

# Variable rate in-field fumigation for soil-borne pathogens: 2022-23

**Steve Fennimore** and Dario Racano *UC Davis, Salinas, CA*

Alex Putman *UC Riverside, Riverside, CA*

**Frank Martin**, Michael Matson, and Peter Henry *USDA-ARS, Salinas, CA*

Oleg Daugovish and Andre Biscaro *UC Cooperative Extension, Ventura, CA*

Rachael Goodhue, Stavros Vougioukas, R. Arikapudi, M. Earles, T. Magney, A. Montes, J. Au, A. Marzougui  
*UC Davis, Davis, CA*

Forrest Melton and Michael Hang  
*CSU Monterey Bay/NASA Ames, Mountain View, CA*

Michael Stanghellini *TriCal, Hollister, CA*

Nathan Dorn *FoodOrigins, Salinas, CA*

Chris Greer *UC Cooperative Extension, San Luis Obispo, CA*

# Acknowledgements



## Area-wide Management of Agricultural Pests Program

Grant “Site-specific Soil Pest Management in Strawberry and Vegetable Cropping Systems”  
to Frank Martin (USDA) and Steve Fennimore (UC Davis)

## Grower Cooperators

Matt Conroy and Dave Murray *Good Farms*

Henry Ito *Ito Bros.*

Jaime Lopez *Mixtekz Berries*

Pal Halsted and Aaron Fukutomi *Fukutomi Farms*



Grant number: 17-PML-R004

Fumigant is often applied uniformly



Soilborne diseases are usually non-uniform or clustered

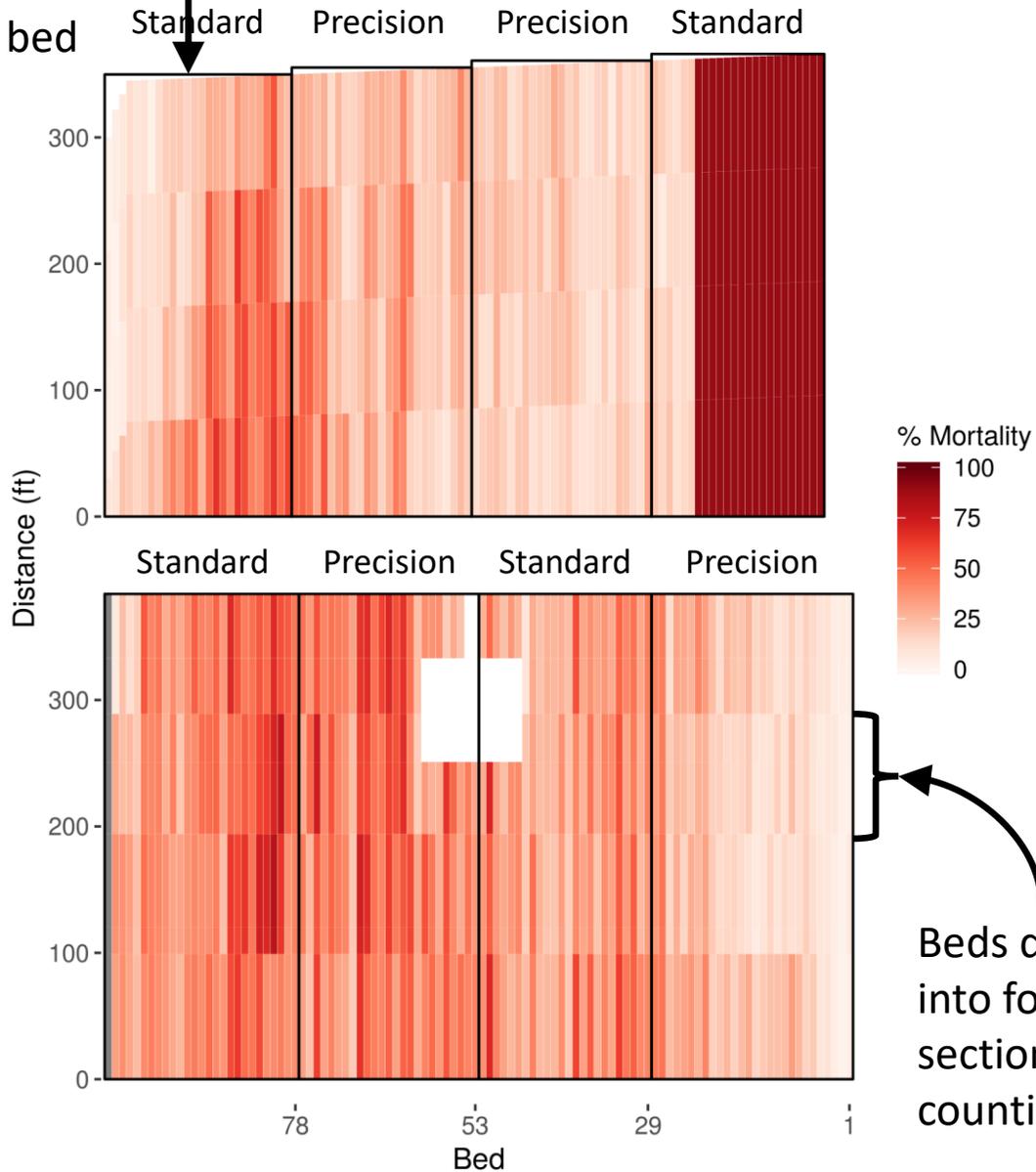
**How to provide tools to growers to take advantage of this knowledge?**



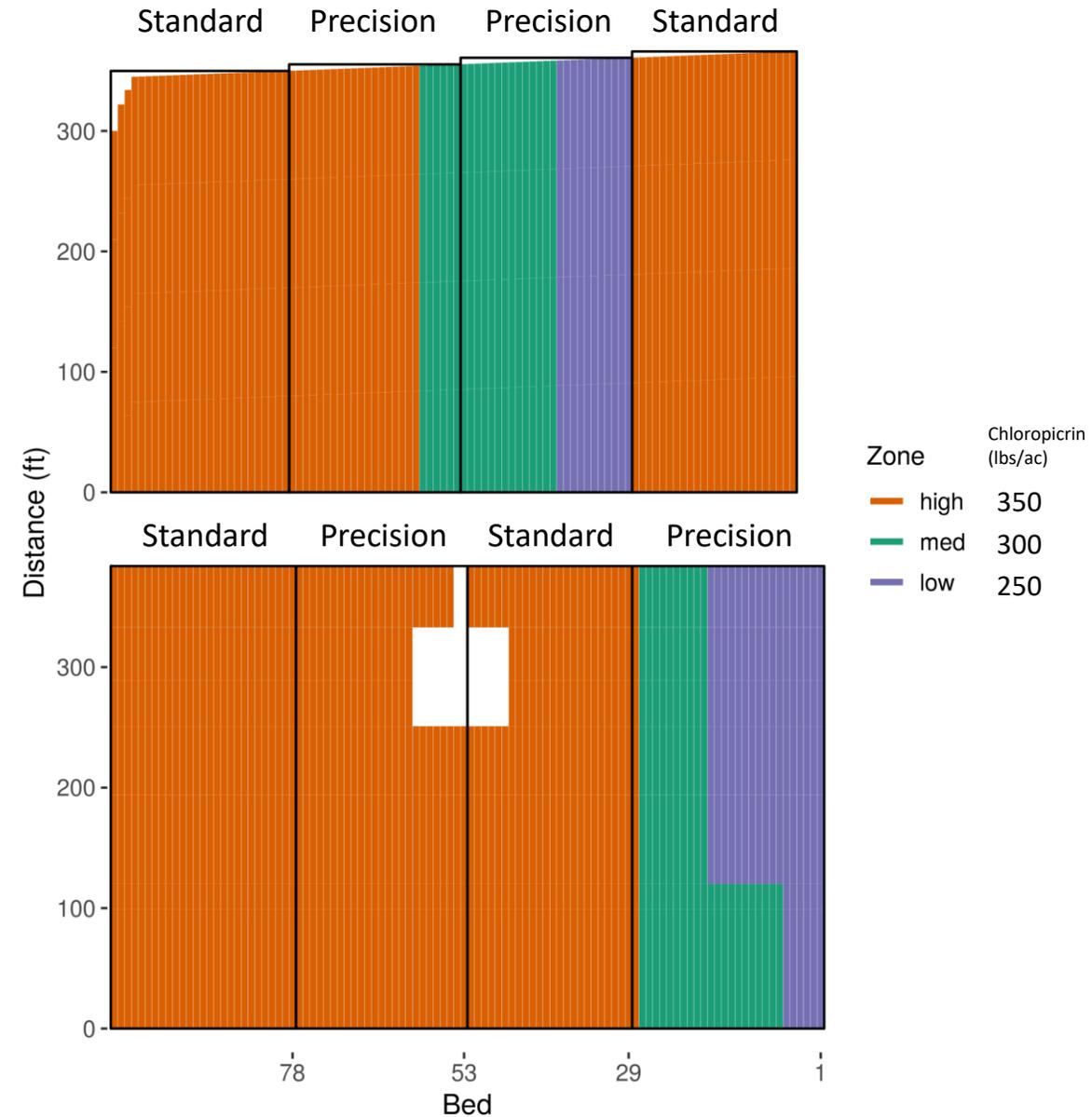
Can this information be used to reduce overall fumigation rate in low disease pressure areas without sacrificing yield?

# Field B – End of Previous Season (2019-20)

Each  
column =  
one bed



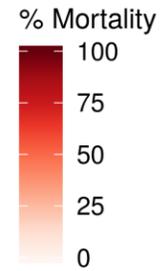
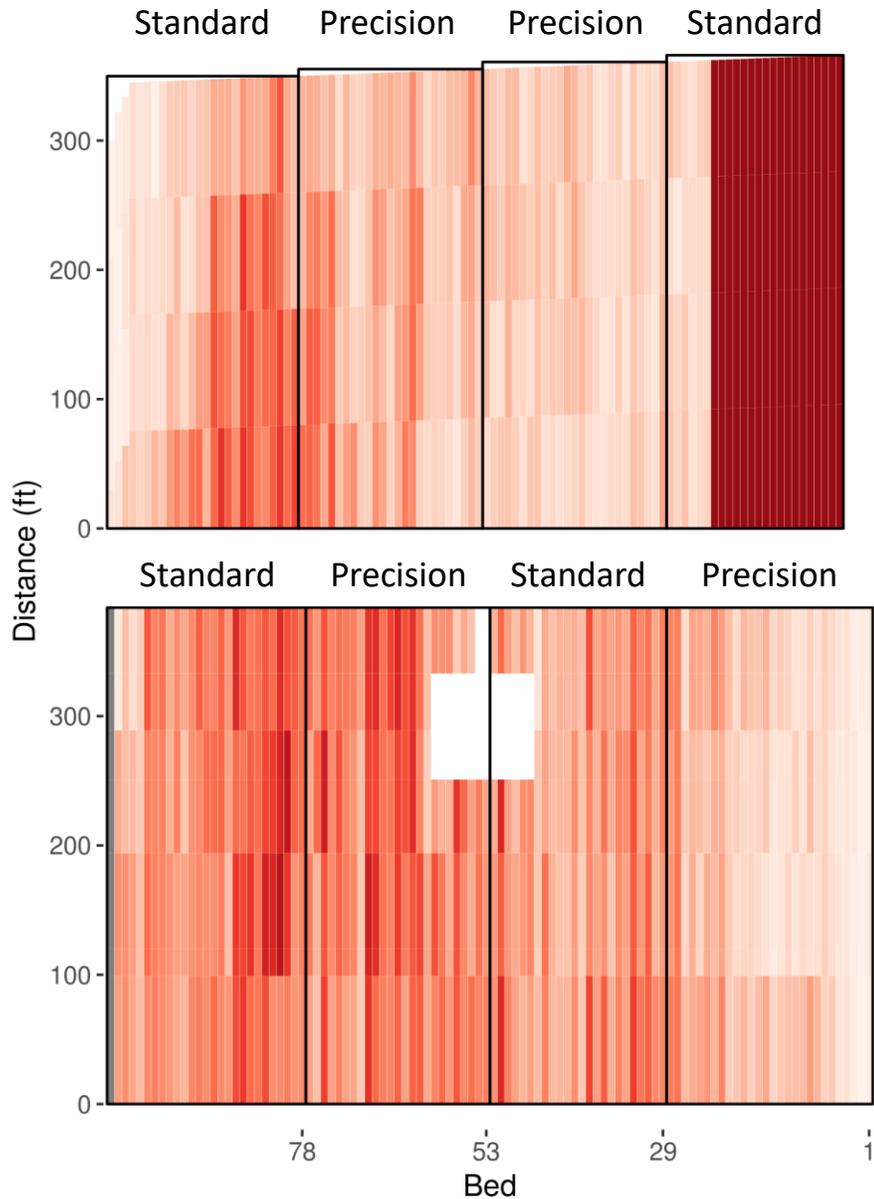
Beds divided  
into four  
sections for  
counting



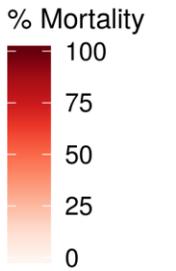
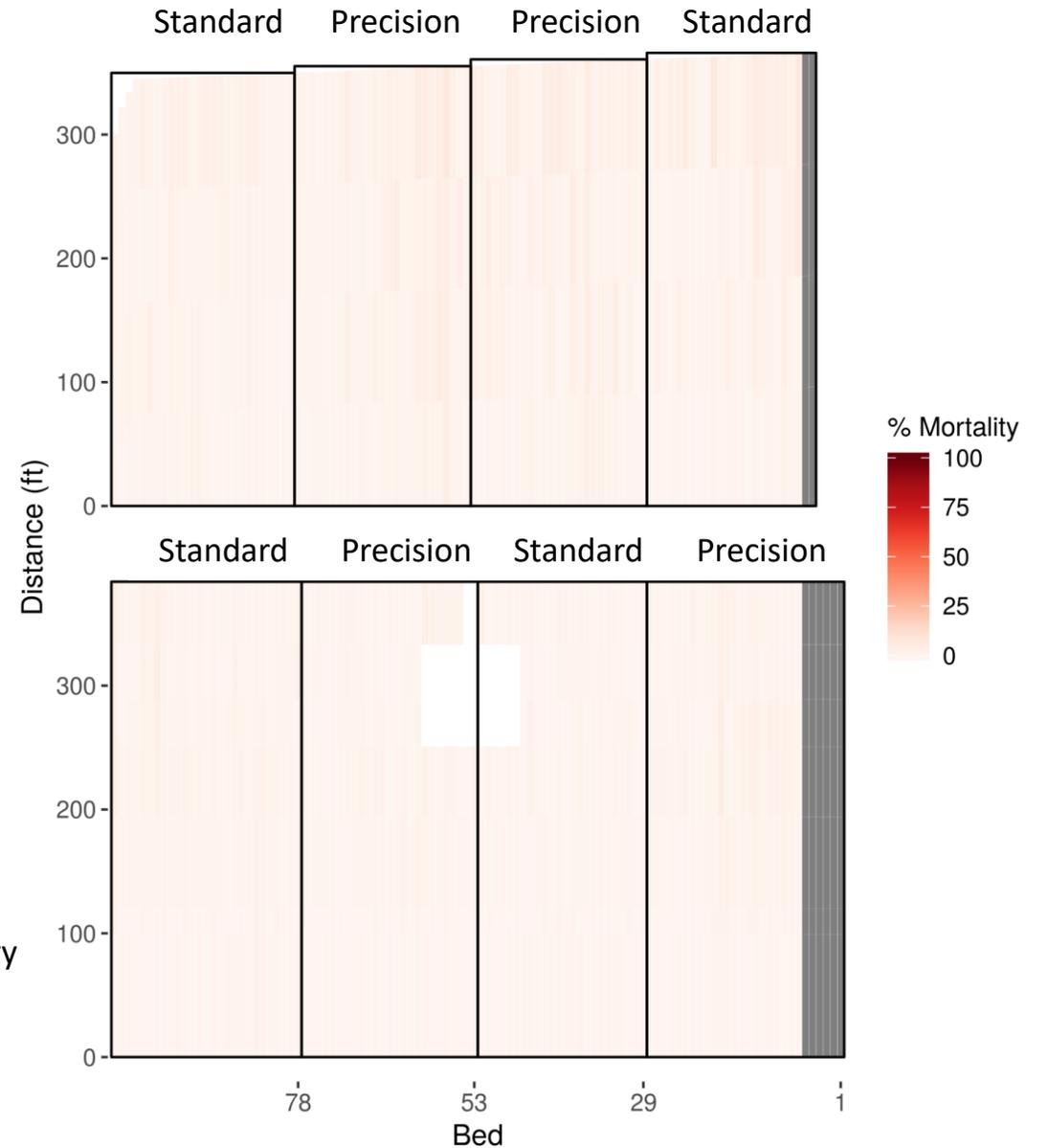
# Previous

# Mortality

# Trial Season



\*Thanks to Kevin Tate (CA Strawberry Commission) for help counting mortality



# Field B – Yield and Mortality (2019-20)

Treatment	Rate	Area (acres)	Avg Rate (lbs/acre)	Yield (crates/acre)	Mortality (%)	
					June 2019	June 2020
standard	-	4.78	350	4,503	45.0	0.9
precision	Total	4.86	309	4,625	27.0	1.1
	low	1.19	250	-	13.4	1.5 a
	med	1.60	300	-	22.4	1.3 b
	high	2.07	350	-	38.3	0.8 c

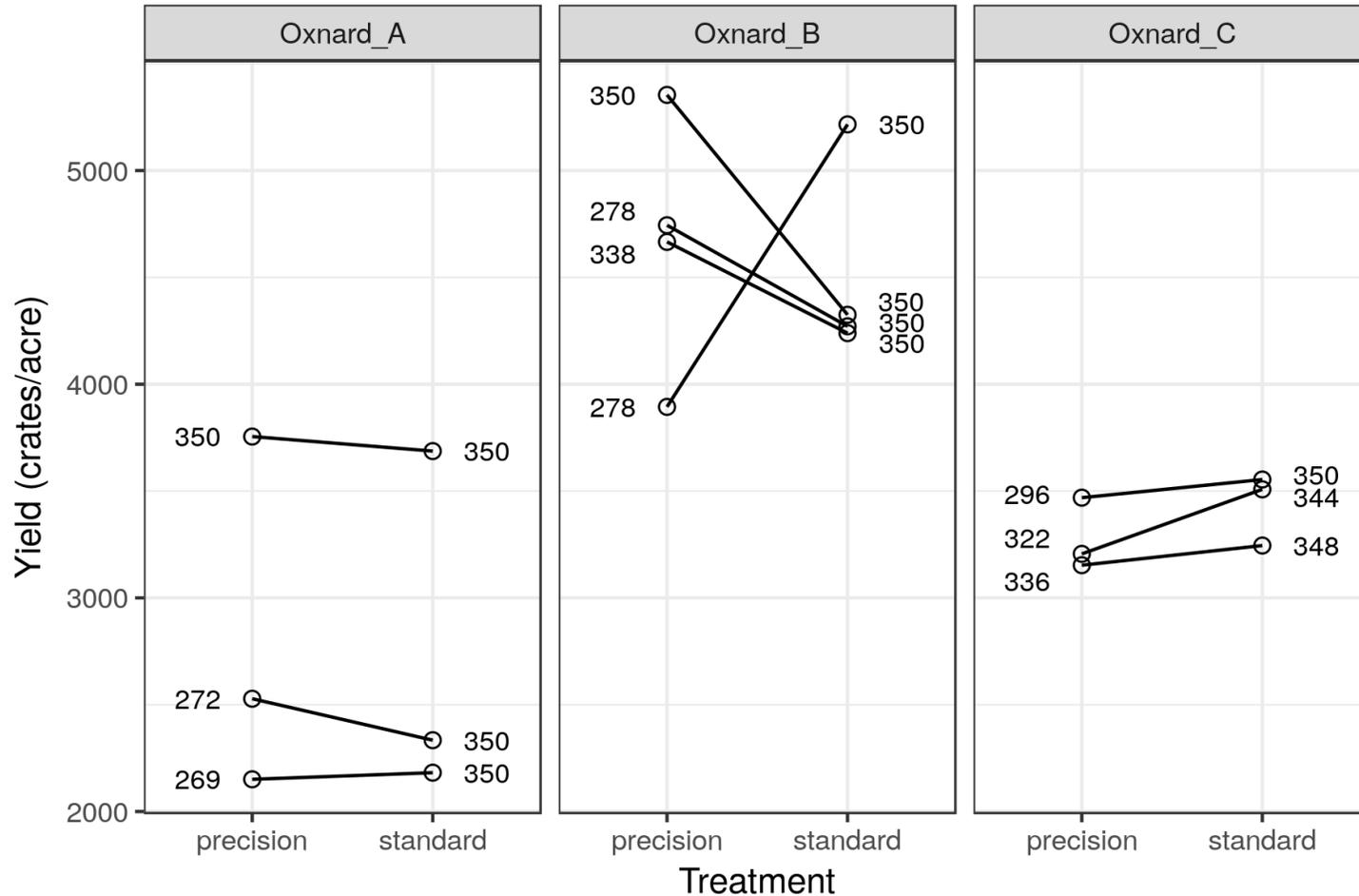
} No statistical difference

} Rate effect of fumigation

\*January 9  
to April 22

Yield 2.7% higher in precision plots

# Summary of Three Fields



Precision compared to Standard (% difference)

Field	Fumigant	Yield
A	-15.2%	+2.8%
B	-11.7%	+2.7%
C	-8.9%	-4.5%

- Under low or no disease pressure, yield does not appear to correlate with fumigation rate

# Field E: 2022-2023 Fall Planting



Photo:  
May 2022

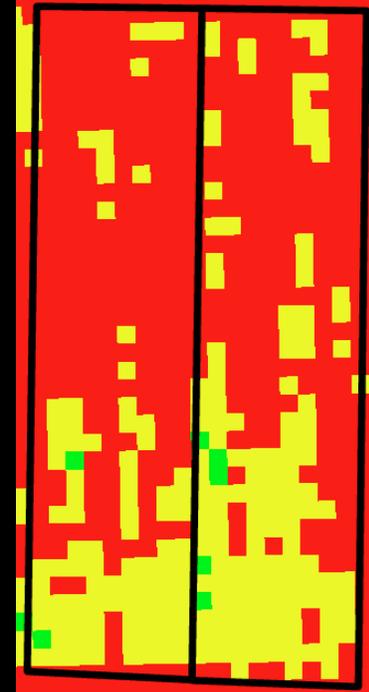
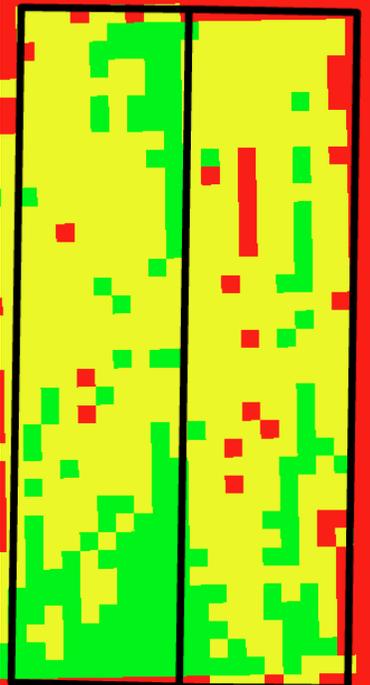
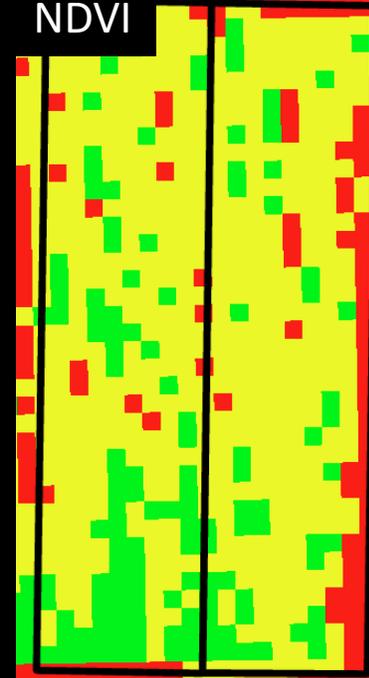
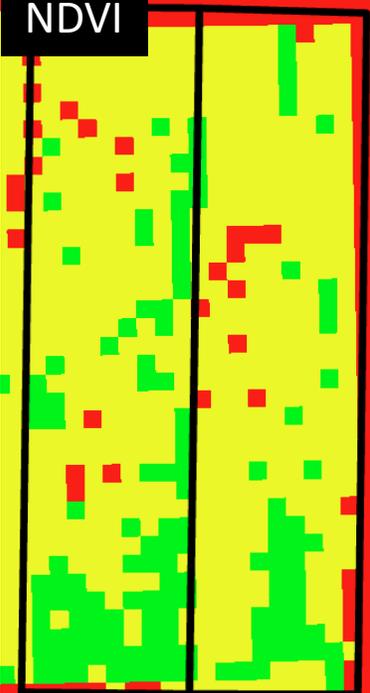
RGB

NDVI

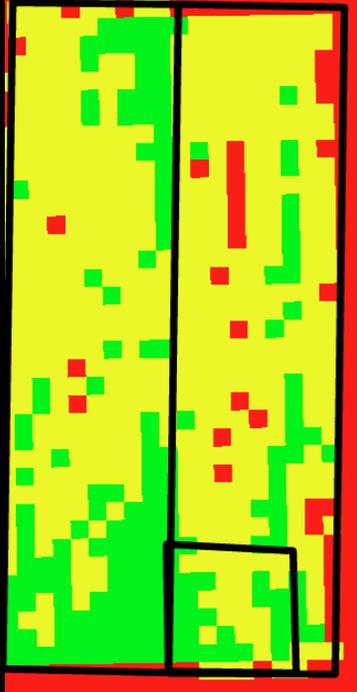
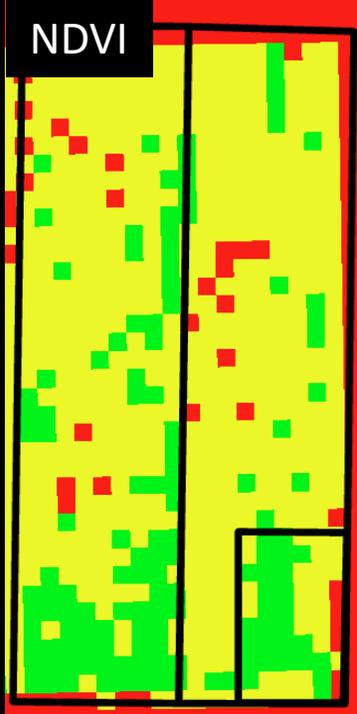
# 2021-2022 End of Season Imagery (July 13 2022)

NDVI

RGB



Color	Upper value	Label
	$\leq 0.45$	0.042 - 0.45
	$\leq 0.6$	0.451 - 0.6
	$\leq 0.860611$	0.601 - 0.861



# 2021-2022 End of Season Imagery (July 13 2022)

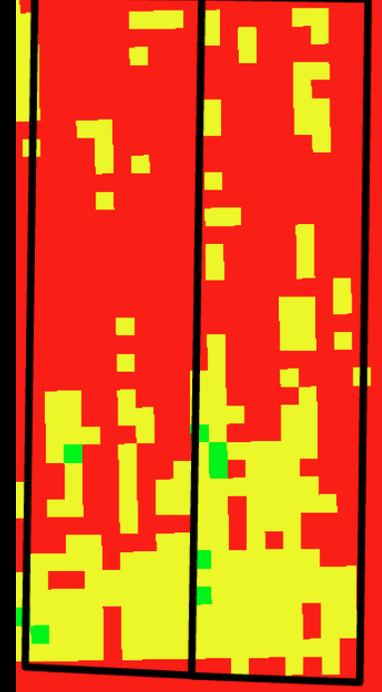
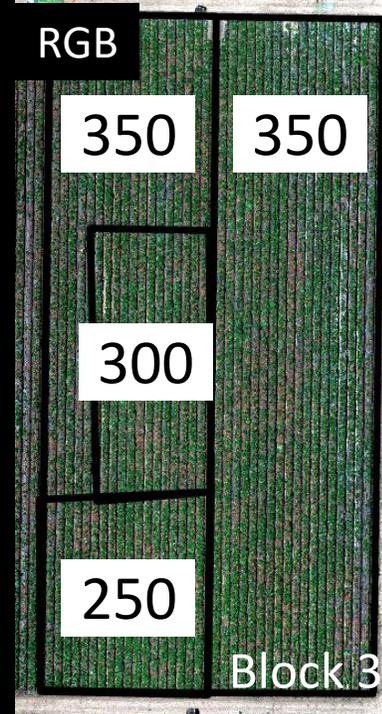
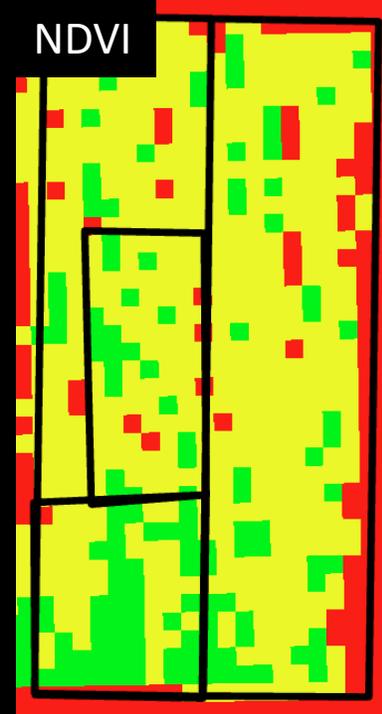
Fumigated Aug. 2022, 3 rates of Pic, lbs/A

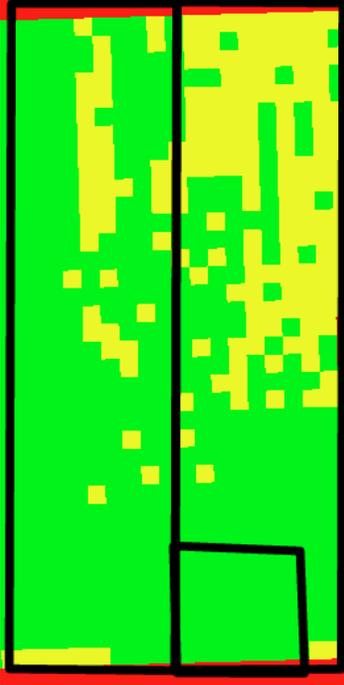
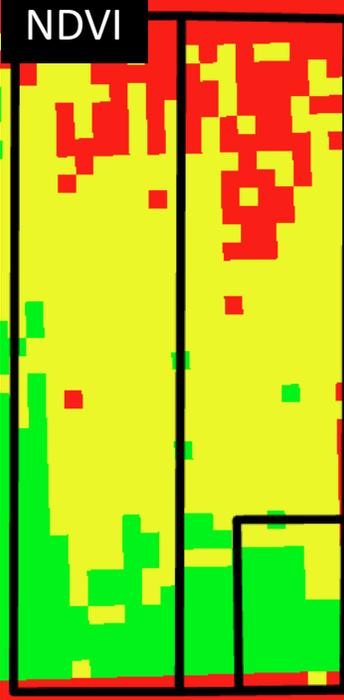
250 (low)

300 (medium)

350 (high - standard)

Color	Upper value	Label
	$\leq 0.45$	0.042 - 0.45
	$\leq 0.6$	0.451 - 0.6
	$\leq 0.860611$	0.601 - 0.861



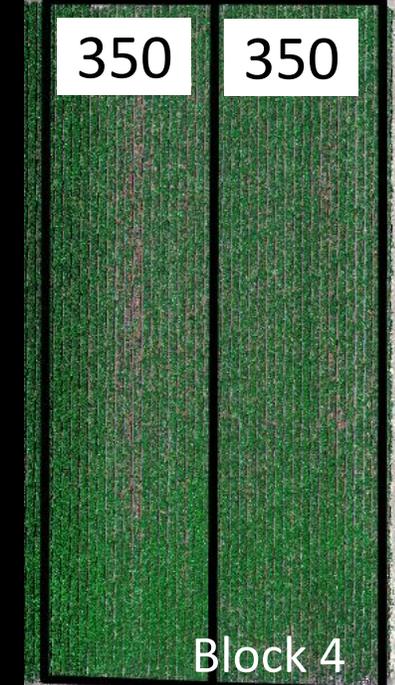
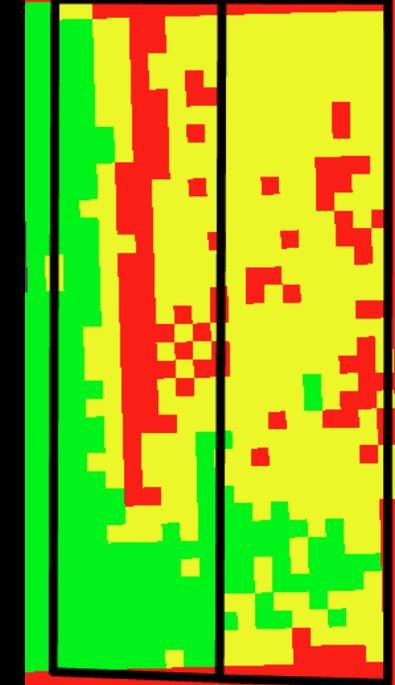
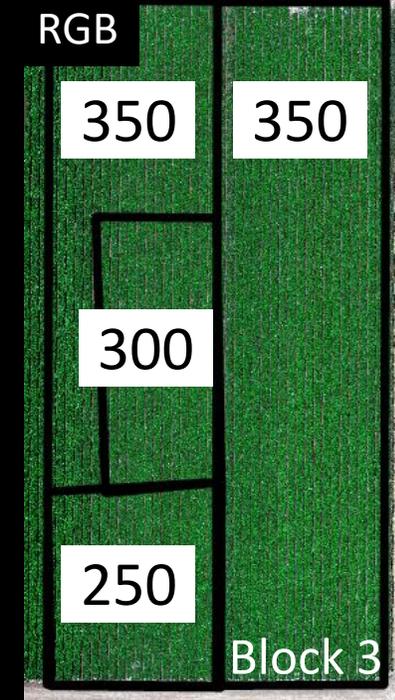
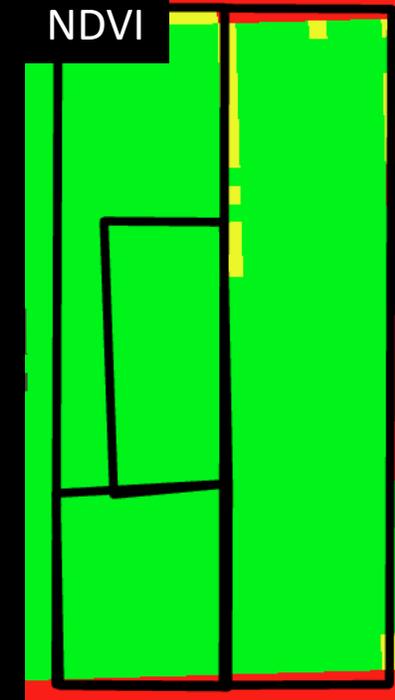


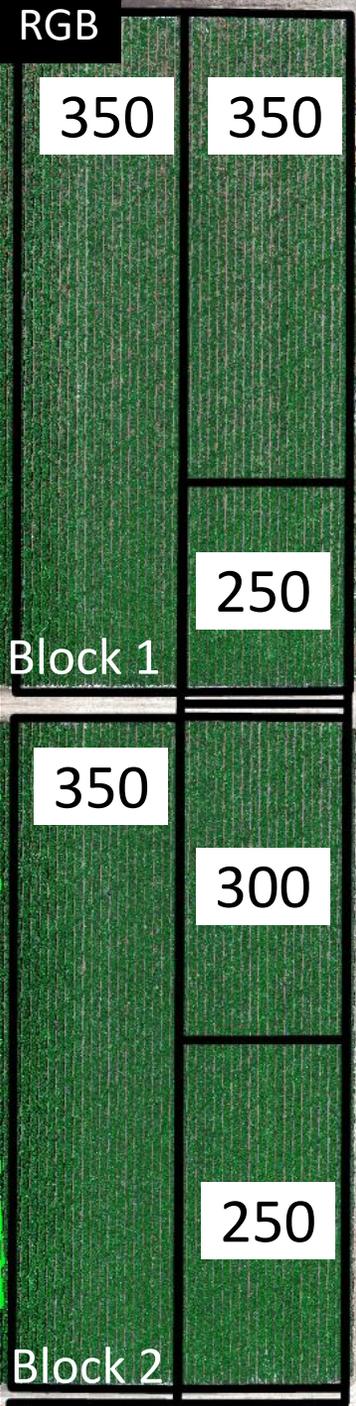
# 2022-23 Trial End (July 20 2023)

Fumigated Aug. 2022, 3 rates  
of Pic, lbs/A

- 250 (low)
- 300 (medium)
- 350 (high - standard)

Color	Upper value	Label
	$\leq 0.65$	0.089 - 0.65
	$\leq 0.75$	0.651 - 0.75
	$\leq 0.967537$	0.751 - 0.968

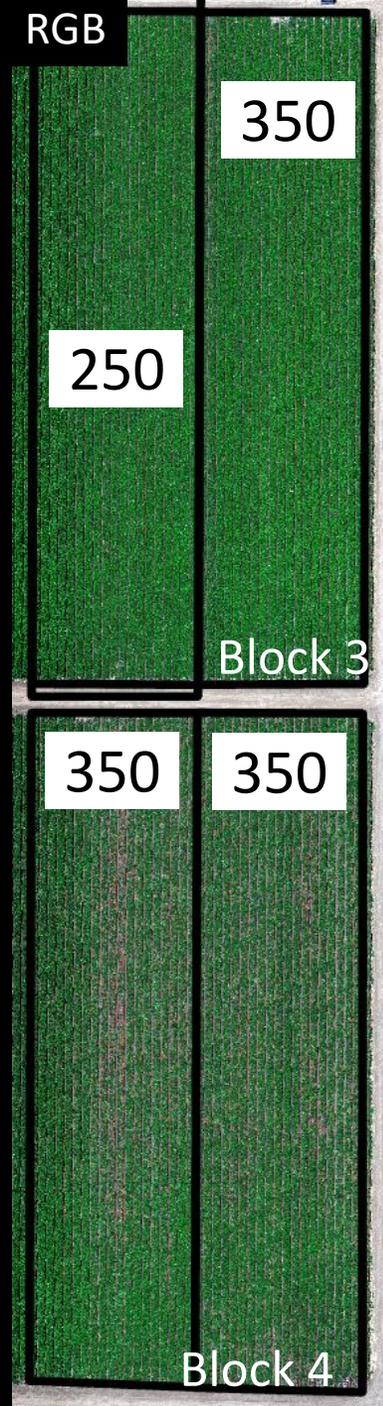
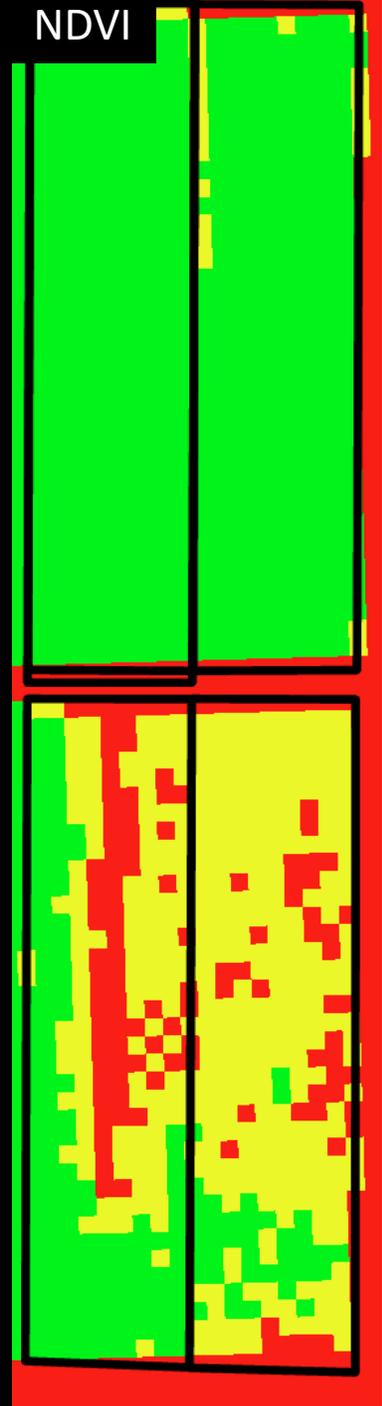




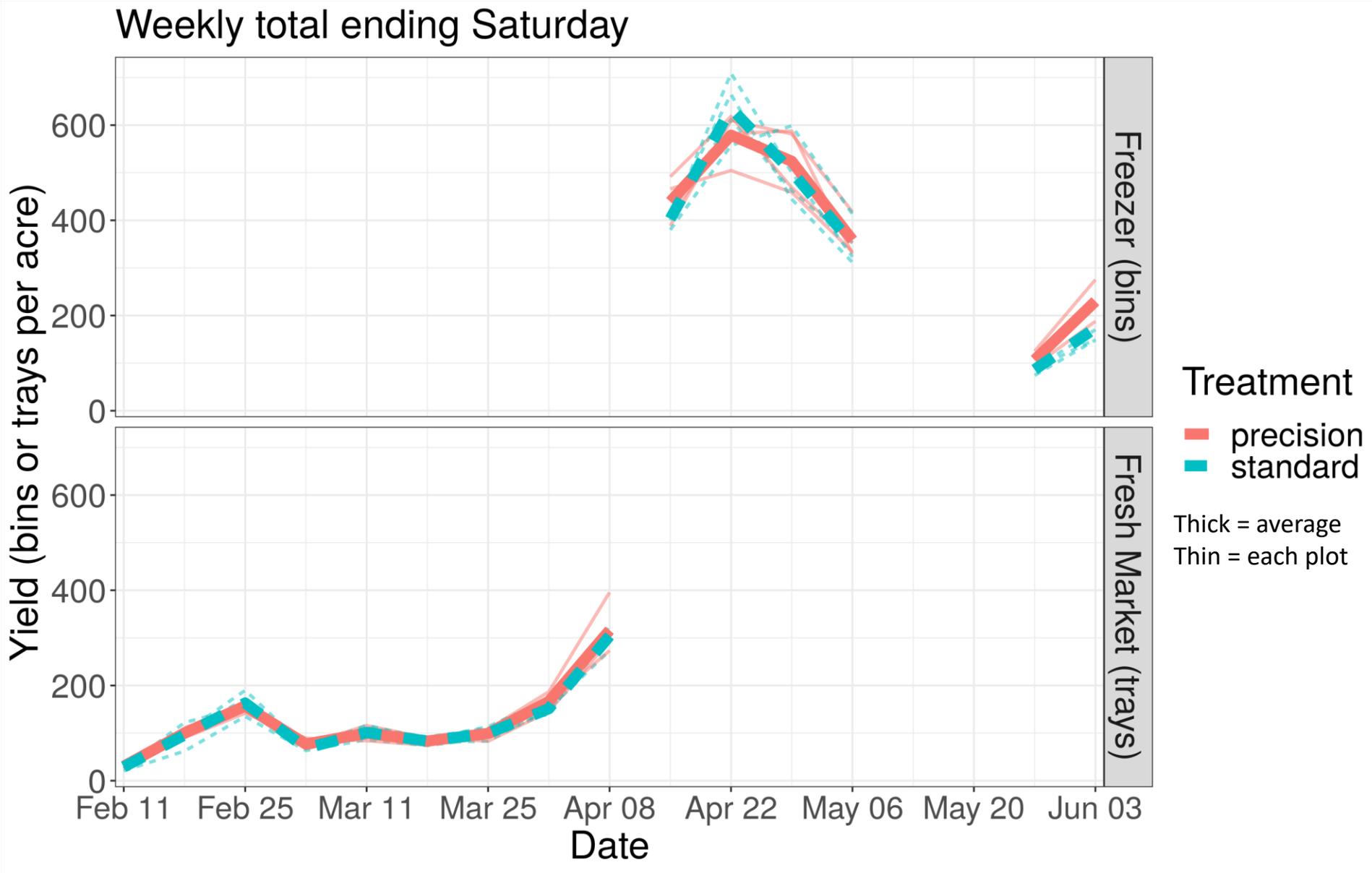
# 2023-24 Year 2 (July 20 2023)

Fumigated Aug. 2023: Pic, 3 rates (lbs/A)  
 Low - 250  
 Medium - 300  
 High - 350 (standard)

Color	Upper value	Label
	$\leq 0.65$	0.089 - 0.65
	$\leq 0.75$	0.651 - 0.75
	$\leq 0.967537$	0.751 - 0.968



# Field E Yield (2022-2023)



- Fronteras
- Whole-plot (~0.95 acre) yield, collected by grower
- Gap in data: May 7 to May 27

# Field E Yield (2022-2023)

Treatment	Area (acres)	Avg Fumigant Rate (lbs/acre)	Fresh Market (trays/acre)	Freezer (bins/acre)
standard	3.84	350	1,096	2,151
precision	3.83	333	1,130	2,237
		<i>P</i> -value:	0.5494	0.0016
			Statistically similar	Significantly different

Yield similar or slightly higher in precision plots versus standard

# Field E Economic Performance (2022-2023)

Treatment	Fresh Market (trays/acre)	Revenue (gross)	Treatment Costs	Net Returns (treatment costs only)
standard	1,096	\$19,419	\$8,984	\$10,435
precision	1,130	\$20,087	\$9,180	\$10,907
			<i>P</i> -value:	0.4445

- Costs included
  - Fumigant
  - Harvest: labor, cooling, sales/marketing fee, CSC assessment
- Costs **not** included: acquiring and analyzing imagery
- Revenue: fresh market only (freezer excluded)

↑  
\*Only using included costs\*

Prices: weekly (CA Strawberry Commission via USDA AMS)

# Discussion

- Under low or no disease pressure, reducing the fumigation rate in areas of low disease pressure can achieve similar yields compared to standard broadcast for flat fumigation

