

Precision Orchard Management: Research update



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1

Overview

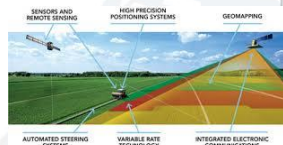
- Definitions and examples
- GIS-based applications
- Weather-based decision support tools



2

Precision management

- Components
 - Sensors and remote sensing
 - Precision positioning
 - Integrated communication
- Geomapping
- Auto-steering
- Variable rate technology



3

Precision management

- Mapping components
 - Soil properties map
 - Grid soil testing (nutrients)
 - Yield history
 - Pest distribution
- Variable management
 - Variety
 - Seeding rate
 - Fertilizer rate
 - Pesticide rate



4

Orchard examples

- TRAPs app



Precision Crop Load Management

- Determine target crop load
 - Bushels per acre to maximize “crop value” (target size class)
 - Fruit # per acre → Fruit # per tree → Fruit # per branch
- Precision pruning
 - Determine flower buds per tree (5 trees per block)
 - Factor this into pruning strategies to reduce flower buds
- Precise thinning program
 - Fruit Growth Model
 - Carbohydrate Thinning Model
 - “Window” hand thinning



Orchard examples

- TRAPs app features
- Precision crop load management
- Variable rate management
 - Fertilizer
 - Based on what?
 - Soil variability
 - Yield history?



Applications for Utah

- Appropriate for tart cherry?
- Research locations
 - Three farms
 - Two orchard blocks per farm
 - Orchard blocks differ in soil uniformity (based on NRCS maps)



Mapping parameters - Soil

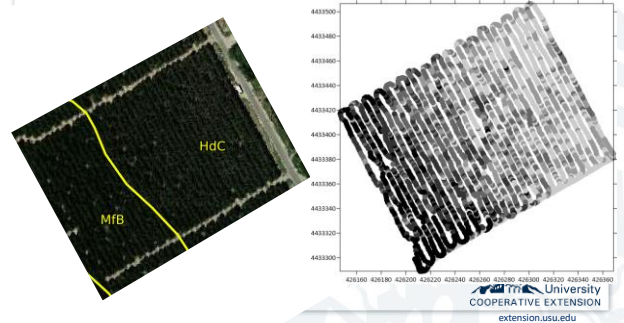
- Soil properties
 - Electromagnetic probe
 - Texture
 - pH
 - Salinity



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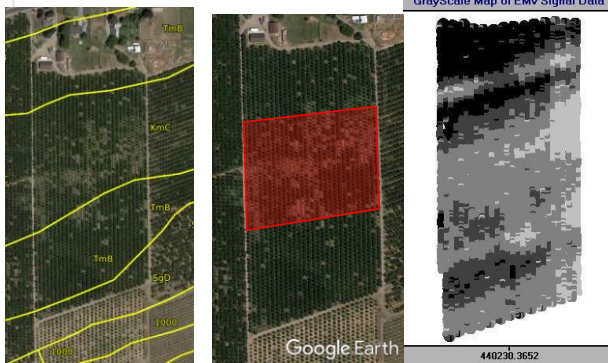
Mapping parameters - Soil

- Soil properties
 - Electromagnetic probe



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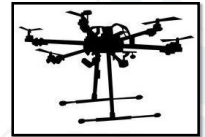
Mapping parameters - Soil



Google Earth
440230.3652
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Mapping parameters - Canopy

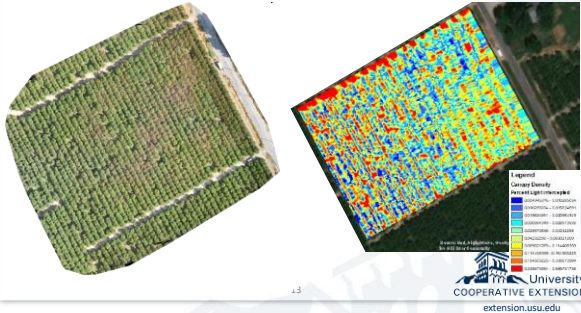
- Aerial imaging
- Light interception mapping
 - Light sensors 5-cm spacing
 - GPS and data logger



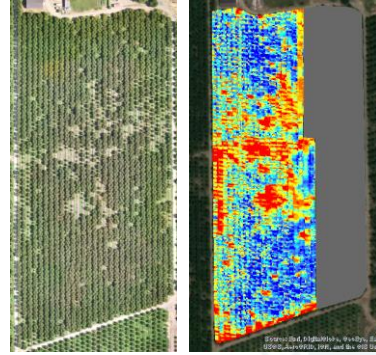
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Mapping parameters - Canopy

- Aerial imaging
- Light interception mapping

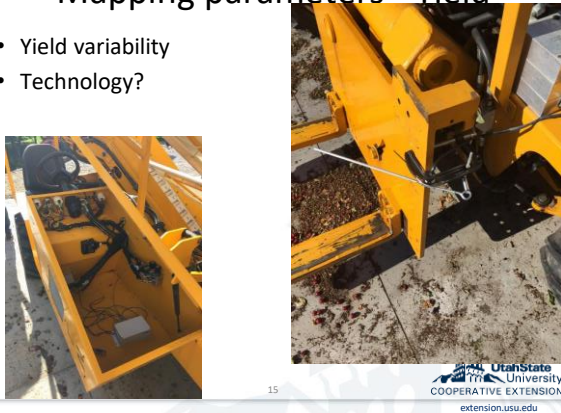


Mapping parameters - Canopy



Mapping parameters - Yield

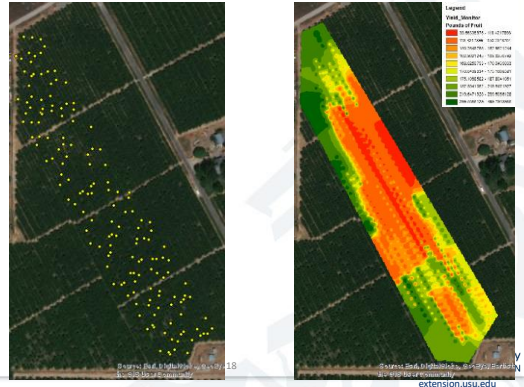
- Yield variability
- Technology?



Mapping parameters - Yield



Mapping parameters - Yield



• Mapping Parameters:



• Next steps?

- Correlations among these and yield, tree health
- Changes in leaf area over time?

19



- Leaf area changes
- Proportional to water needs

- Improved crop coefficients

$$ET_{crop} = ET_{ref} \times K_{crop}$$



20

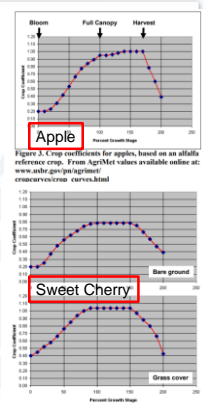


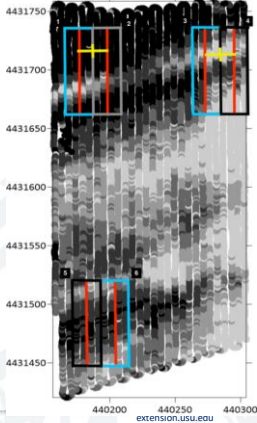


Figure 2. Crop coefficients for cherries with clean cultivated or grass cover row middles. From AgriMet values available online at: www.usbr.gov/pn/agrimet/cropcoefficients_agrius.html

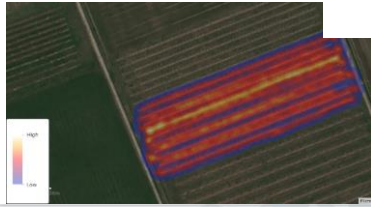
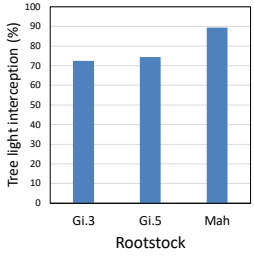
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- Variable rate management
 - Fertility
 - Irrigation
 - Pruning

21

- Pruning
 - Canopy density threshold
 - Fruit color
 - Powdery mildew





Rootstock	Tree light interception (%)
Gi.3	~72
Gi.5	~75
Mah	~90

22

Overview



- Definitions and examples
- GIS-based applications for tart cherry?
- Weather-based decision support tools



23

Weather Based Decision Support

- TRAPs app
 - 10 Insect pests
 - 1 disease
- Crop growth models?

24

Apple Carbohydrate Model

- Carbon balance affects thinning response
- Surplus = difficult to thin
- Deficit = easy to thin

Table 1. Decision rules for using the output of the carbohydrate model to adjust rate.

4-day Av. Carb. Balance	Thinning Recommendation
+20g/day to 0g/day	Increase Chemical Thinning Rate by 30%
0g/day to -20g/day	Apply Standard Chemical Thinning Rate
-20g/day to -40g/day	Decrease Chemical Thinning Rate by 10%
-40g/day to -60g/day	Decrease Chemical Thinning Rate by 20%
-60g/day to -80g/day	Decrease Chemical Thinning Rate by 30%
< than -80g/day	Do not thin (many fruits will fall off naturally)

25

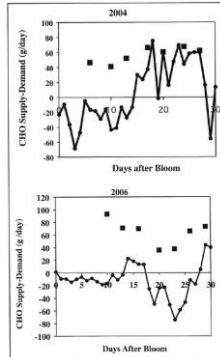
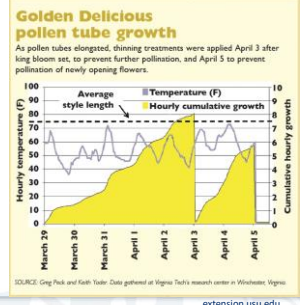


Fig. 3. Predicted daily carbohydrate balance (line) at Geneva, NY in 2004 and 2006, and results of timing trials of thinning in % of the early load on unfertilized trees (square data points).

Pollen Tube Growth Model

- Predicts time to pollination
- Used to time bloom thinners



SOURCE: Greg Peck and Keith Taylor. Data gathered at Virginia Tech's research center in Wisehamlet, Virginia. extension.usu.edu

Improved ET estimates

$$ET_{crop} = ET_{ref} \times K_{crop}$$

- Orchard-specific ET_{ref} calculations
- Projected ET from weather forecasts

Date	Max Temp (°F)	Min Temp (°F)	Max Wind (mph)	Relative Humidity (%)	Wind Speed (mph)	Wind Dir (°)	Cloud Cover (%)	Soil Temp (°F)	Soil Moisture (%)	Soil Depth (in)	Soil Type	ET (mm)	ET (in)
2017-03-29	68	48	12	75	10	135	100	55	10	10	CLAY	1.2	0.05
2017-03-30	65	45	15	78	12	140	100	55	10	10	CLAY	1.1	0.05
2017-03-31	62	42	18	80	15	145	100	55	10	10	CLAY	1.0	0.05
2017-04-01	60	40	20	82	18	150	100	55	10	10	CLAY	0.9	0.05
2017-04-02	58	38	22	85	20	155	100	55	10	10	CLAY	0.8	0.05
2017-04-03	55	35	25	88	25	160	100	55	10	10	CLAY	0.7	0.05
2017-04-04	52	32	28	90	30	165	100	55	10	10	CLAY	0.6	0.05
2017-04-05	50	30	30	92	35	170	100	55	10	10	CLAY	0.5	0.05
2017-04-06	48	28	32	95	40	175	100	55	10	10	CLAY	0.4	0.05
2017-04-07	45	25	35	98	45	180	100	55	10	10	CLAY	0.3	0.05
2017-04-08	42	22	38	100	50	185	100	55	10	10	CLAY	0.2	0.05

irrigation scheduler mobile

Add New Field [Help](#)

Check box to start with existing field

Name:

Year: 2017

Network: Select Network

Station: Select Station First

Crop: Select Station First

Soil: Select Soil Type

Dashboard

Daily Budget Table

Soil Water Chart

More Charts

Field Settings

Add/Delete Fields

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Crop Phenology

- Growing Degree Days (GDD) from 1-Jan to crop growth stages – apple (by cultivar: Cripps Pink, Gala, Red Delicious)



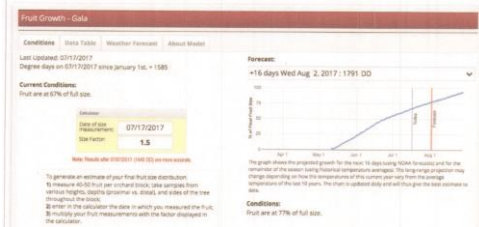
- GDD to bloom for peach and cherry

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28

Fruit Growth Model - Apple

- Uses GDD, fruit measurements and date to estimate harvest fruit size distribution. (Cripps Pink, Gala, Red Delicious)



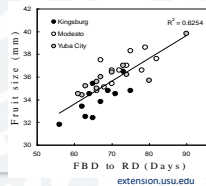
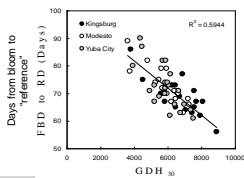
Honey Bee Foraging Activity

- Bee activity based on weather – (rain, wind, temperature, sunlight)
- Past three days,
- Forecast of next three days
- Limiting factor



Peach fruit development

- California model
 - GDH for first 30 days after bloom
 - Predicts fruit size potential
- Used to determine thinning timing and severity



Weather-based tools

UDAF Specialty Crop grant (2019-2021)

- Integrate new heat unit models into Climate Center Website
- Validate these models under Utah Conditions
- Refine/Improve the models where appropriate
- Integrate validated models into Utah TRAPs app.

Which weather-based tools

General

- Improved ET estimate and forecasts
- Chill unit accumulation
- Bee activity

Apple

- Pollen tube growth (bloom thinning)
- Carbohydrate model (thinning)
- Bloom date
- Fruit growth (estimate final size)

Peach

- Bloom date
- Fruit development (thinning severity)

Cherry

- Bloom date
- Priority: High, Medium, Low, No Interest

