SITE-SPECIFIC SOIL PEST MANAGEMENT IN STRAWBERRY AND VEGETABLE CROPPING SYSTEMS

F. Martin, S. Fennimore, M. Matson, D. Racano, A. Putmán, M. Hang, F. Melton, T. Magney, M. Earles, R. Goodhue, S. Vougioukas, R. Arikapudi, C. Peng, N. Dorn, P. Henry, C. Greer, O. Daugovish, A. Biscaro, and M. Stanghellini

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What we are trying to avoid!

Is it Possible to Develop an Integrated Pathogen Control Strategy

Important to know:

- What pathogens are present in a field prior to making cropping decisions
- How cropping practices influence pathogen survival and subsequent pathogen inoculum densities
- What their inoculum densities are throughout the field so risk can be assessed; can fumigant type and rate can be modified to improve control?

Project Objectives

Develop site specific management program for control of soilborne pathogens in strawberry and vegetables grown in rotation utilizing knowledge of:

I. Risk assessment
   - Pathogen identification and determining inoculum density present
   - How cropping practices affect inoculum densities
   - Variable rate fumigant application based on risk assessment

II. Measuring the impact of treatment on crop productivity
   - Precision evaluation of yield
     - Strawberry and vegetable rotation crop
   - Remote sensing data to gain a field wide view of production field and follow individual plants
     - Develop improved crop management strategies for the grower

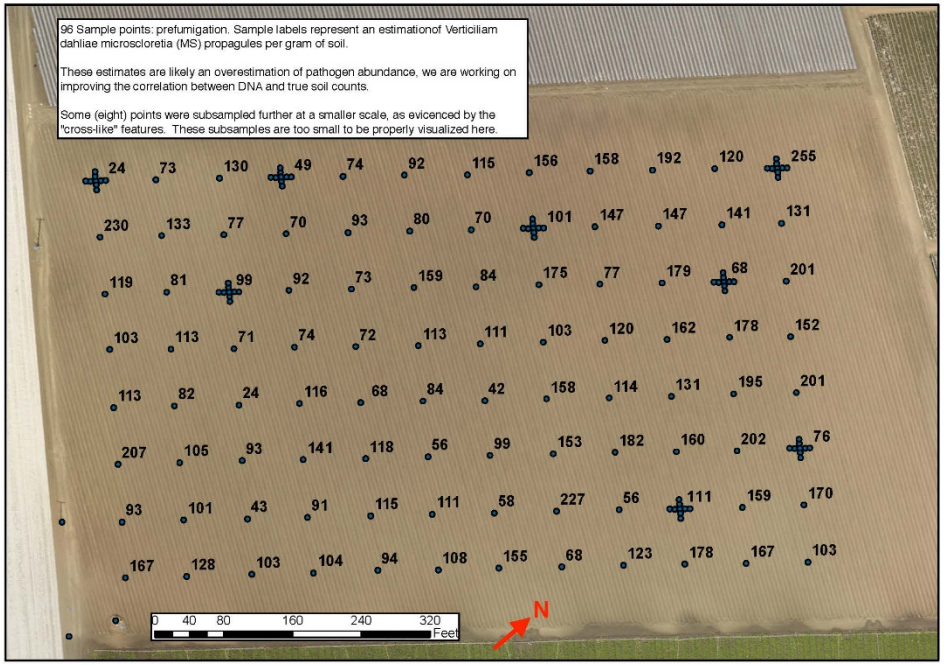
III. Economics of production system

Pathogen Identification and Determining Inoculum Density Present

- Have accurate, rapid molecular quantification assays to determine soil inoculum densities
  - TaqMan real time PCR
    - *Verticillium dahlia* - Phytopathology 102:331-343
      - Sensitive down to 1-2 ms/g soil
    - *Macrophomina phaseolina* – strawberry genotype - Phytopathology 108:1386-1394
      - Sensitive down to 2-3 ms/g soil
    - *F. oxysporum* f. sp. *fragariae* – strawberry - Plant Disease 103:1006-1013
      - Quantification assay using 15 g soil for DNA extraction, sensitive to below 10 cfu/g soil

Pathogen Identification and Determining Inoculum Density Present

Risk Map

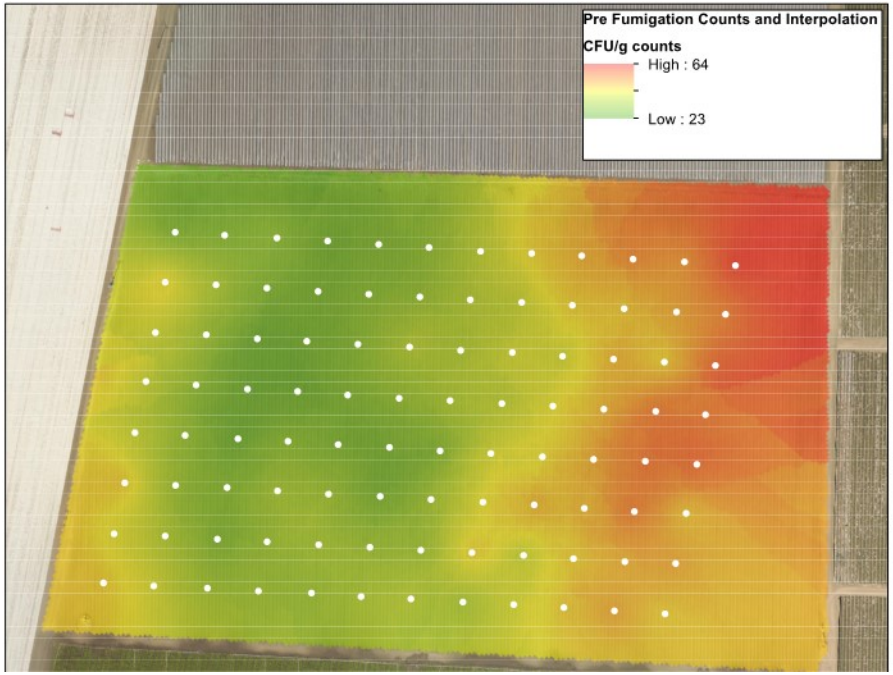


Prefumigation Inoculum Density
V. dahliae ms/g soil

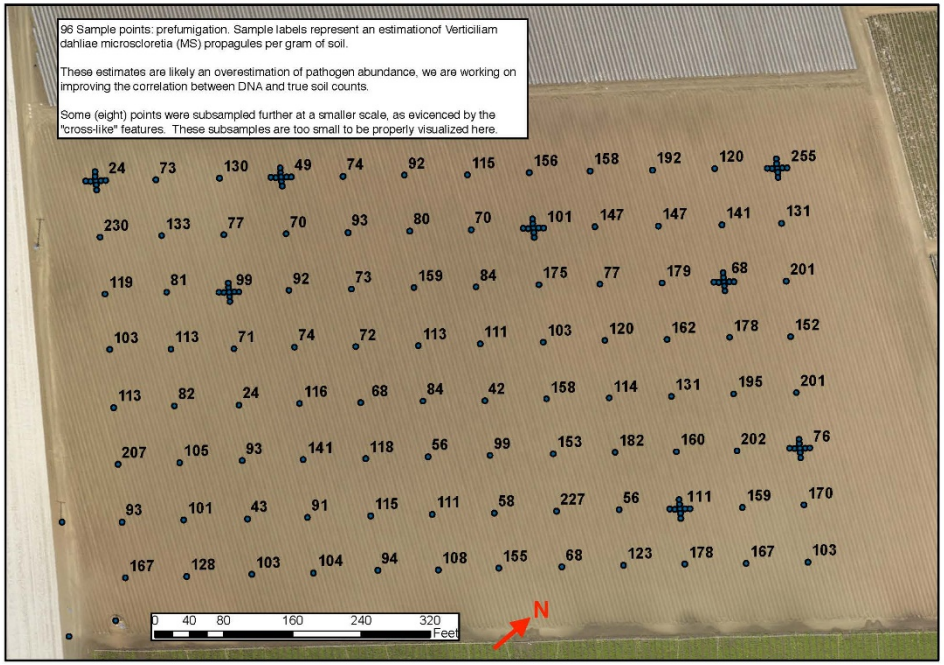
Mike Matson

Pathogen Identification and Determining Inoculum Density Present

Risk Map



Risk Map Based on Inoculum Density



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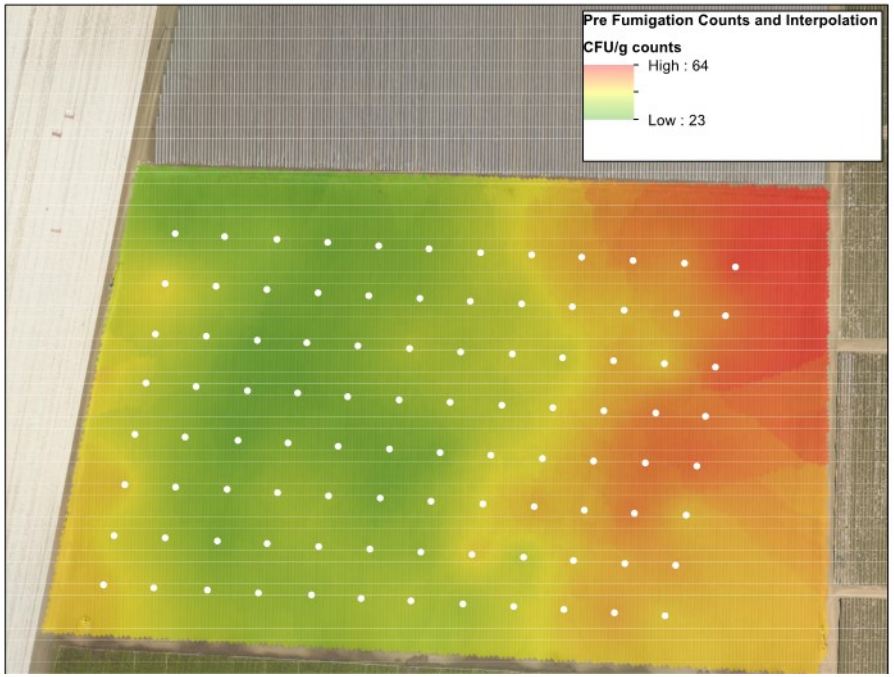
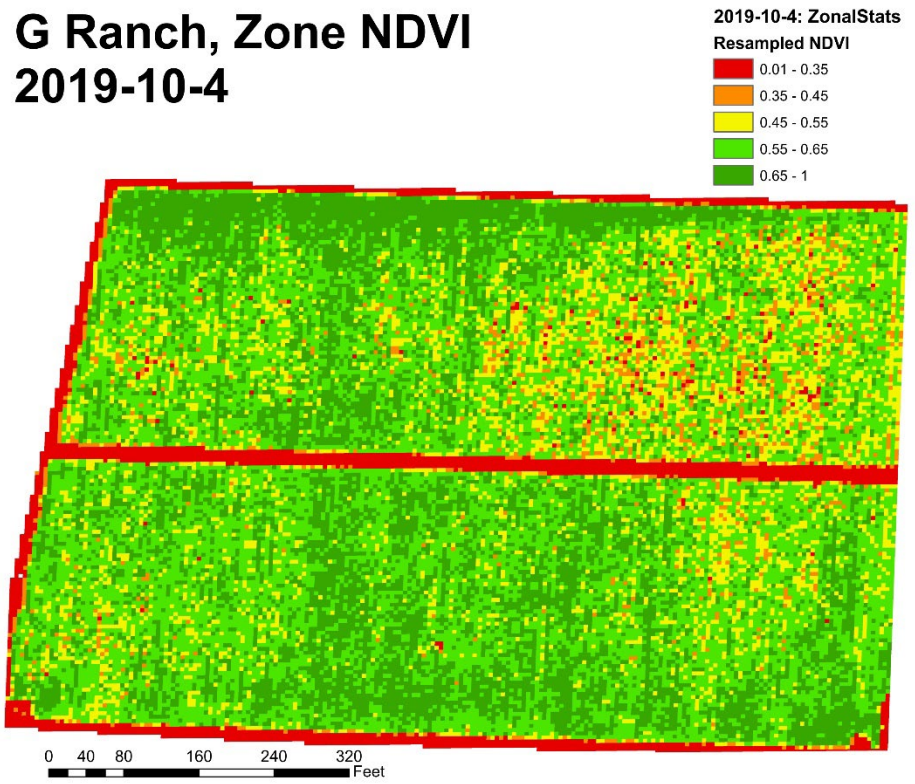


Risk Map Based on Inoculum Density



Late Season Remote Sensing Image

Field was preplant broadcast fumigated with 340 lbs/A Chloropicrin, pathogen not completely controlled

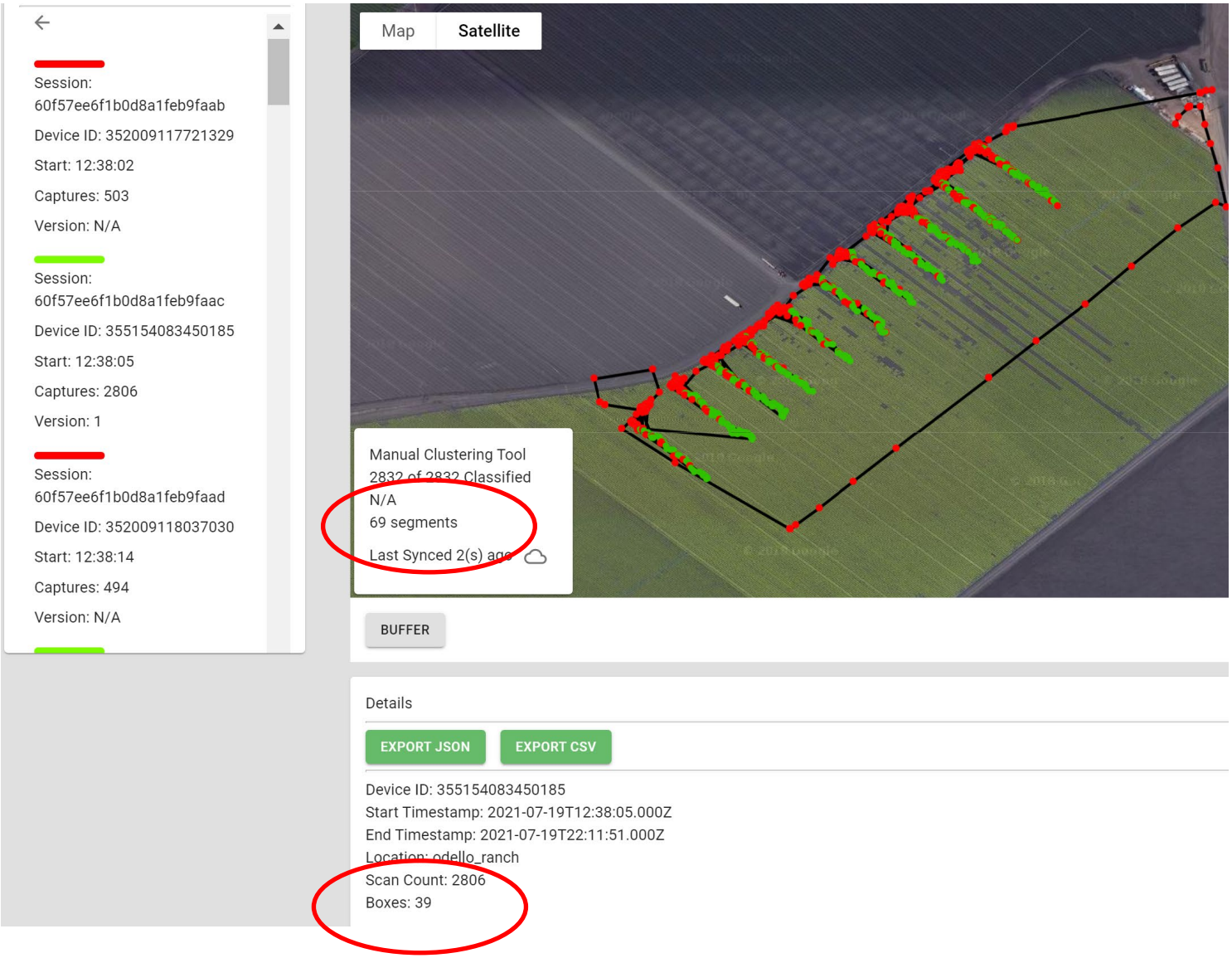
Precision Evaluation of Yield

Two approaches being used to measure yield in a commercial field

- Passive monitoring of worker – worker wears a GPS tracker that sends data to a central server where software delineates the different speed of walking when picking compared to turning a harvested tray in.
- Passive monitoring of yield – harvesting cart modified with GPS and load sensor

- Collaborator currently working on video analysis system

Tracking Harvester Movement in the Field



Yield Map of Field

Yield Aggregation

Yield Aggregation

Form

History

Calendar

Location

Odello Ranch

« ‹ July 2021 › »

MON	TUE	WED	THU	FRI	SAT	SUN
28	29	30	1	2	3	4
40	0	0	36	30	0	0
15	0	0	18	0	0	0
5	6	7	8	9	10	11
38	0	0	34	30	0	0
19	0	0	17	0	0	0
12	13	14	15	16	17	18
37	0	0	32	0	0	0
19	0	0	18	0	0	0
19	20	21	22	23	24	25
31	0	0	30	23	0	32
14	0	0	15	0	0	0
26	27	28	29	30	31	1
80	32	0	57	35	0	0
26	0	0	18	0	0	0

Query Report

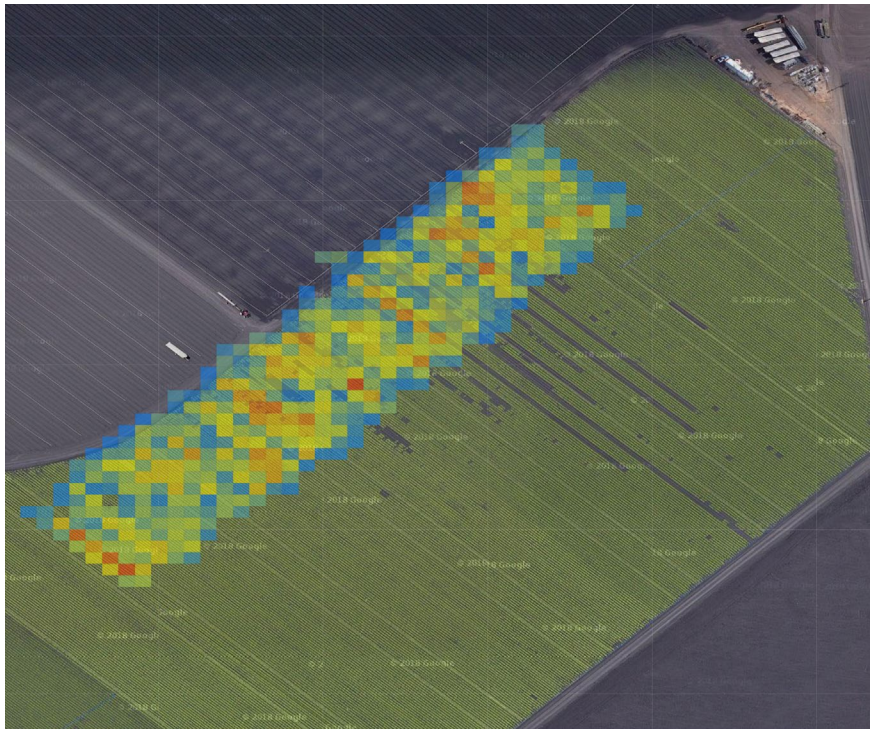
061364c5-9add-4100-a04c-cedc530238bc

Map Satellite

Google Keyboard shortcuts Map data ©2021 Terms of Use

Weight	8 lb
Size	20 ft
Start Date	2021-07-19T03:07:00.000Z
End Date	2021-07-25T03:07:00.000Z
Captures	26
Boxes	470

DOWNLOAD CSV



FOOD ORIGINS

Precision Evaluation of Yield
"i-carrito" components

Load cells

GPS antenna

Electronics box

- Microcontroller
- GPS receiver
- Accelerometer
- Storage
- Bluetooth.

Weekly Cumulative Yield Map

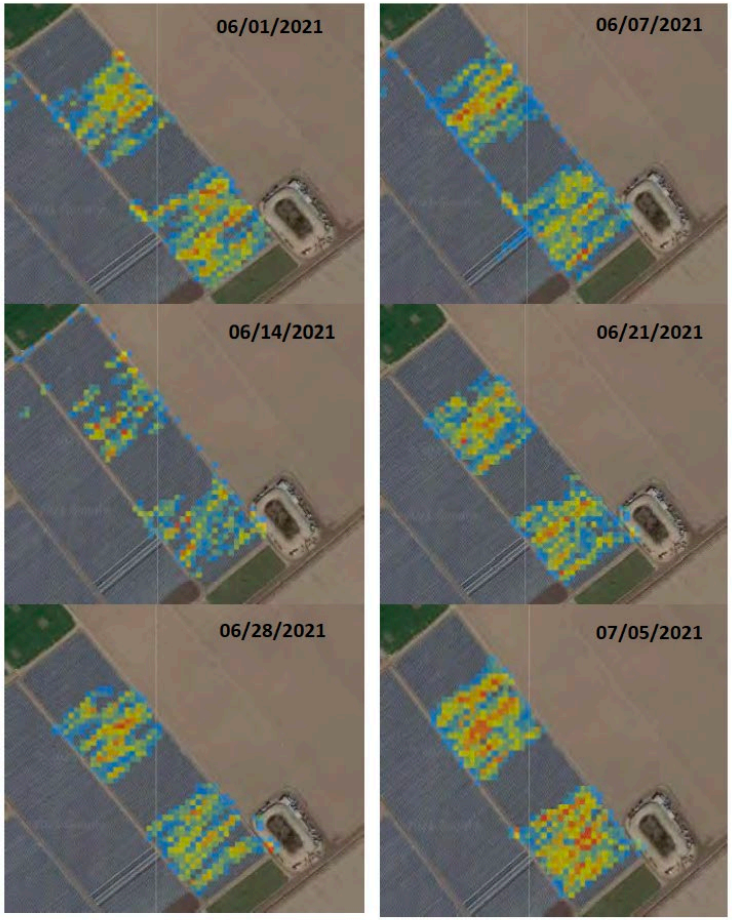


Figure 15. Weekly cumulative yield map throughout the strawberry season 20/21 at Spence Ranch field Salinas gained from early June until early of July 2021.

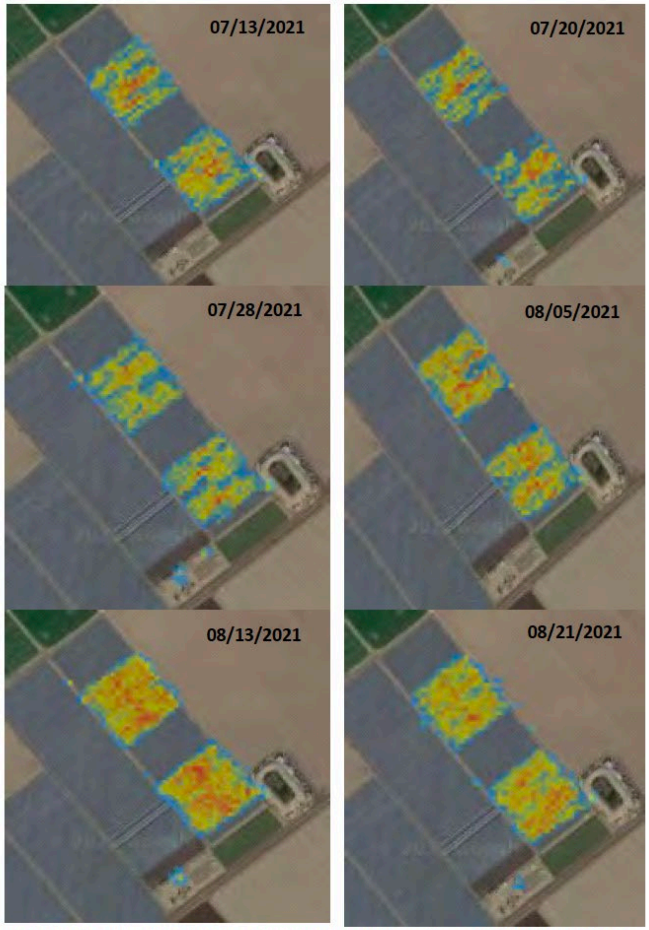


Figure 16. Weekly cumulative yield map throughout the strawberry season 20/21 at Spence Ranch field in Salinas gained from early July until late of August 2021.

S. Vougioukas

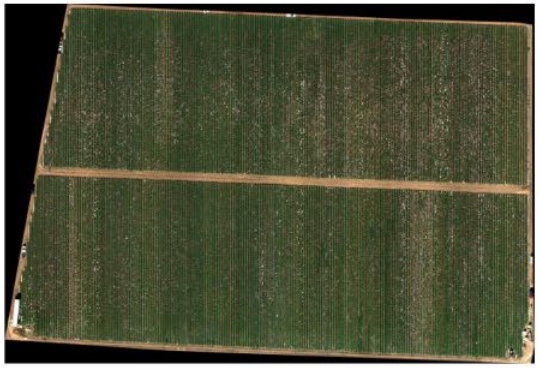
Remote Sensing Data to Gain a Field Wide View of Production Field

- Use of aerial remote sensing to:
  - Evaluate uniformity in the field
  - Will help evaluate the efficacy of variable rate fumigation to manage soilborne pathogens
  - Identify regions with poor plant growth/survival to target soil sampling and determining future treatments
    - If done yearly will provide a historical record of the field and provide information on long term effects of management on pathogen survival and distribution
    - Supports field scouting to determine which pathogens are causing losses

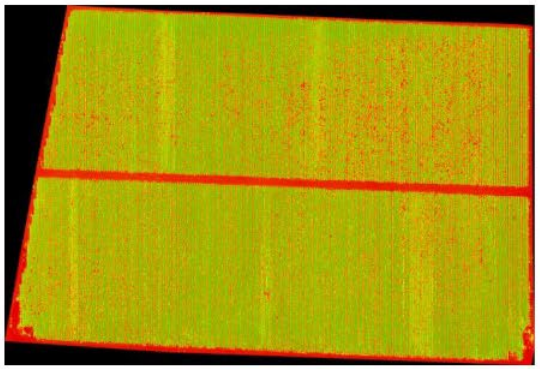
III - Remote Sensing Data Collection

- Drone collected data, 5.2 cm spatial resolution
  - DJI Matrice 600 Pro with Micasense Altum
- Calibration tarps deployed in field at the time pictures are taken so images from different days can be compared
- Frequency of image collection important to assess change over time
  - weekly
- Combining with yield data will enhance the utility of the remote sensing data
  - Collaborator Melton currently working on this

Imagery Examples

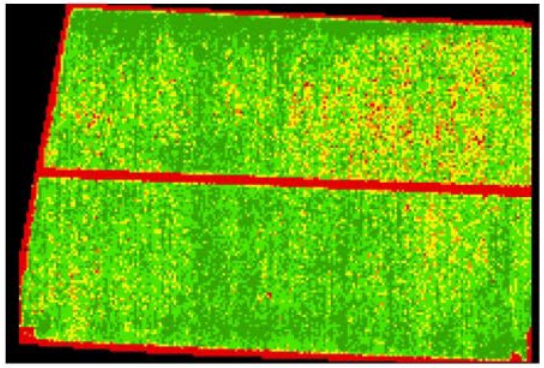


RGB Composite
5.2 cm/pixel



NDVI
5.2 cm/pixel

High resolution
for research



Resampled mean NDVI
1.32 m/pixel

Lower resolution
for grower

M. Hang, F. Melton

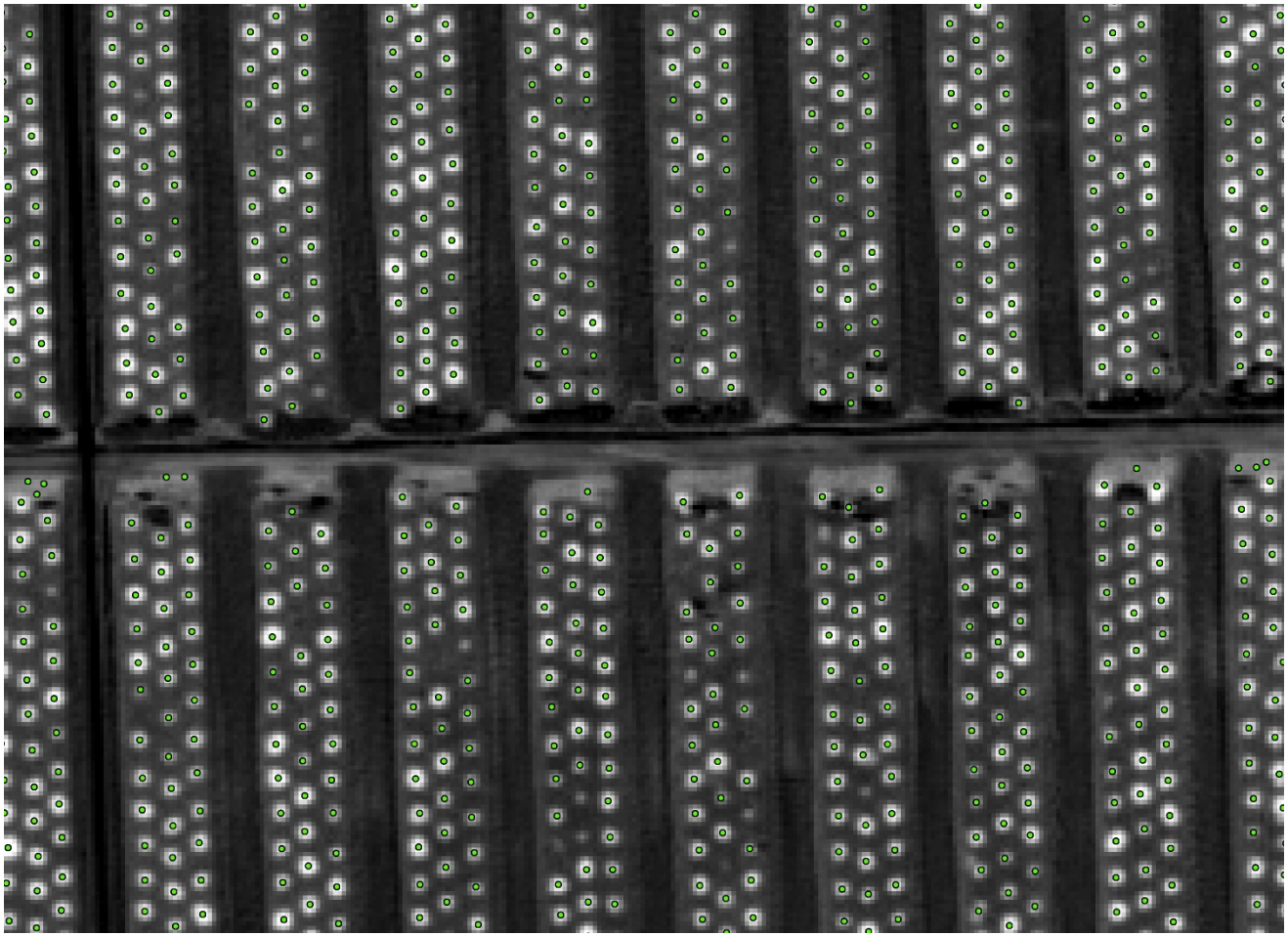
III - Remote Sensing Data Collection

Also able to use these high-resolution images to:

- Identify individual plants for doing plant counts of the field
- Collect NDVI values for individual plants
  - Color code plants that have unexpected changes in NDVI (decreases)
- Follow individual plants over time
  - Particularly important for determining when dead plants became infected
  - Supports soil sampling in specific areas of the field to look at relationship between inoculum density and disease severity.

III - Remote Sensing Data Collection

Determining plant counts in the field (see green dots)



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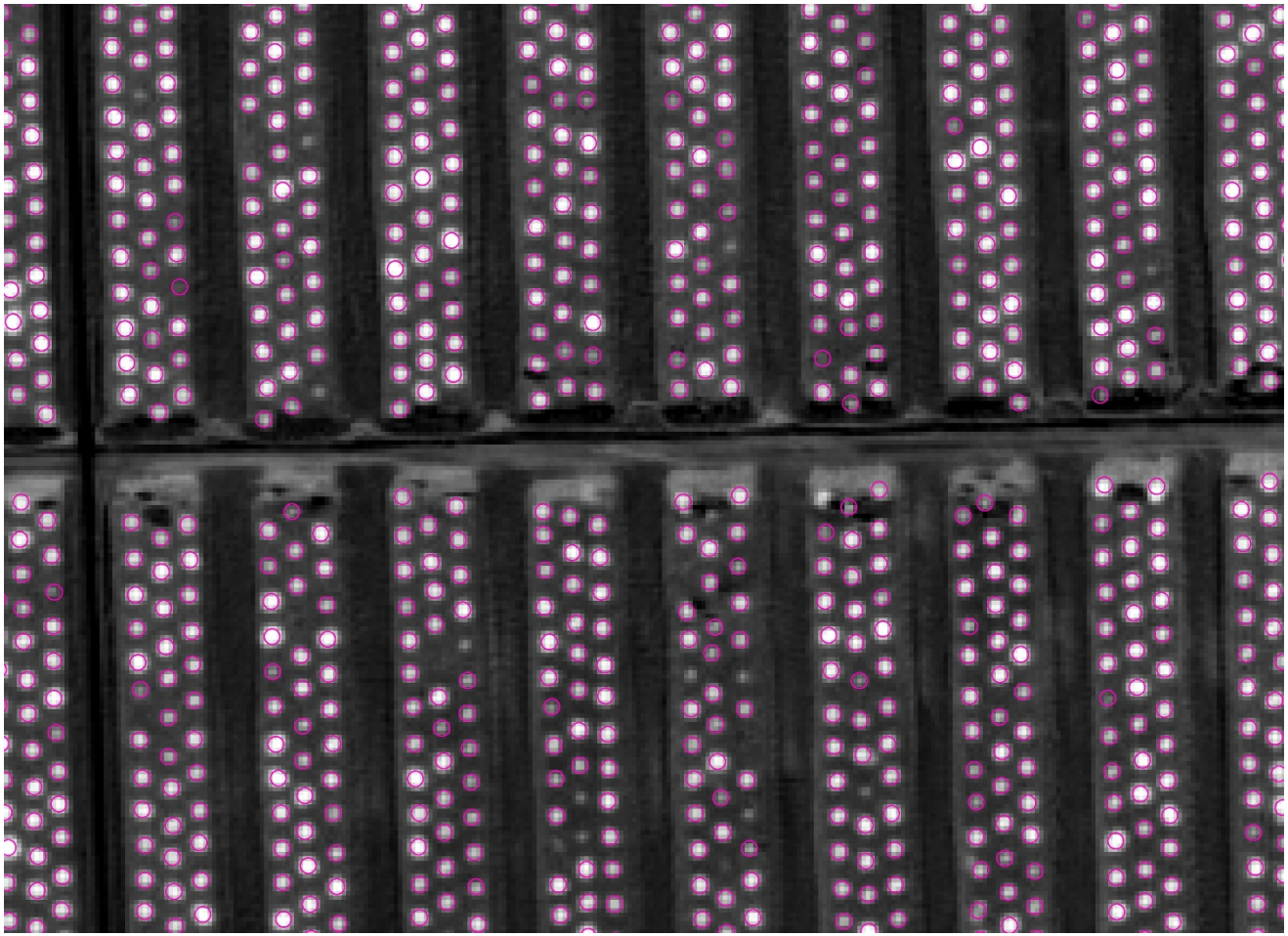
III - Remote Sensing Data Collection

Placing circles around plants for collection of NDVI data from each plant



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III - Remote Sensing Data Collection

Color coded changes in NDVI over time

- NDVI for individual plants – changes color coded
- Assist with scouting efforts
- Follow each plant throughout season
- Quantify disease progression
- Look for correlation with yield
- Look for correlation with pathogen ID

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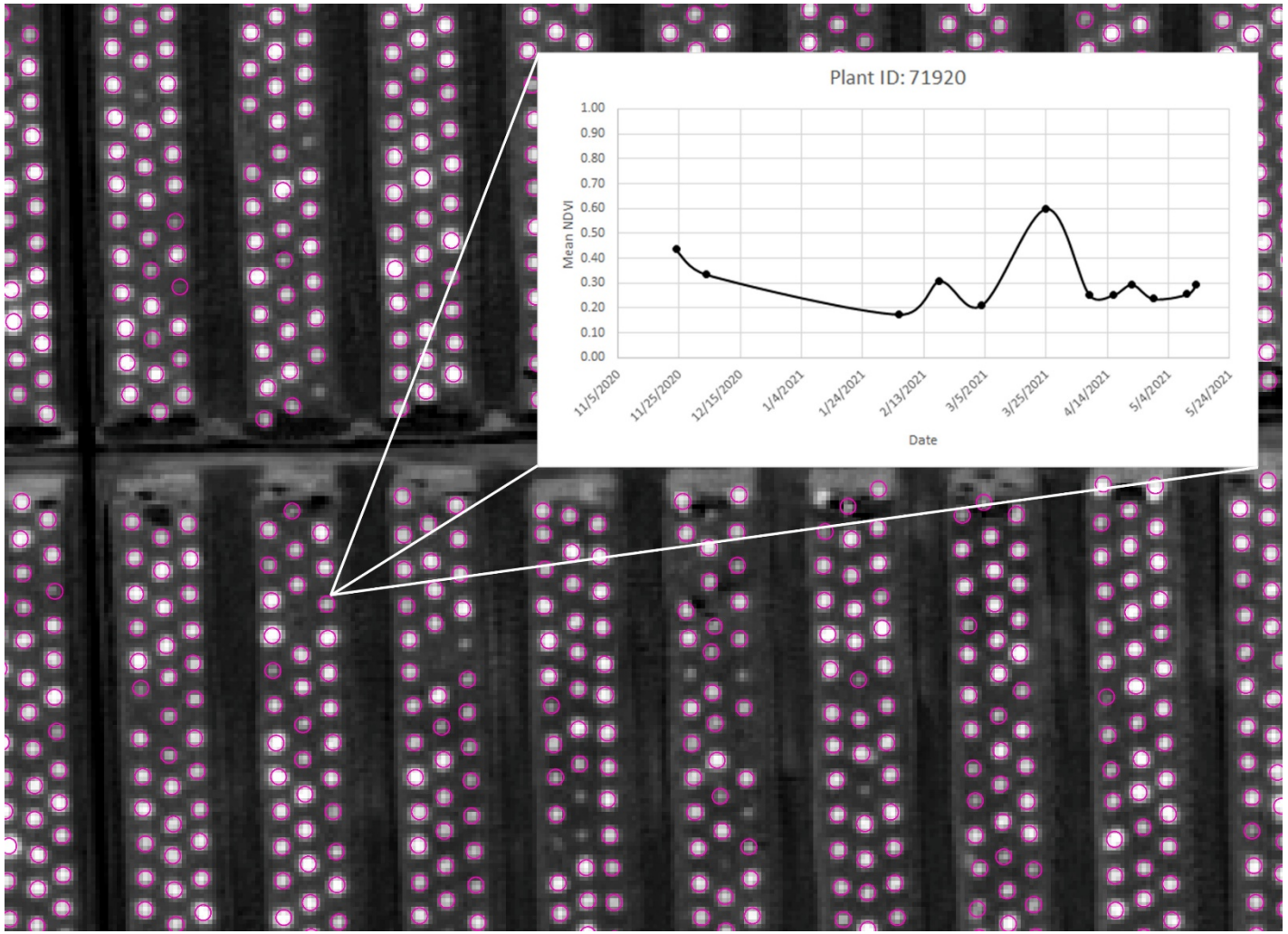
III - Remote Sensing Data Collection

Follow NDVI of individual plant over time



Note intensity of the signal in the image for this diseased plant is less than adjacent plants

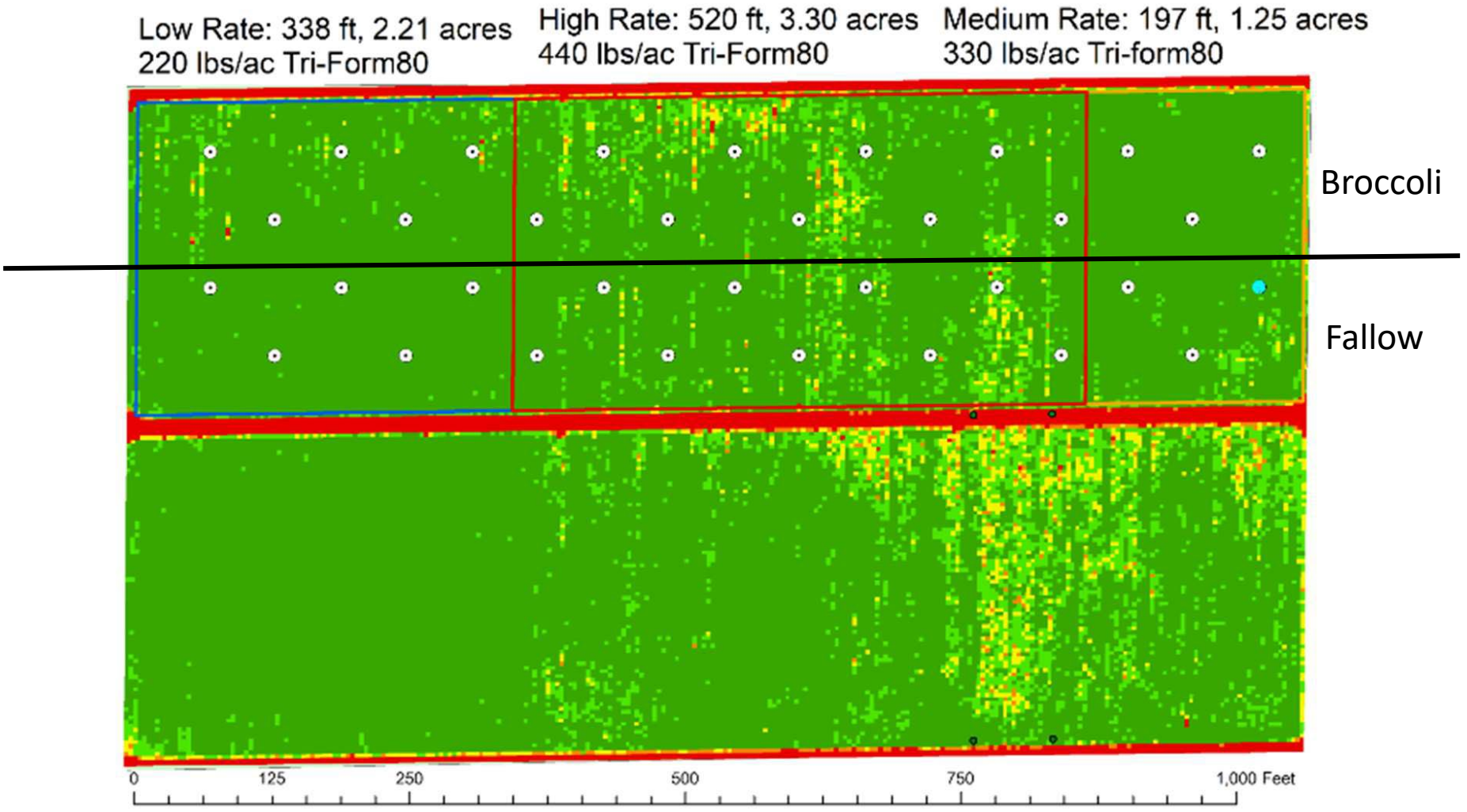
M. Hang, F. Melton

USDA-ARS Areawide Funded Project 2021

- Four sites
  - Salinas/Watsonville area
    - USDA-ARS Spence Rd Research Farm
      - *Macrophomina phaseolina*
    - Site 2
      - Problem with Fusarium wilt of lettuce, will rotate with strawberry
    - Site 3
  - Oxnard/Ventura
    - One site in 2021/22 season, looking for additional site for 2022/23 season
      - *F. oxysporum* f. sp. *fragariae*
- Currently in year 3 of a 5-year project

USDA-ARS Research Farm

End of Season Fall 2019



III - Remote Sensing Data Collection

Sequential Images of single 7-acre plot

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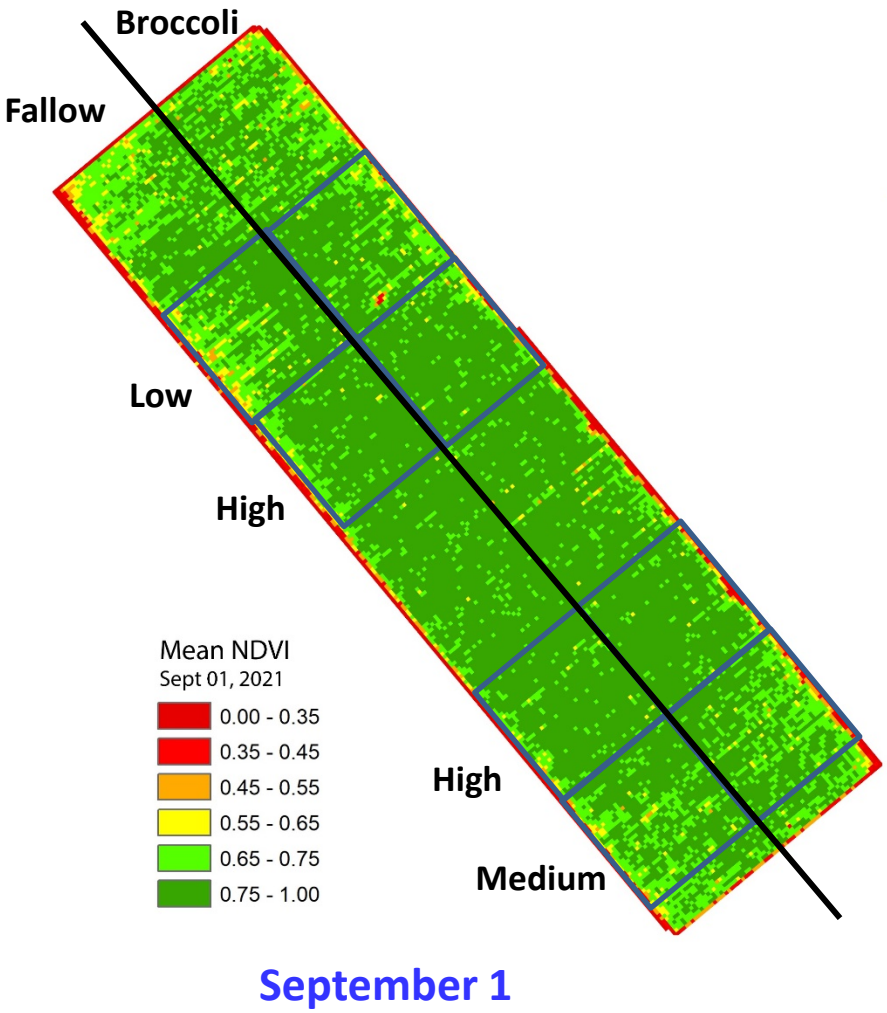
End of Season NDVI



September 1

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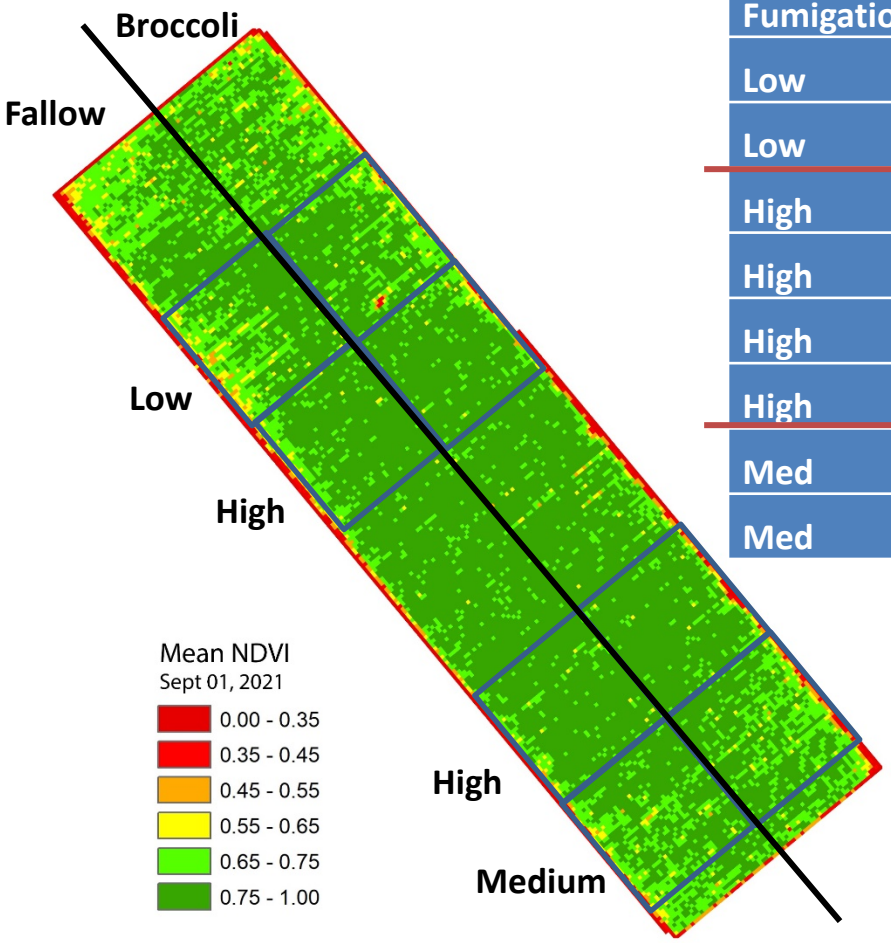
End of Season NDVI



Treatment		September 2021	
Fumigation Rate	Previous Crop	Mean NDVI	% Healthy Crop
Low	Broccoli	0.753778	0.973018081
Low	Fallow	0.741918	0.96699624
High	Broccoli	0.786897	0.982174934
High	Fallow	0.782322	0.987558108
High	Broccoli	0.798973	0.996315502
High	Fallow	0.781201	0.987043418
Med	Broccoli	0.760804	0.996261423
Med	Fallow	0.74748	0.987576773

September 1

M. Hang, F. Melton

Effect of Fumigation on Yield

Treatment	Cumulative Yield (kg)	Plant Count
Low – broccoli	8,496.7	7,190
Low -fallow	8,715.7	7,181
Medium – broccoli	11,483.0	7,222
Medium – fallow	9,494.3	7,164
High – broccoli	10,841.3	7,282
High - fallow	9,624.3	7,284

No significant difference in yield between medium and high rate of fumigant application

- 25% less fumigant applied in medium rate (330 lbs/A vs 440 lbs/A)
- Yield in broccoli rotation prior to strawberry plots had significantly higher yield than fallow

Conclusion

Project to develop site specific management program for soilborne diseases of strawberry and vegetable rotation crops is in progress and includes:

- Accurate determination of pathogen pressure through out the field
- Precision yield data collection
- High resolution remote sensing data collection enabling following of individual plants
- Looking for correlations among plant health, yield, and pathogen pressure.
- Working with the grower on economic analysis to evaluate if variable rate fumigation strategy is economically viable.
- Techniques for rapid disease diagnostics

ACKNOWLEDGEMENTS

- Funding
  - California Department of Pesticide Regulation
  - USDA-ARS Areawide Pest Management Program
  - NIFA Methyl Bromide Transition Grant Program
  - California Strawberry Commission

Frank.Martin@ars.usda.gov

safennimore@ucdavis.edu