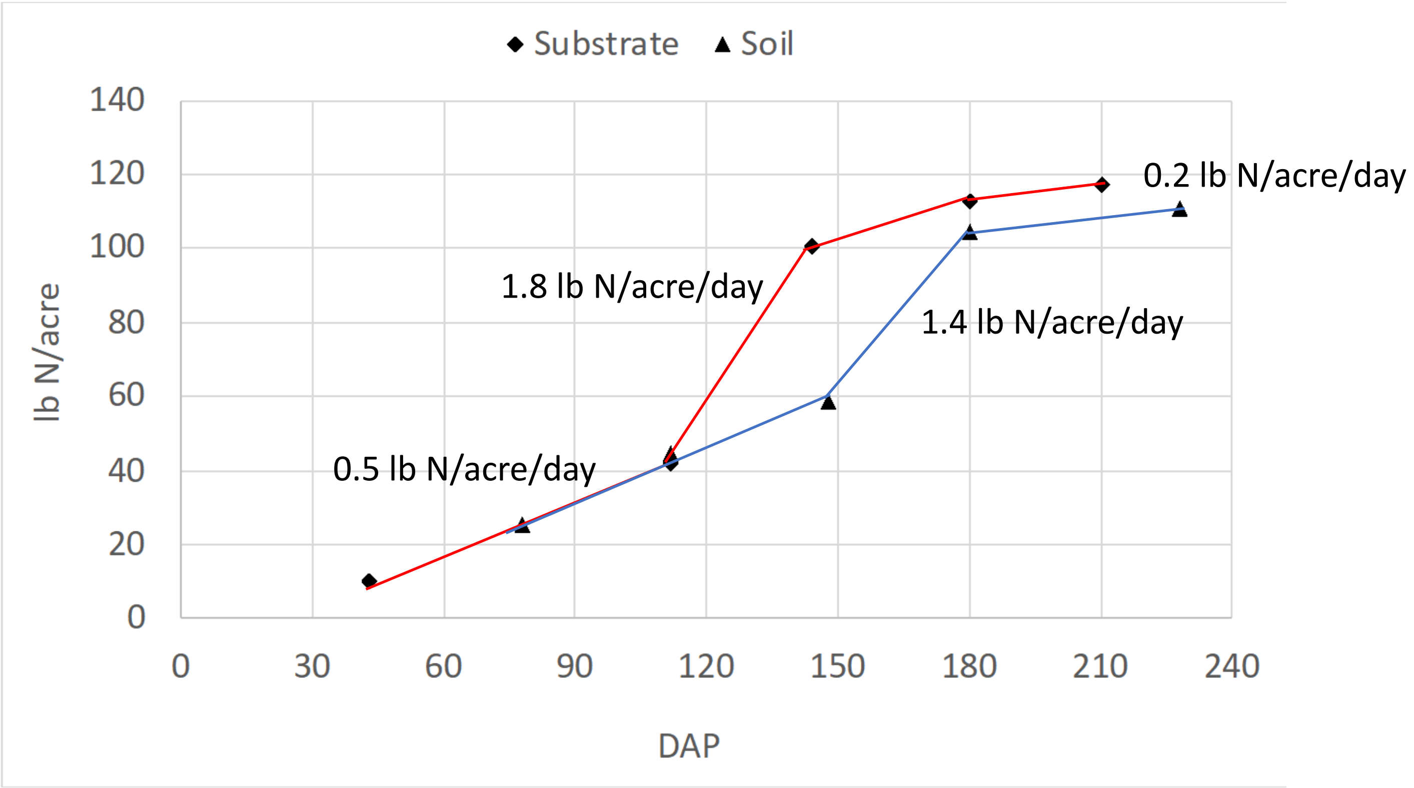
Celery N Uptake



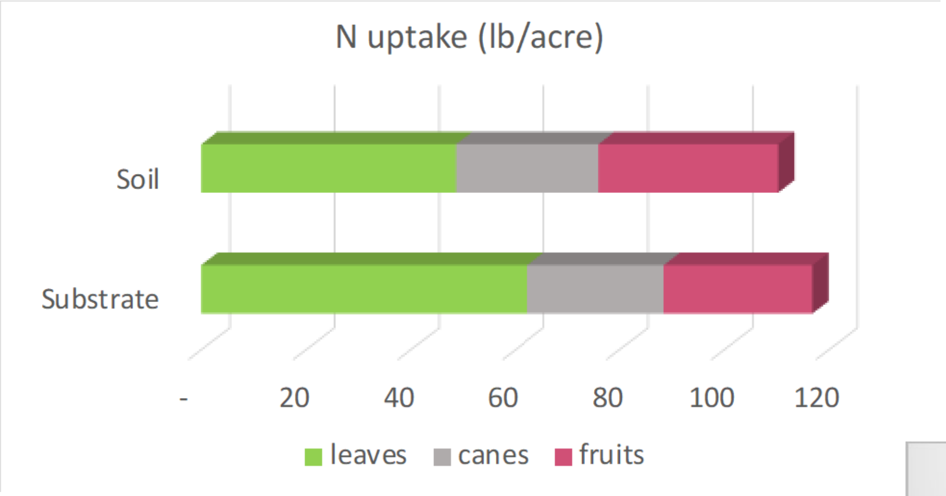
Starting approx. 40 DAP:

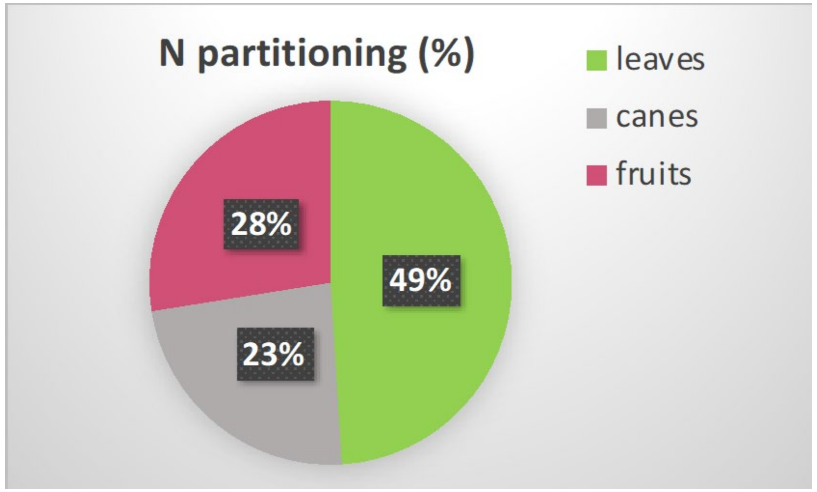
Season	lb N/acre/day
Spring	4.2
Fall	3.2

Raspberry N Uptake, primocane

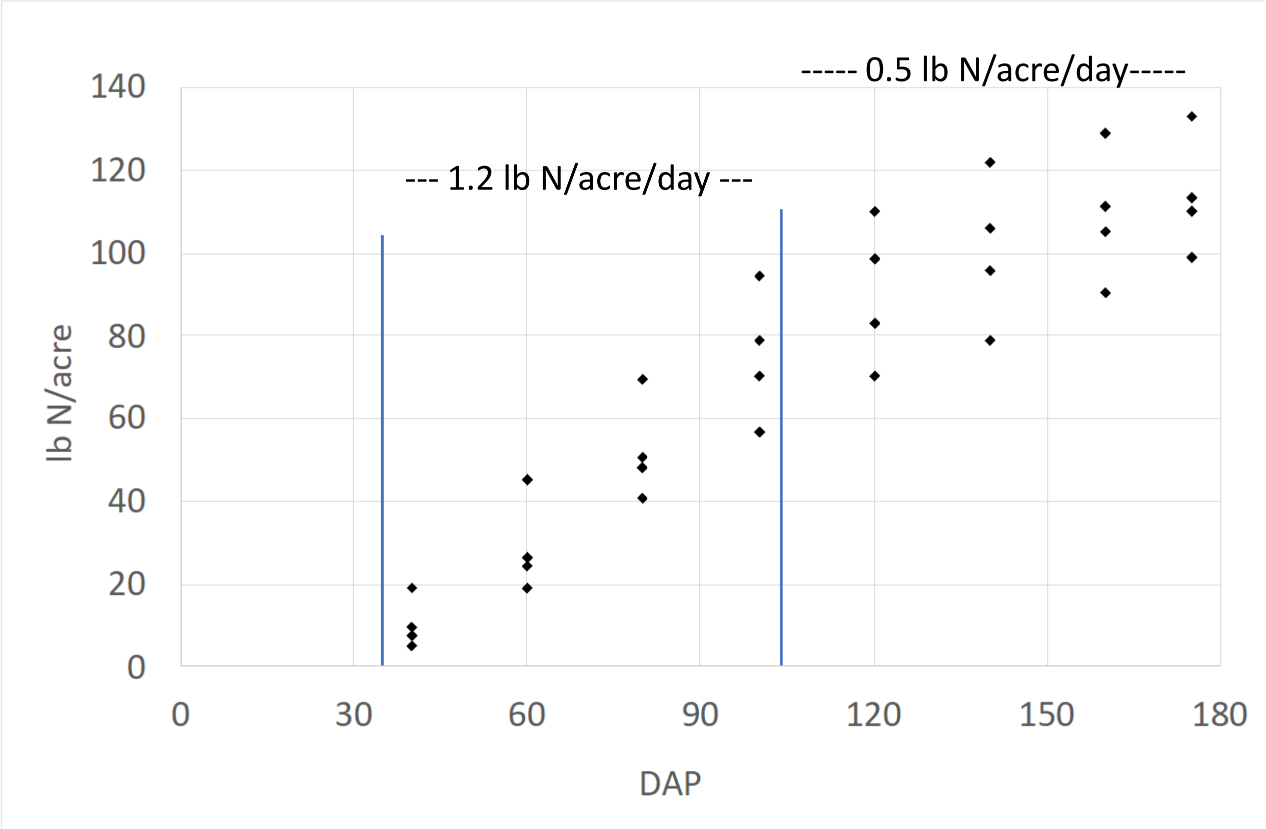


Raspberry N Partitioning, primocane

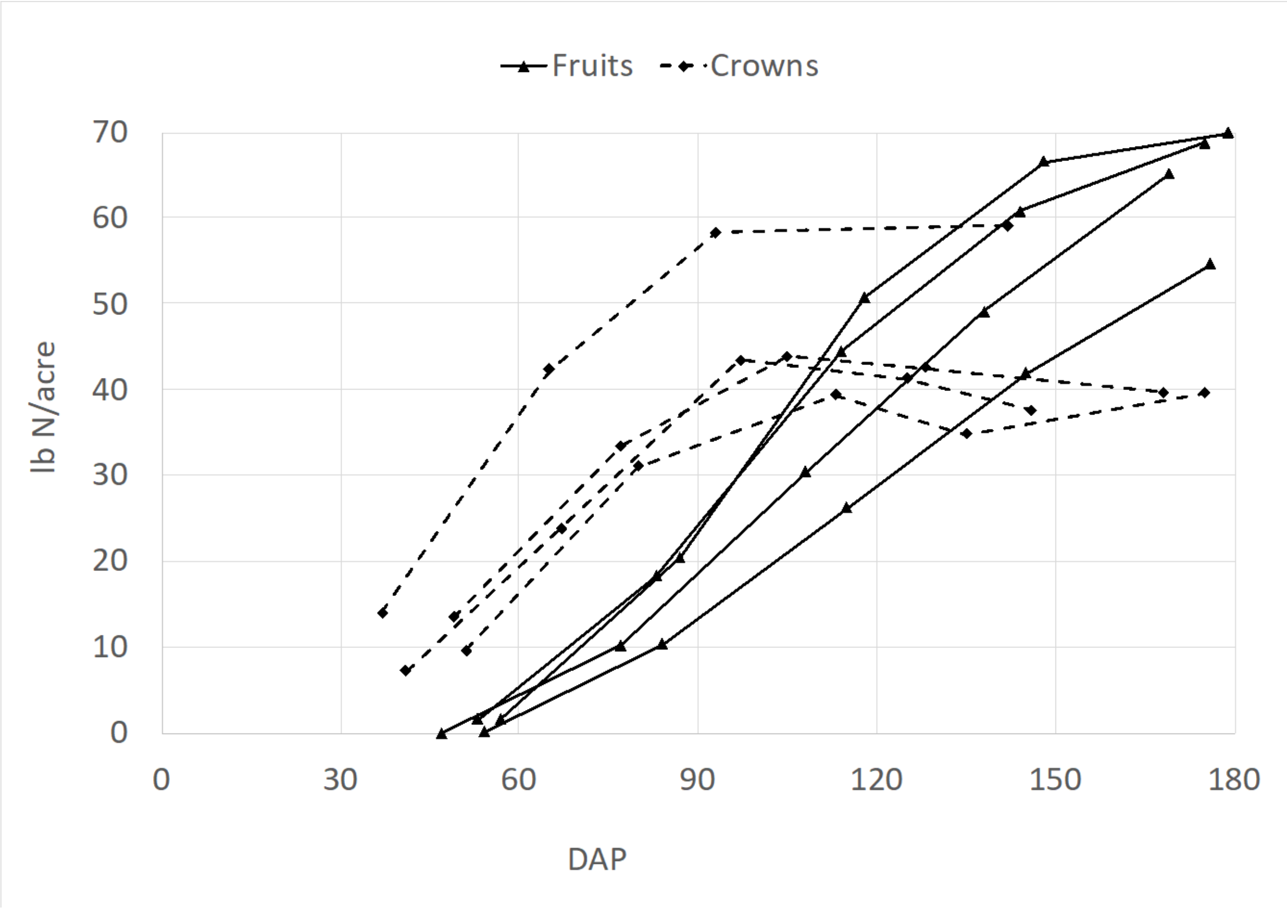




Summer-Planted Strawberry N Uptake



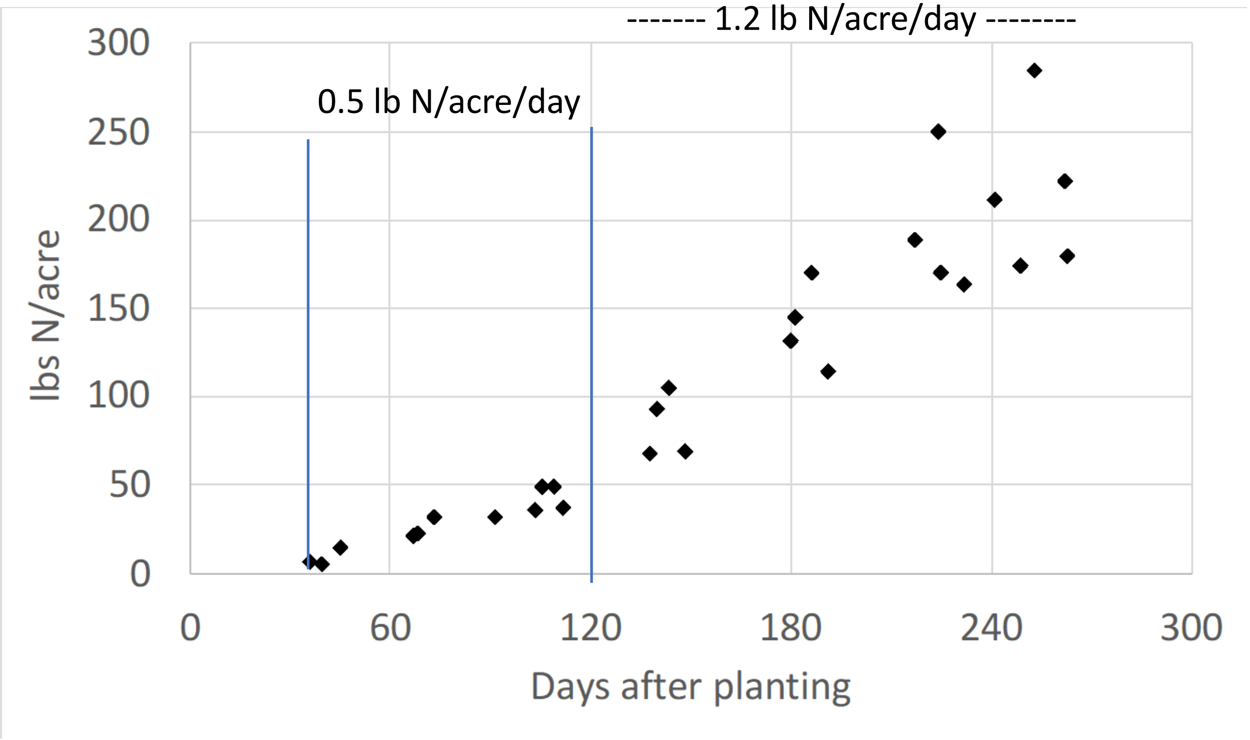
Summer-Planted Strawberry N Uptake



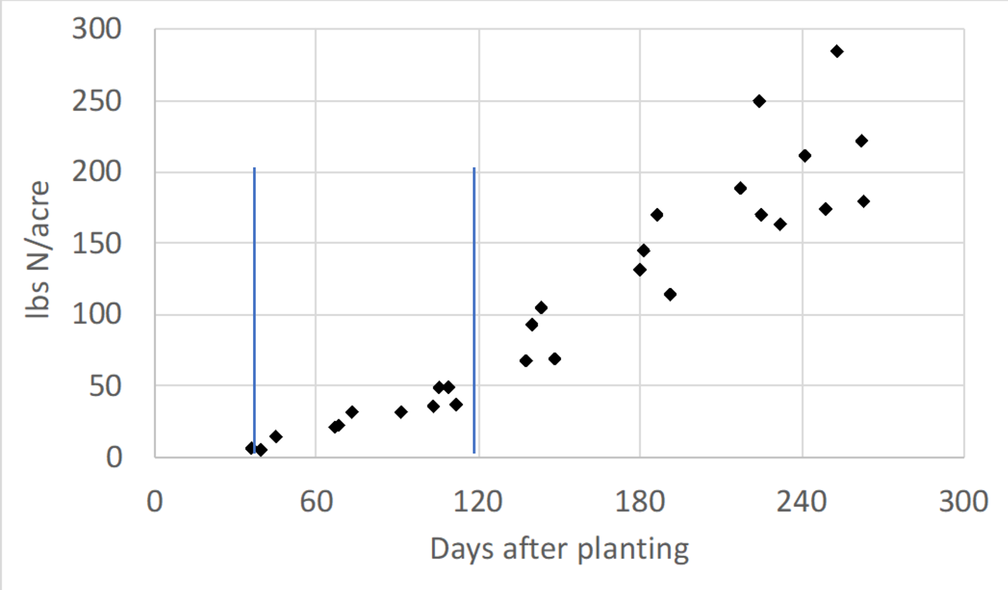
Applied – Removed N

	lb N/acre						
	Fertilizer						
	pre-plant	in-season	total	uptake	A-U	removed	A-R
Field 1	42	250	292	133	159	69	223
Field 2	27	132	159	110	49	65	94
Field 3	0	142	142	113	28	70	72
Field 4	24	144	168	99	69	55	113

Fall-Planted Strawberry N Uptake



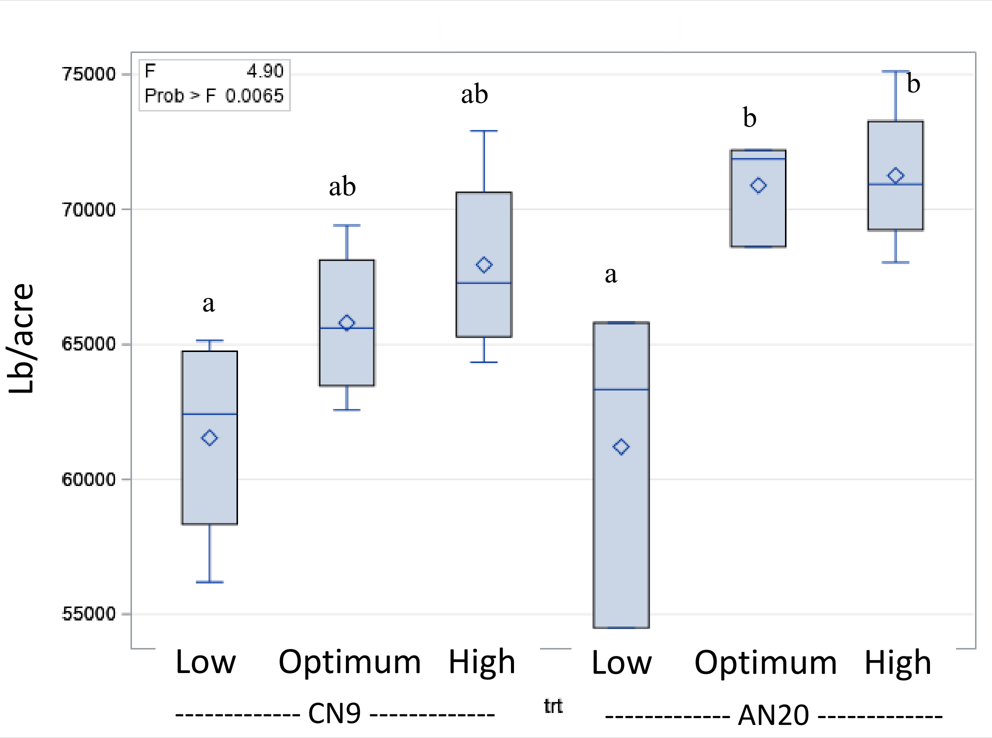
Fall-Planted Strawberry N Uptake

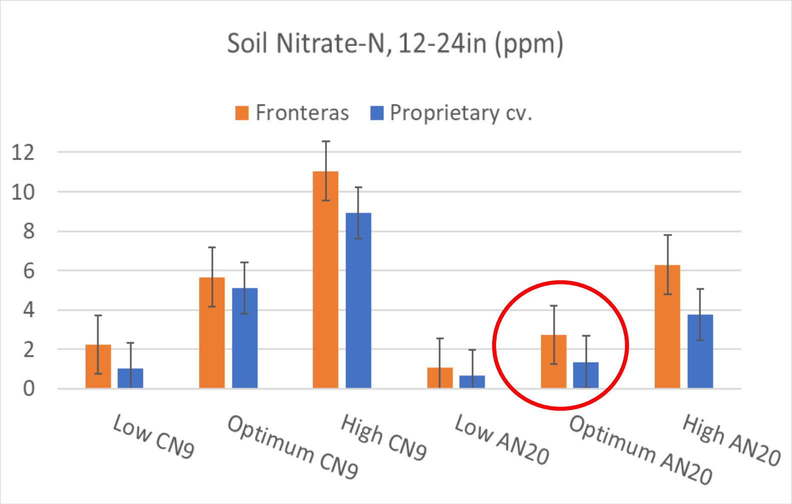


N Fertilizer rates

	lb N/acre/week		
	low	**optimum**	**high**
Early season (Oct-Feb)	2	4	6
Late season (Mar-May)	6	10	14
Total*	118	208	298

Total Marketable Yield, Fronteras





✓ Combine the right rate with the right N source

Assessing nitrogen uptake and the impact of fertilizer amounts and sources on strawberry production in California (Biscaro et al., 2022), in Agrosystems, Geosciences & Environment

N Removal

Recent changes for region 3

A-R = nitrogen application limits

Limit (lb N/acre/year)	Compliance Date
500 (target)	2023
400 (target)	2025
300	2027
200	2031
150	2036
100	2041
50	2051

N Removal Coefficients for Vegetable Crops

commodity	product	pack type	# fields sampled	mean coefficient	Minimum coefficient	Maximum coefficient
Annual Artichoke	Fresh Market	Carton	19	0.00382	0.00307	0.00473
Arugula	Bulk	Bulk	15	0.00580	0.00477	0.00737
Beet	Fresh Market	Carton	15	0.00305	0.00227	0.00384
Broccolini	Fresh Market	Carton	15	0.00520	0.00410	0.00756
Brussels Sprouts	Fresh Market	RPC/Carton	20	0.00629	0.00503	0.00810
Cabbage, Green	Bulk	Bulk (not fc[1])	16	0.00174	0.00102	0.00239
Cabbage, Green	Bulk	Bulk (fc)	15	0.00183	0.00113	0.00239
Cabbage, Green	Fresh Market	Carton	19	0.00216	0.00143	0.00293
Cabbage, Red	Bulk	Bulk (not fc)		0.00196	0.00153	0.00224
Cabbage, Red	Bulk	Bulk (fc)	15	0.00205	0.00126	0.00267
Cabbage, Red	Fresh Market	Carton	18	0.00199	0.00136	0.00274
Cauliflower	Fresh Market	Carton	28	0.00279	0.00213	0.00386
Celery	Fresh Market	Carton	10	0.00110	0.00048	0.00169
Celery	Processing		5	0.00099	0.00061	0.00143
Chinese Celery	Fresh Market	Carton	15	0.00301	0.00143	0.00459
Cilantro	Bulk	Bulk	5	0.00673	0.00464	0.00885
Cilantro	Fresh Market	Carton	1	0.00616	0.00575	0.00656
Endive	Fresh Market	Carton	15	0.00274	0.00192	0.00377
Escarole	Fresh Market	Carton	15	0.00242	0.00175	0.00323
Fennel	Fresh Market	Carton	15	0.00202	0.00118	0.00259
Gai Choy	Fresh Market	Carton	15	0.00354	0.00262	0.00523
Jalapeno	Fresh Market	Carton	0			
Kale, multi pick	Planta	RPC	1	0.00712	0.00681	0.00761
Kale, multi pick	Retail	RPC	42	0.00544	0.00360	0.00730
Leek	Bulk	Bulk	12	0.00229	0.00131	0.00371
Leek	Fresh Market	Carton	3	0.00213	0.00158	0.00269
Butter	Fresh Market	Carton	20	0.00199	0.00142	0.00274
Green Leaf	Fresh Market	Carton	20	0.00207	0.00134	0.00300
Head Lettuce	Bulk	Bulk (fc)	20	0.00120	0.00088	0.00199
Head Lettuce	Fresh Market	Film Wrap	19	0.00127	0.00100	0.00181

Head Lettuce	Fresh Market	Naked (Liner)	21	0.00129	0.00095	0.00175
Red Leaf	Fresh Market	Carton	20	0.00224	0.00173	0.00320
Romaine	Bulk (undefined)	Bulk	3	0.00144	0.00129	0.00155
Romaine	Bulk Tops & Tails	Bulk & RPC	5	0.00152	0.00127	0.00204
Romaine	Bulk Whole	Bulk & RPC	12	0.00151	0.00130	0.00188
Romaine	Bulk, All	Bulk & RPC	20	0.00150	0.00127	0.00204
Romaine	Fresh Market	Naked (Liner)	20	0.00184	0.00132	0.00271
Romaine	Hearts	Carton	21	0.00188	0.00105	0.00252
Onion, Red	Bulk	Bulk	16	0.00126	0.00085	0.00245
Onion, Yellow	Bulk	Bulk	15	0.00164	0.00109	0.00235
Parsley, Curly	Fresh Market	Carton	3	0.00452	0.00315	0.00568
Parsley, Italian	Fresh Market	Carton	3	0.00444	0.00373	0.00534
Parsley, All	Fresh Market	Carton	6	0.00449	0.00315	0.00568
Edible Pod Pea	Fresh Market	RPC	15	0.00472	0.00405	0.00550
Pepper, Red Bell	Fresh Market	Carton	3	0.00194	0.00176	0.00229
Radicchio	Bulk	Bulk	2	0.00216	0.00200	0.00232
Radicchio	Fresh Market	Carton	13	0.00235	0.00181	0.00307
Radicchio	All	All	15	0.00233	0.00181	0.00307
Red Radish	Bulk	Bulk	15	0.00167	0.00112	0.00228
Red Radish	Fresh Market	Carton & RPC	15	0.00248	0.00209	0.00286
Rapini	Fresh Market	Carton	15	0.00605	0.00521	0.00731
Shallots	Bulk	Bulk	16	0.00251	0.00152	0.00363
Tong Ho	Fresh Market	Carton	15	0.00331	0.00182	0.00419
Yam Leaves	Fresh Market	Carton	15	0.00510	0.00352	0.00629
Bok Choy	Fresh Market	Carton	12	0.00179	0.00137	0.00214
Broccoli	Fresh Market	Carton	19	0.00466	0.00376	0.00626
Kale, baby	Bulk	Bulk	7	0.00694	0.00571	0.00879
Lettuce, baby green	Bulk	Bulk	19	0.00333	0.00220	0.00478
Lettuce, baby red	Bulk	Bulk	21	0.00346	0.00239	0.00550
Mizuna	Bulk	Bulk	5	0.00546	0.00454	0.00666
Napa Cabbage	Fresh Market	Carton	12	0.00183	0.00138	0.00231
Spinach, baby	Bulk	Bulk	20	0.00484	0.00381	0.00731

Berry Crops N Removal Coefficients

Strawberry

Coefficient: 2.75
Yield (tons/acre) x 2.75 = lb N removed/acre

Raspberry

Coefficient: 3.11
Yield (tons/acre) x 3.11 = lb N removed/acre

Summary

- ✓Optimize irrigation efficiency to minimize N losses
- ✓Use of tensiometers can help optimizing yield, water use and plant health.
- ✓Threshold for starting irrigation: Veg crops: 20-30 cbars; strawberries: 10 cbars.
- ✓Use of ET-based data can help with determining how long to irrigate
- ✓Pay attention to the root depth

Summary

- ✓N uptake info helps with optimizing fertilization. N removal data is required by law
- ✓Less N in pre-plant, more later in the season
- ✓Know your numbers: when and how much uptake happens
- ✓Choose the N source wisely: nitrate leaches readily
- ✓Consider applying most N fertilizer throughout the season (fertigating)
- ✓Consider using the SNQT

Thank you!

Questions/comments?

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