University of California
Agriculture and Natural Resources

Project Overview: Irrigation and Nutrient Management in Strawberry Production

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Objectives

- Fill gaps in nutrient and water management data
- Improve fertilizer and water use efficiency
- Devise CropManage for strawberry

Nitrogen and Water Management in Strawberry Production

- ✓ Successful water and N management = maximum yields and profits
- ✓ Changes in water availability and regulations in recent years = increasing efficiency of water and N fertilizer use

Measurements

- 4 strawberry fields; one variety
- 3 sampling locations per field

Weekly or monthly:

- Biomass - N content for uptake curves
- Canopy coverage (%)
- Root depth
- Soil nutrient content
- Yield

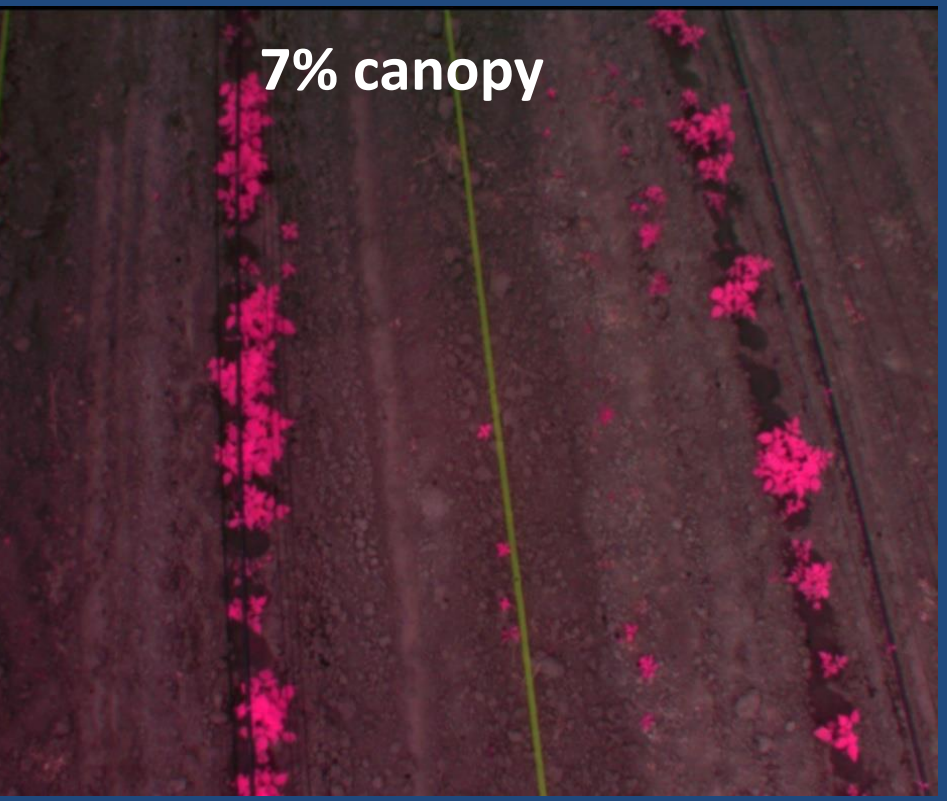
Biomass and Laboratory Analysis

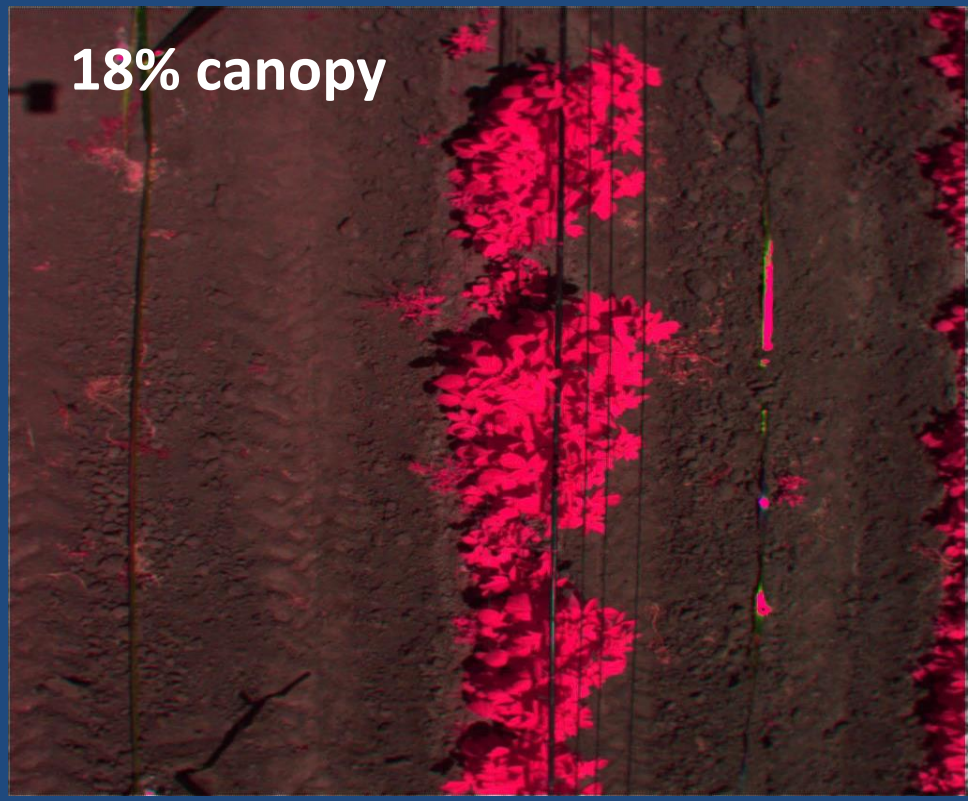
Canopy Cover

- Vegetation index camera

$$ET_{crop} = ET_o \times K_c$$

K_c can vary from 0.1 to 1.2

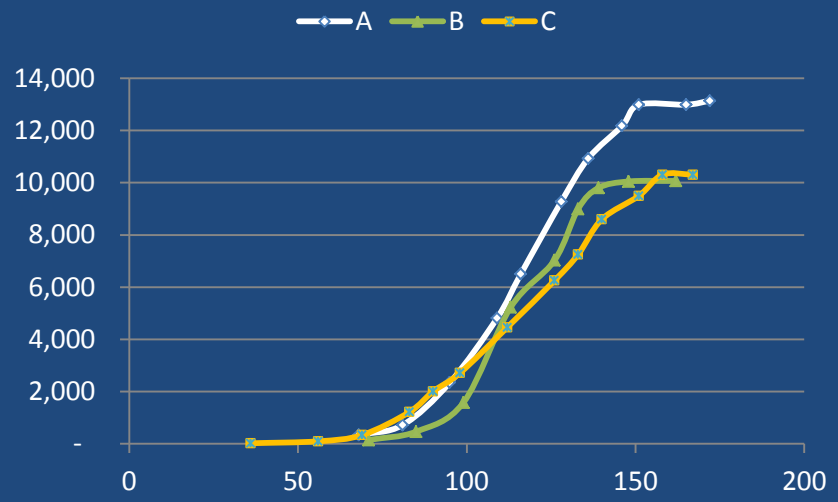




(Cahn)

Root Depth

Biomass



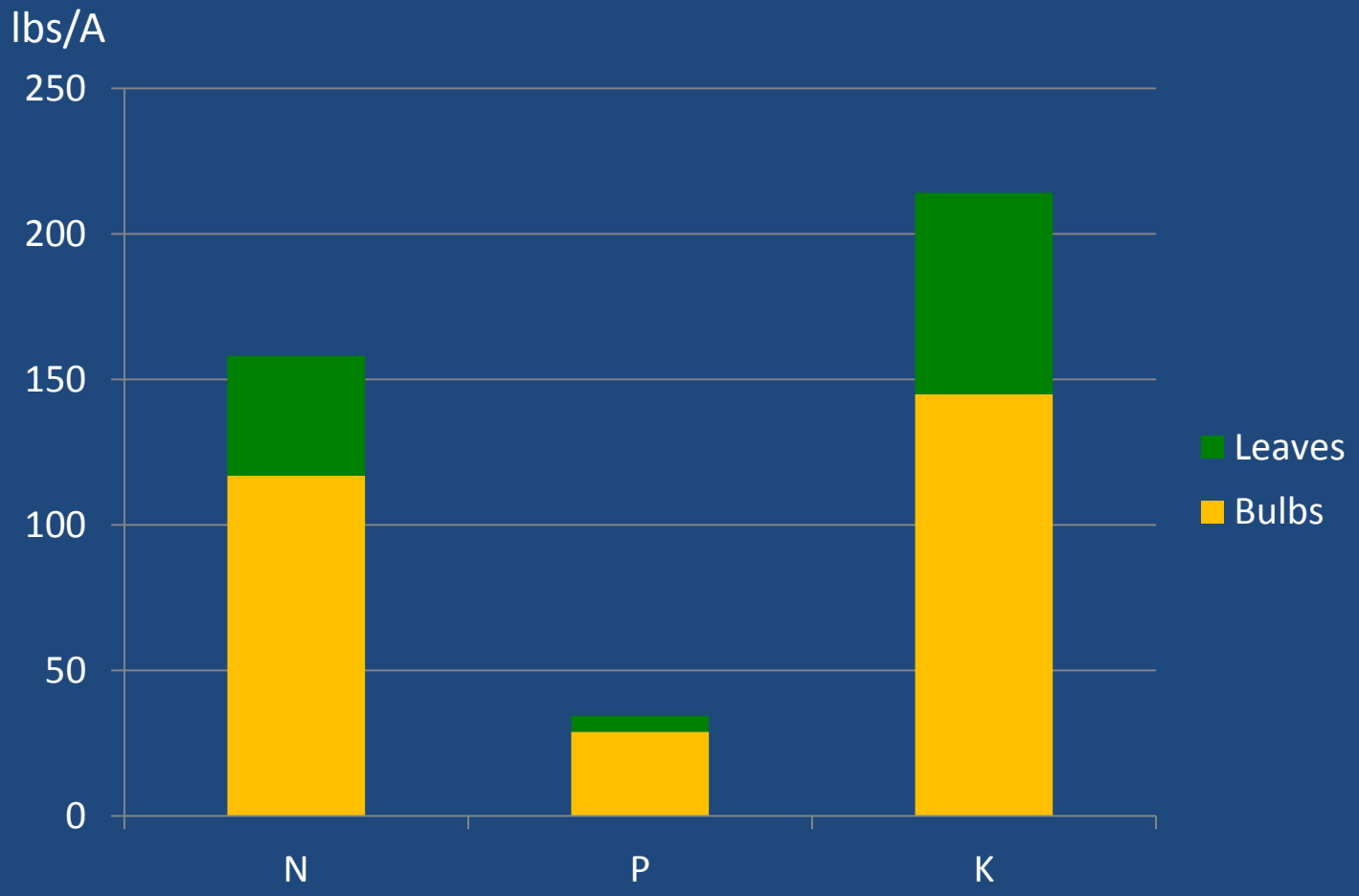
X

Lab Analysis

Lab ID	N (% Total)	P (% Total)	K (% Total)
1	4.65	0.472	5.97
2	4.66	0.497	5.51
3	4.44	0.47	5.33
4	4.49	0.381	4.74
5	3.94	0.336	4.83
6	4.66	0.438	5.48
…	…	…	…

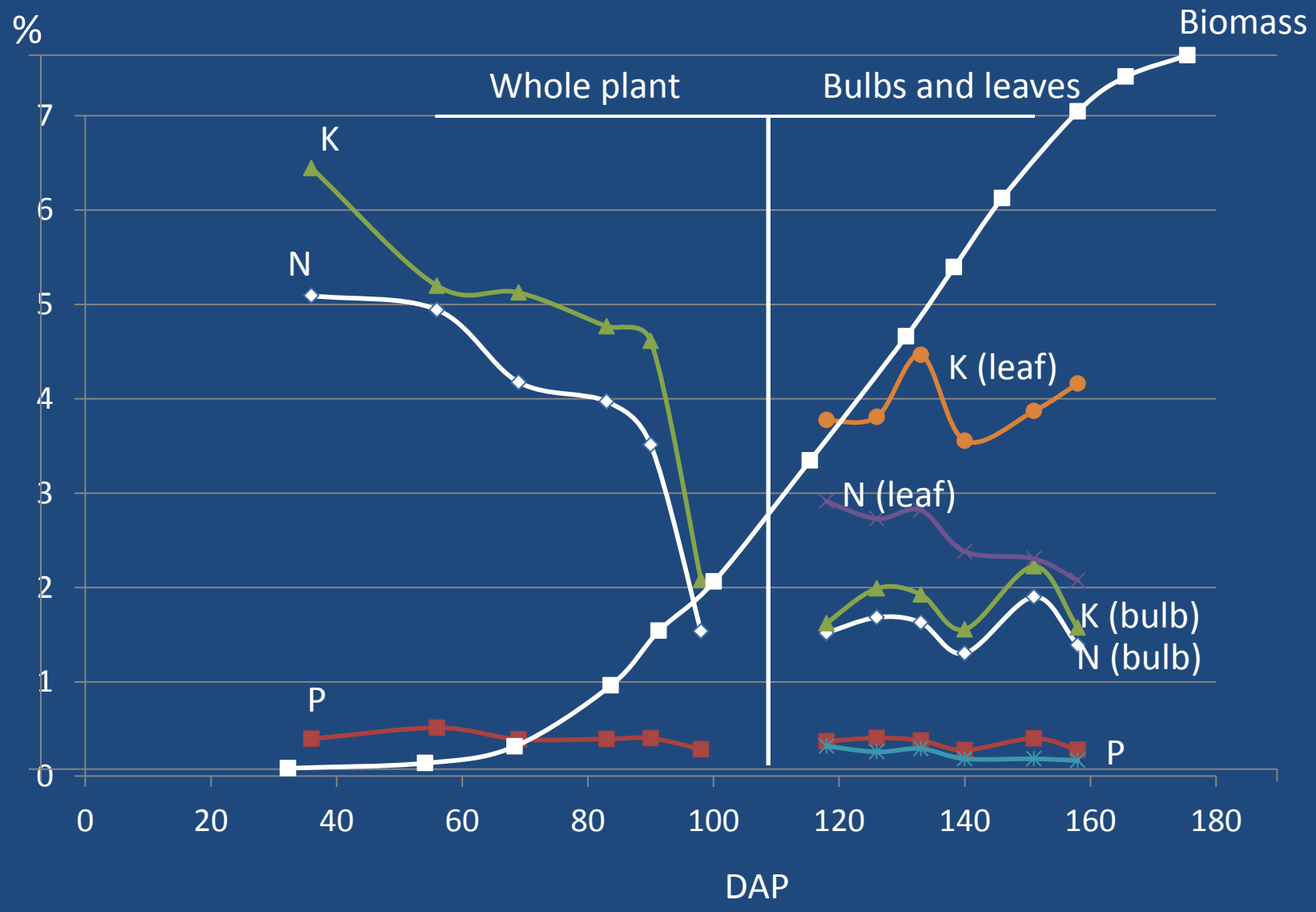
→ lbs of NPK/A

Total Nutrient Uptake



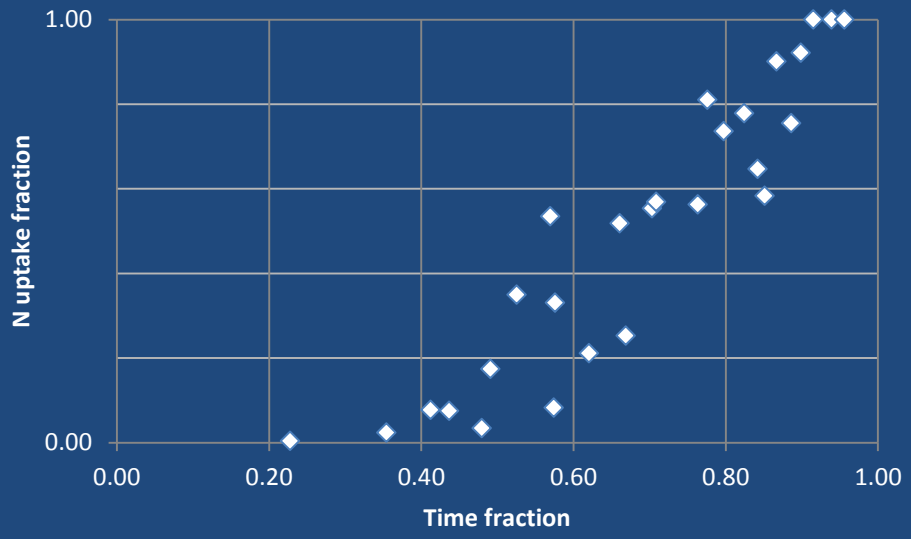
- Average of 3 varieties, 4 sampling locations each

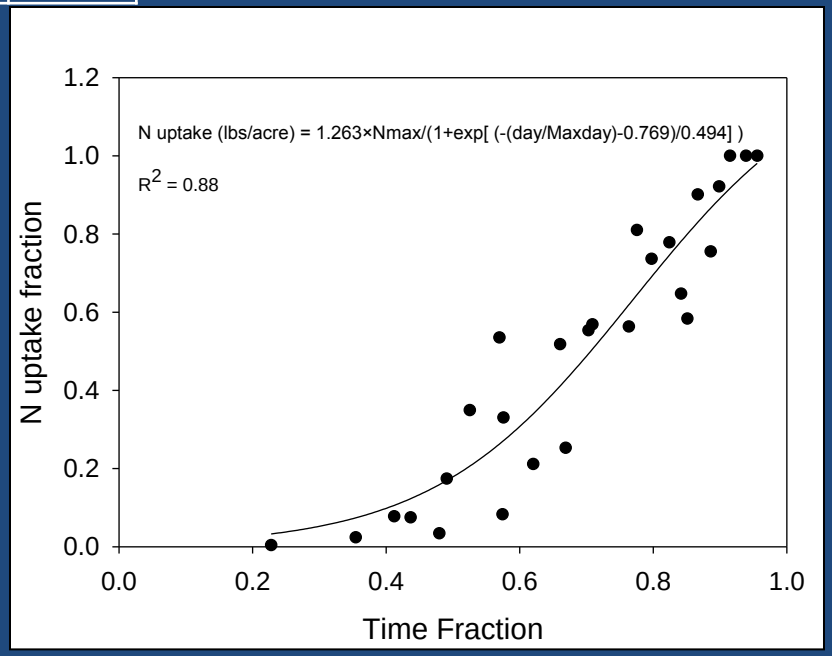
NPK concentration



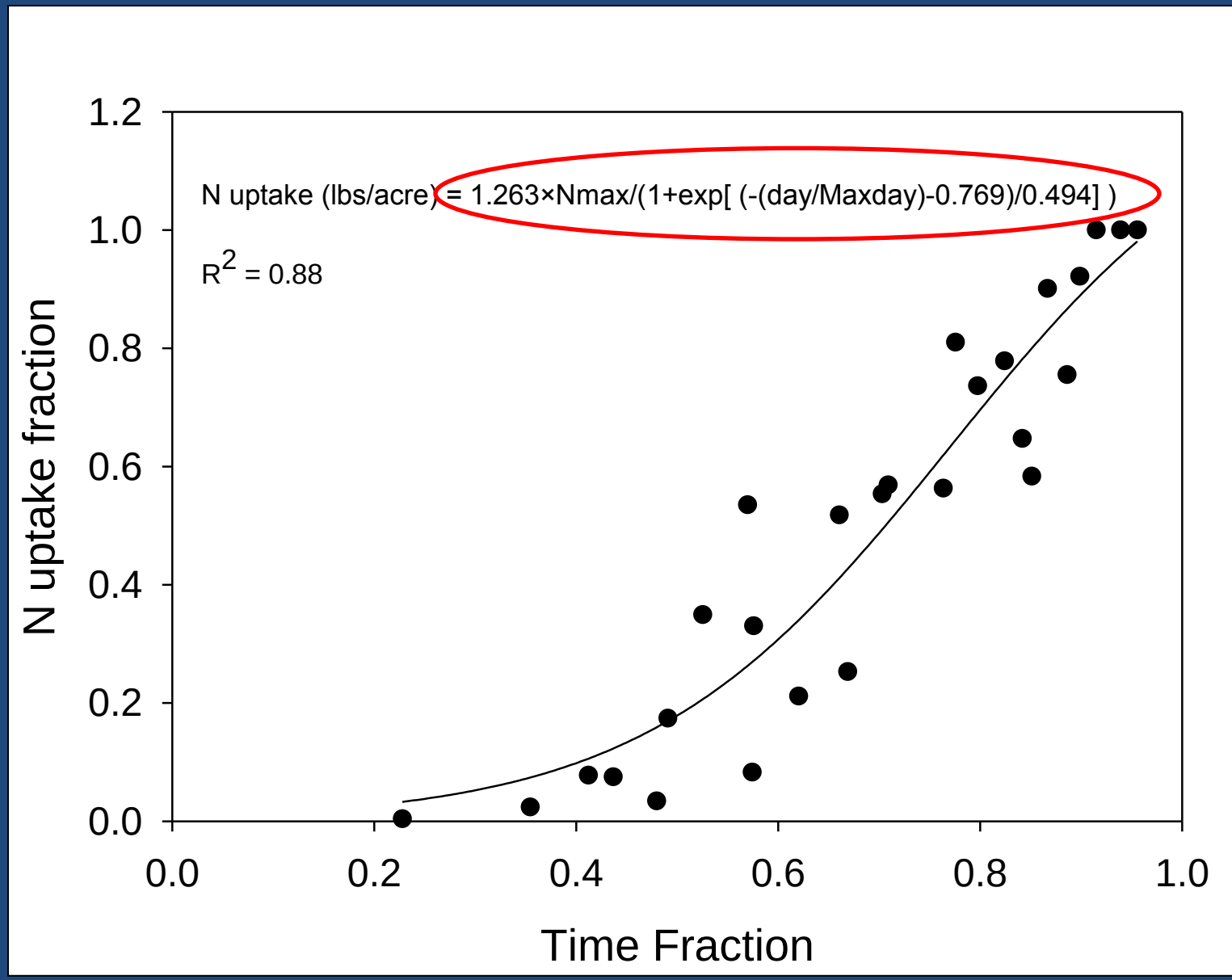
Data analysis

DAP	time fraction	Time fraction harvest	N	P	K	fraction N	Fraction P	Fraction K
68	0.41	0.41	14	1	17	0.08	0.03	0.06
81	0.49	0.49	32	3	38	0.17	0.06	0.14
95	0.58	0.58	62	10	80	0.33	0.19	0.29
109	0.66	0.66	97	19	131	0.52	0.36	0.47
116	0.70	0.70	103	21	149	0.55	0.40	0.53
128	0.78	0.78	151	33	213	0.81	0.63	0.76
136	0.82	0.82	145	34	198	0.78	0.66	0.71
143	0.87	0.87	168	41	246	0.90	0.80	0.88
151	0.92	0.92	187	52	279	1.00	1.00	1.00



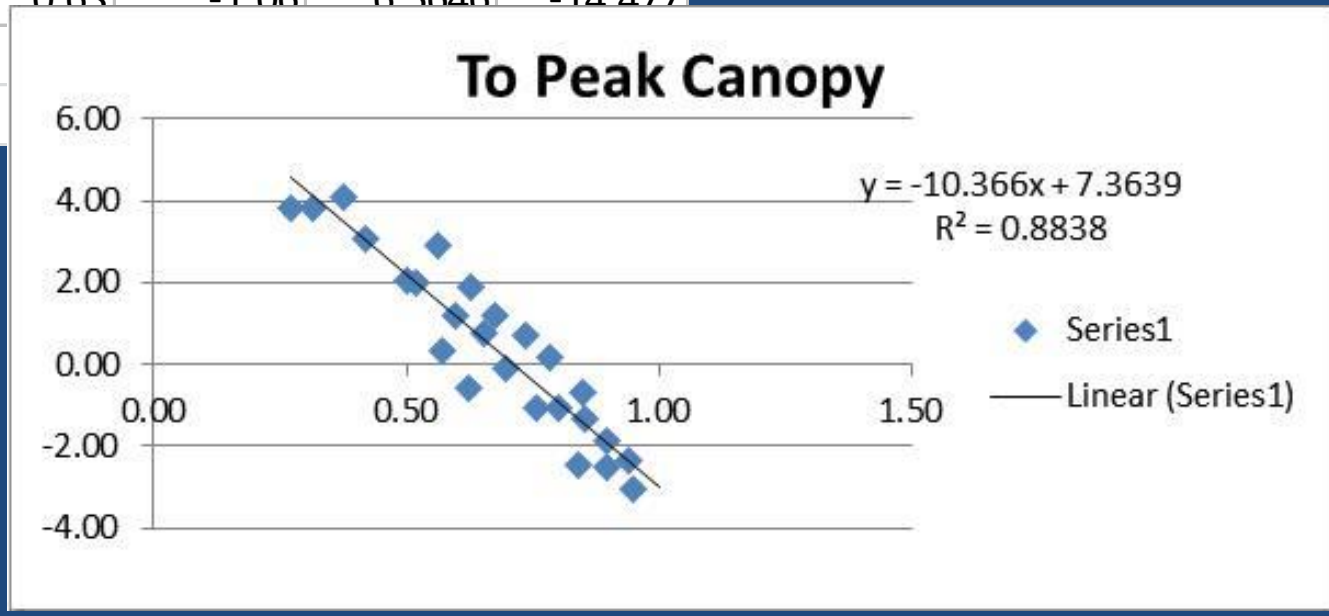


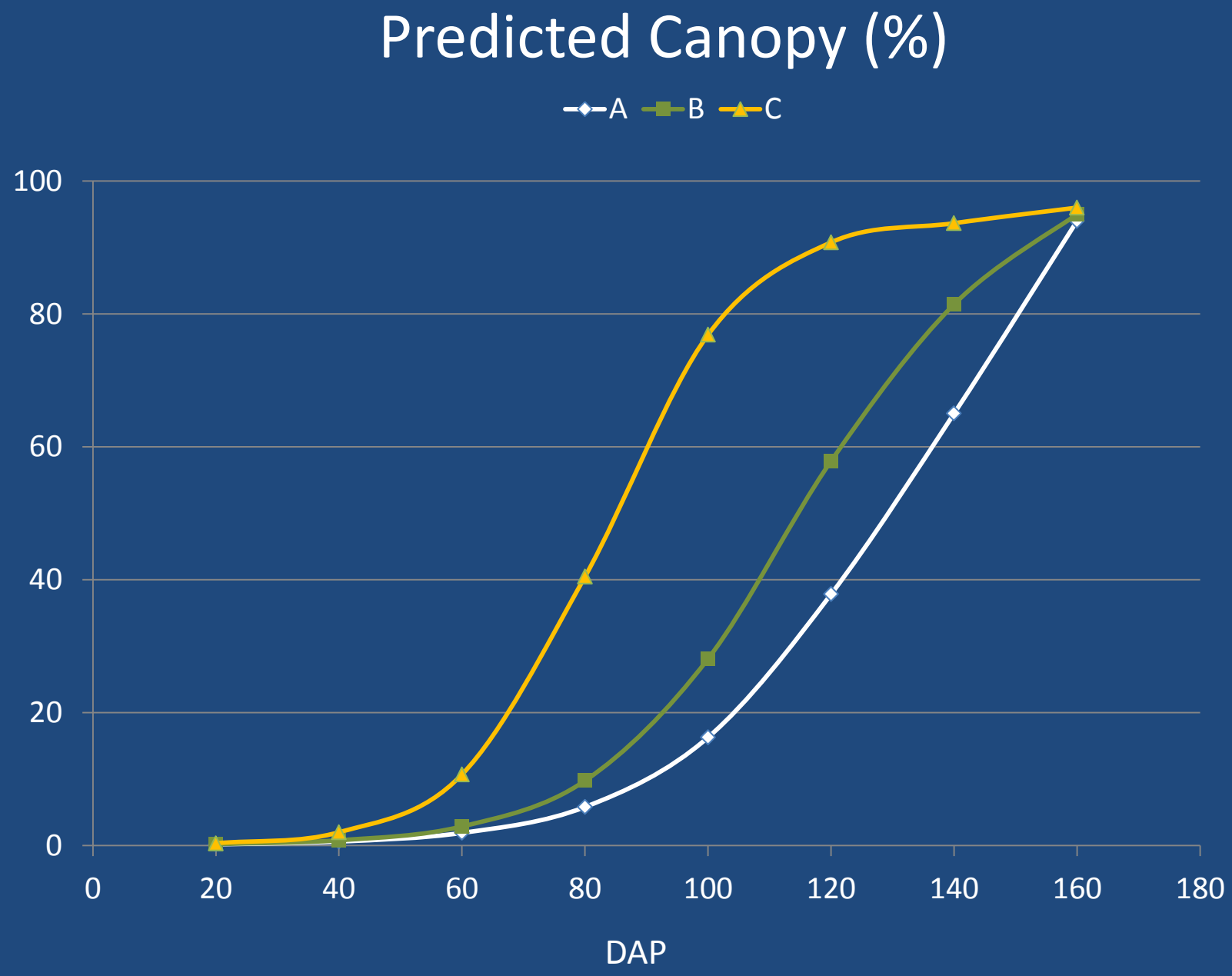
N Uptake Curve



Predicted Canopy =
Max Canopy/(1+EXP(coef_A+coef_B*Ni*fc))

Ni	ln(Gx/Gi)	Ni Calc	ln(Gx/Gi)-1 calc	Canopy coef A	Canopy coef B
0.40	2.04	0.40	2.04	6.5646	-14.477
0.47	1.20	0.47	1.20	6.5646	-14.477
0.52	0.76	0.52	0.76	6.5646	-14.477
0.55	-0.09	0.55	-0.09	6.5646	-14.477
0.60	-1.06	0.60	-1.06	6.5646	-14.477
0.63	-1.06	0.63	-1.06	6.5646	-14.477
0.67	-1.32				
0.74	-2.37				




Predicted Canopy (%)
A
B
C
100
80
60
40
20
0
0
20
40
60
80
100
120
140
160
180
DAP

N Uptake Information

- Nutrient uptake information for strawberries in California was very limited

HortScience 48(8):1034–1039. 2013.

Crop and Soil Nitrogen Dynamics in Annual Strawberry Production in California

Thomas G. Bottoms and Timothy K. Hartz[1]
Department of Plant Sciences, University of California, 1 Shields Avenue, Davis, CA 95616

Michael D. Cahn and Barry F. Farrara
University of California Cooperative Extension, 1432 Abbott Street, Salinas, CA 93901

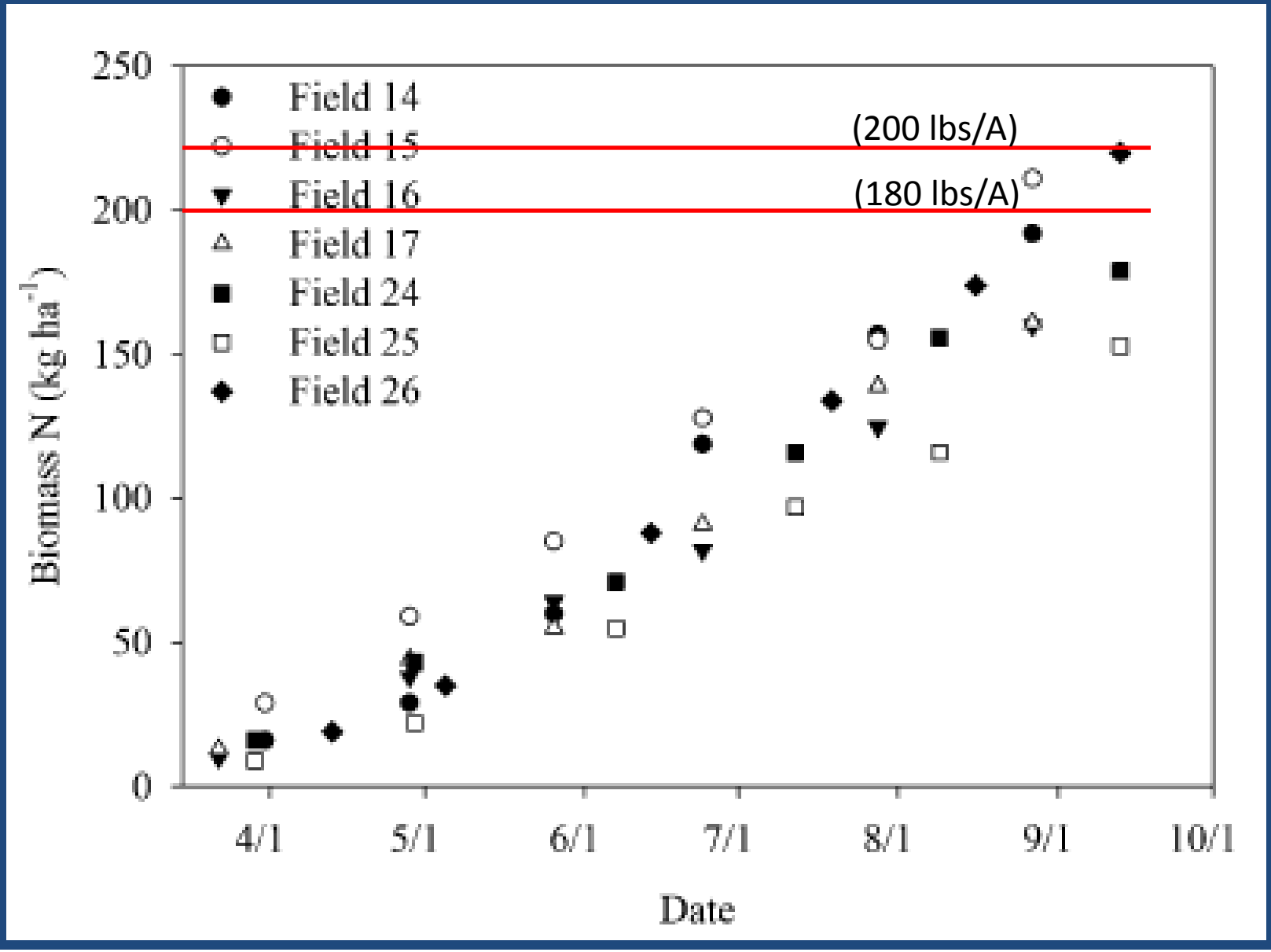
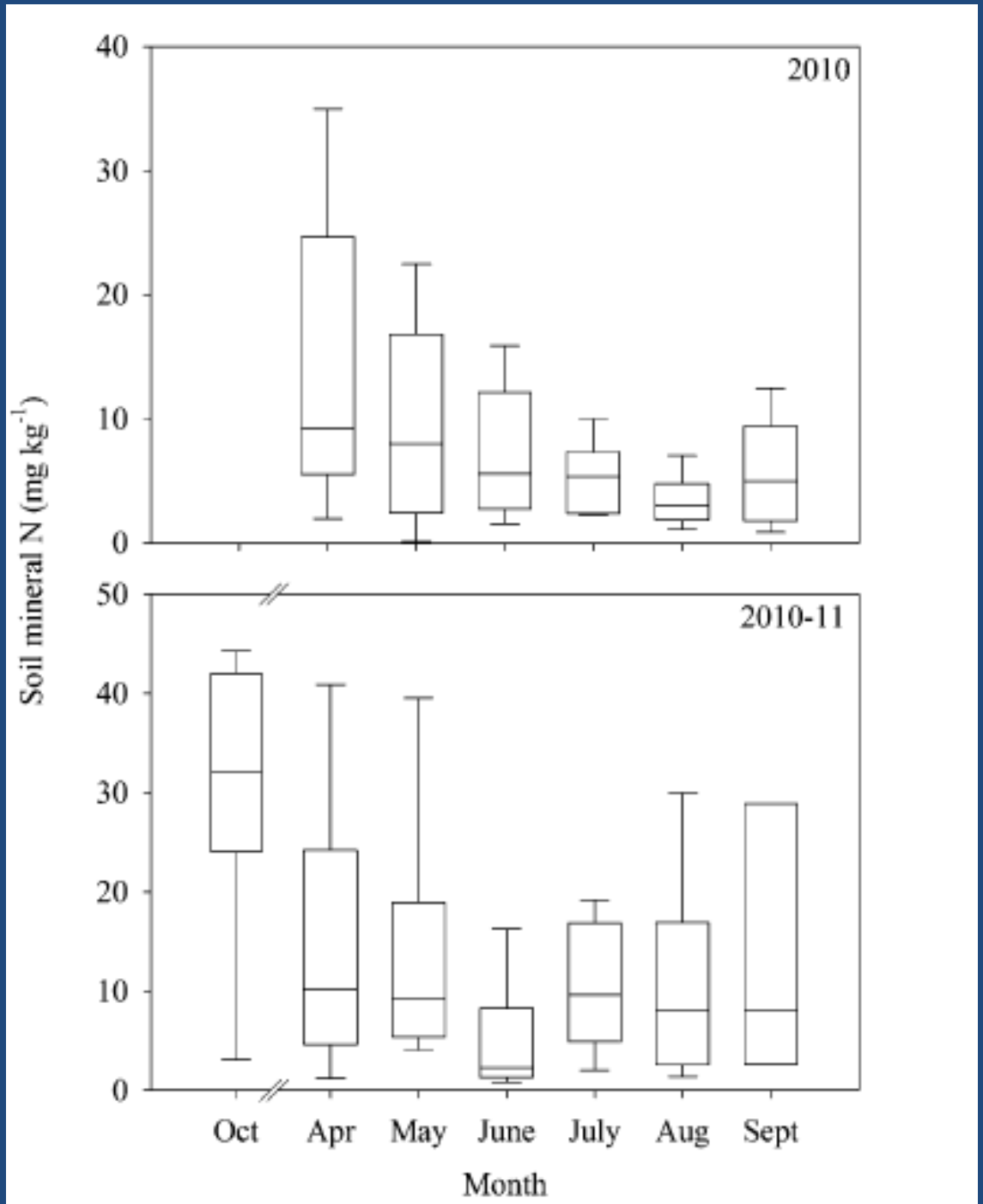


Fig. 2. Aboveground crop biomass nitrogen (N) accumulation (vegetative tissue and marketable fruit) over the growing season in seven strawberry fields; measurements made in 2010 and 2011.

Bottoms et al. (2013)



Pre-plant of 60 lbs of N/A was ideal to max. yield

High slow-release fert. rates were not efficient

Slow-release fert:
N release and crop uptake not ideally matched

Bottoms et al. (2013)

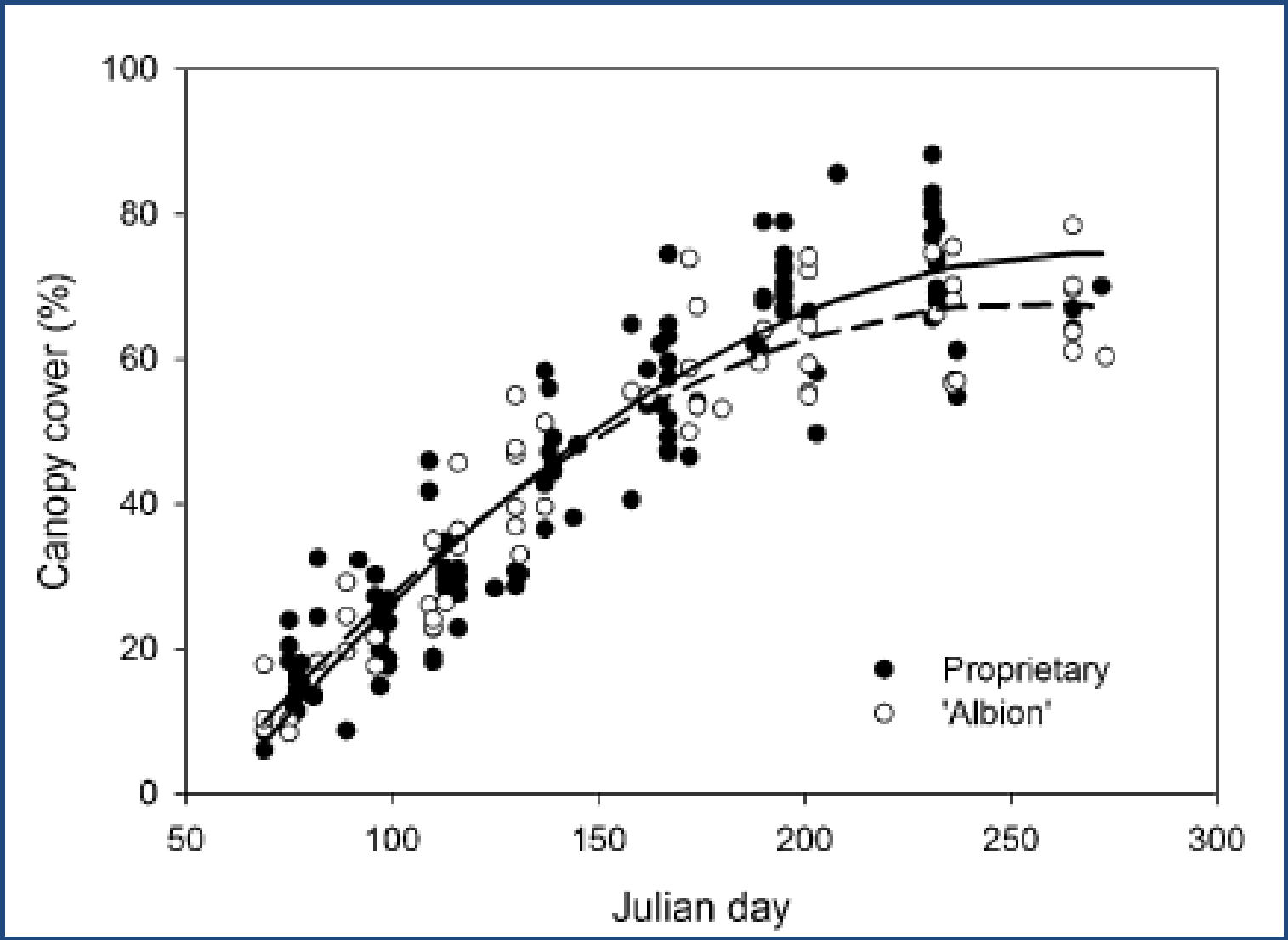


Fig. 4. Plant canopy cover (% of the ground surface) over the production season in 25 strawberry fields; measurements made in 2010 and 2011. The solid line represents the model for the proprietary cultivar ($y = 0.86x - 0.0015x^2 - 44$, $r^2 = 0.88$) and the dashed line the model for 'Albion' ($y = 0.93x - 0.0019x^2 - 47$, $r^2 = 0.89$), where x = Julian day.

Bottoms et al. (2013)

CropManage

https://ucanr.edu/cropmanage/

Database driven web application

Crop ET model

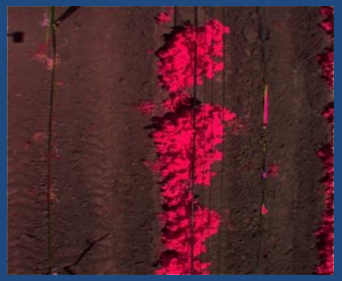
Crop N model

(Cahn)

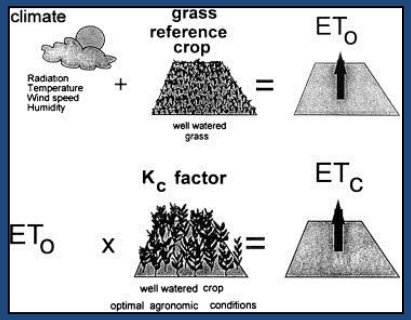
How is irrigation rate determined?

Cimis, ETo

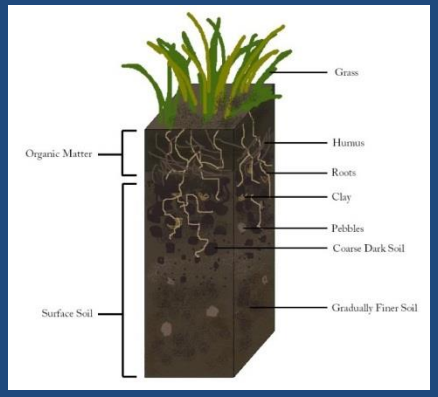
Kc



ETc



Water recommendation



- Allowable depletion
- Irrigation system application rate
- Irrigation system application uniformity
- Leaching fraction (water salinity)
- And more

How is N fertilizer rate determined?

Fertilizer N = Crop N uptake – Soil N

Soil N:

– Quick Test N (ppm NO_3-N)

– Soil mineralization N

Crop uptake???

CropManage

Web-based Irrigation and N management software

https://ucanr.edu/cropmanage/

Michael Cahn,
UCCE Monterey

CropManage

About CropManage

Login

To login enter your e-mail and password below.

E-mail Address: asbiscaro@ucdavis.edu

Password: •••••••

Login

Forgot Password

Create New Account

CropManage

Home | Ranch List | Help

Ranch List

Select a Ranch to work in from the list below.

- Freyer
- Home
- Onion test
- test
- UCCE ranch
- USDA-ARS Spence

New Ranch | Request Access to a Ranch

Getting Started

Ranch Home | Ranch List | Help | Es

Ranch/Field: UCCE ranch

Add Ranch

Info | Options

Ranch Information

Ranch Name

Ranch Owner: Andre Biscaro

Acres: 0

Soil Type: Antioch very fine sandy loam

Info for creating a ranch and field:

- Location
- Soil type
- Crop
- Acreage
- Planting and harvesting dates
- Previous crop
- Previous harvest date
- Sprinkler application (in/h)
- Sprinkler distribution uniformity (%)
- Drip application rate (in/h)
- Drip distribution uniformity (%)
- Leaching factor
- Maximum crop N uptake
- Default days to next fertilization
- Flow meter data
- Coordinates

CropManage

Ranch Home | Ranch List | Help | Español | Edit Profile | Logout

Ranch/Field: UCCE ranch

Plantings

Showing current Plantings

Planting	Wet Date	Harvest Date	Lot	Action
Iceberg	2/9/2013	7/25/2013	1	View Detailed View Edit
romaine 2	1/1/2013	3/27/2013	1	View Detailed View Edit
winegrapes	12/26/2012	3/27/2013	1	View Detailed View Edit
VEG/STRAW	1/9/2013	5/4/2013	2	View Detailed View Edit

New Planting | View All Plantings | Import Export Options

CropManage

Planting Home | Ranch Home | Ranch List | Help | Español | Edit Profile | Logout

Ranch/Field: UCCE ranch, Lot 1, 0
Planting: romaine 2, 5.0 acres
Crop: Romaine 2 row, 40 inch bed, 1/1-3/27/13

Detailed View

Planting - romaine 2

Crop: Romaine 2 row, 40 inch bed

January 1, 2013 - March 27, 2013

Latest Events (by type)

Soil Sample	February 8, 2013 Soil N: 44.78 (ppm)
Fertilization	February 8, 2013 Applied Fertilizer: 0.0 gallons/acre
Watering	February 8, 2013 Rainfall: 0.05 (inches) Rain since last irrigation: 0.07 (inches)

Last 5 Events (by date)

February 8, 2013	Sample: 44.78 (ppm)
	Fertilizer: 0.0 gallons/acre
	Rainfall: 0.05 (inches)
	Total Rainfall: 0.07 (inches)
February 5, 2013	Irrigation: 0.08 (inches)
January 25, 2013	Fertilizer: 14.0 gallons/acre
January 23, 2013	Sample: 50.88 (ppm)
January 22, 2013	Irrigation: 0.08 (inches)

Soil Samples | Fertilization | Irrigation | New ▾

Advanced Settings | Recalculate | Refresh Weather Data

New Soil Sample | View all Nutrients

Fertilizer Summary

Show / Hide Columns

Fertilizer Date	Crop Stage	Soil NO_3-N (ppm)	Fertilizer N Recommended (lb N/acre)	Cumulative N Uptake	Fertilizer	Applied N (lb N/acre)	Applied Fertilizer
1/1/13	Planting	20.00	0.2	0.00	15-8-4	3.1	2.0 gallons/acre
1/25/13	Post-thinning	20.00	30.4	4.77	CAN-17	30.0	14.0 gallons/acre
2/8/13	1st sidedress	N/A	N/A	11.33	UAN32	0.0	0.0 gallons/acre
Totals			30.7			33.1	

New Fertilizing

Irrigation Summary

Show / Hide Columns | Show Previous Columns | Show Next Columns

Water Date	Irrigation Method	Recommended Irrigation Interval (days)	Recommended Irrigation Amount (inches)	Recommended Irrigation Time (hours)	Irrigation Water Applied (inches)	Kc	Canopy Cover (%)	Average Reference ET (inches/day)	Total Crop ET (inches)
1/1/13	Sprinkler	N/A	N/A	N/A	1.20 in	0.00	0	0.00	0.00
1/5/13	rainfall	N/A	N/A	N/A	0.00 in	0.37	0	0.06	0.08
1/6/13	rainfall	N/A	N/A	N/A	0.00 in	1.00	0	0.05	0.05

CropManage

Planting Home | Ranch Home | Ranch List | Help | Español | Edit Profile | Logout

Ranch/Field: UCCE ranch, Lot 1, 0
Planting: romaine 2, 5.0 acres
Crop: Romaine 2 row, 40 inch bed, 1/1-3/27/13

Add / Edit Watering

Irrigation Summary

< Back | Go to:

Show / Hide Columns | Show Previous Columns | Show Next Columns

Water Date	Irrigation Method	Recommended Irrigation Interval (days)	Recommended Irrigation Amount (inches)	Recommended Irrigation Time (hours)	Irrigation Water Applied (inches)	Kc	Canopy Cover (%)	Average Reference ET (inches/day)	Total Crop ET (inches)
1/1/13	Sprinkler	N/A	N/A	N/A	1.20 in	0.00	0	0.00	0.00
1/5/13	rainfall	N/A	N/A	N/A	0.00 in	0.37	0	0.06	0.08
1/6/13	rainfall	N/A	N/A	N/A	0.00 in	1.00	0	0.05	0.05
1/11/13	Sprinkler	15.1	0.05 in	0.16 hrs	0.15 in	0.30	1	0.04	0.07
1/18/13	Drip	14.4	0.11 in	0.71 hrs	0.15 in	0.22	2	0.06	0.10
1/22/13	Drip	34.6	0.04 in	0.26 hrs	0.08 in	0.12	3	0.07	0.03

Add / Edit Fertilizer

Fertilizer Summary

< Back | Go to:

Show / Hide Columns

Fertilizer Date	Crop Stage	Soil NO_3-N (ppm)	Fertilizer N Recommended (lb N/acre)	Cumulative N Uptake	Fertilizer	Applied N (lb N/acre)	Applied Fertilizer
1/1/13	Planting	20.00	0.2	0.00	15-8-4	3.1	2.0 gallons/acre
1/25/13	Post-thinning	20.00	30.4	4.77	CAN-17	30.0	14.0 gallons/acre
2/8/13	1st sidedress	N/A	N/A	11.33	UAN32	0.0	0.0 gallons/acre
Totals			30.7			33.1	

Show / Hide Table

Fertilization Date m/d/yyyy

Days To Next Fertilization 10

Crop Stage Select Crop Stage

Previous Fertilization

Fertilization Date 2/8/2013
Days To Next Fertiliz... 10
Crop Stage 1st sidedress
Soil Sample N (avg): 0.00
Fertilizer Type UAN32 - Liquid: 11.1 lbs/gallon
Fertilizer Applied 0 lbs N/acre
0.0 gallons/acre

Fertilization Date 02/11/2013

Days To Next Fertilization 10

Crop Stage 1st sidedress

Soil Sample 2/8 - Post-thinning, N (avg): ·

Fertilizer Type Select fertilizer Type

Save Fertilizer

Previous Fertilization

Fertilization Date	2/8/2013
Days To Next Fertiliz...	10
Crop Stage	1st sidedress
Soil Sample	N (avg): 0.00
Fertilizer Type	UAN32 - Liquid: 11.1 lbs/gallon
Fertilizer Applied	0 lbs N/acre 0.0 gallons/acre

Fertilization Date: 2/8/2013

Days To Next Fertilization: 10

Crop Stage: 1st sidedress

Soil Sample: 2/8 - Post-thinning, N (avg): 1

Fertilizer Type: UAN32 - Liquid: 11.1 lbs/gallo

Fertilizer Details:
UAN32
Formulation: Liquid
Nutrients:
Nitrogen, 32%

Recommended Fertilizer: 43.0 lbs N/acre at 32.0% = 12 gallons/acre

Fertilizer Applied: 0 lbs N/acre = 0.0 gallons/acre

Save Fertilizer | Delete Fertilization

Previous Fertilization

Fertilization Date	1/25/2013
Days To Next Fertiliza...	15
Crop Stage	Post-thinning
Soil Sample	1/23/2013 Pre-thinning, N (avg): 12.50
Fertilizer Type	CAN-17 - Liquid: 12.6 lbs/gallon
Fertilizer Applied	30 lbs N/acre 14.0 gallons/acre

Thank you!