Precision Orchard Management: Research update

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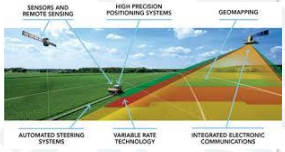
Overview

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

Precision management

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

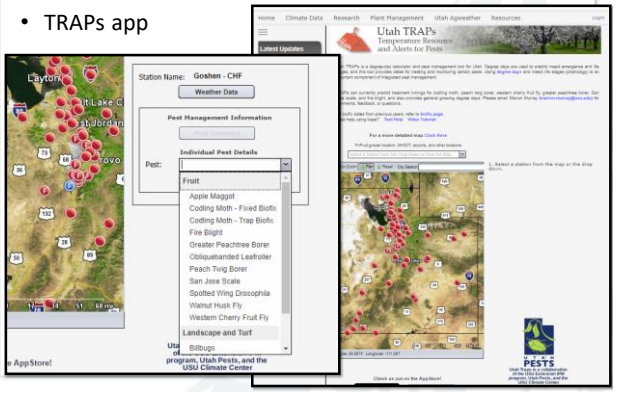


Precision management

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

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

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Orchard examples

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

Applications for Utah

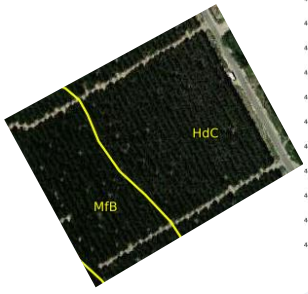
- Appropriate for tart cherry?
- Research locations
  - Three farms
  - Two orchard blocks per farm
  - Orchard blocks differ in soil uniformity (based on NRCS maps)

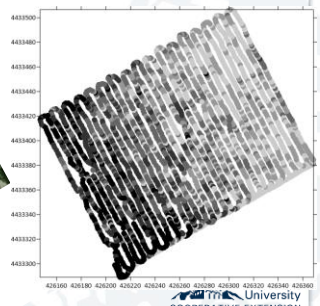
Mapping parameters - Soil

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

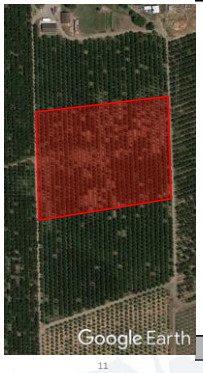
Mapping parameters - Soil

- Soil properties
  - Electromagnetic probe





Mapping parameters - Soil

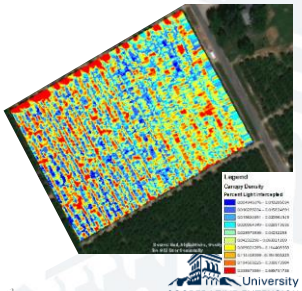


Mapping parameters - Canopy

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

Mapping parameters - Canopy

- Aerial imaging
- Light interception mapping



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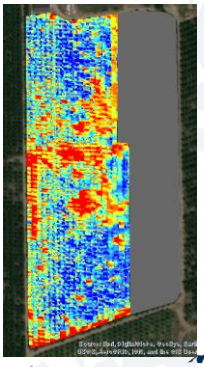
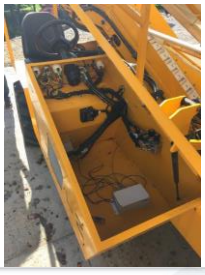
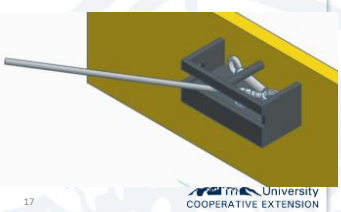


Mapping parameters - Yield

- Yield variability
- Technology?



Mapping parameters - Yield



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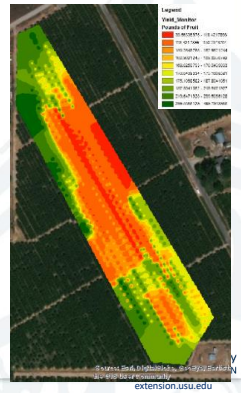

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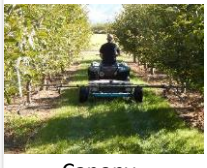


Canopy

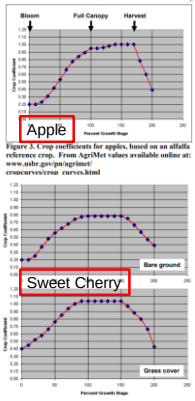
Soil

Yield

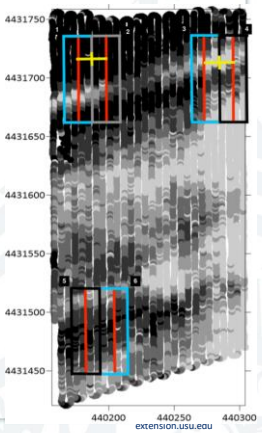
- Next steps?
  - Correlations among these and yield, tree health
  - Changes in leaf area over time?

- Leaf area changes
  - Proportional to water needs
- Improved crop coefficients

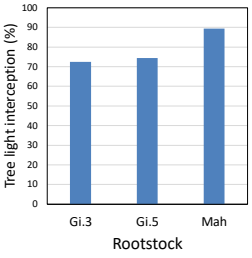
$$ET_{crop} = ET_{ref} \times K_{crop}$$

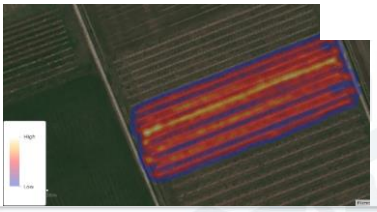


- Variable rate management
  - Fertility
  - Irrigation
  - Pruning



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



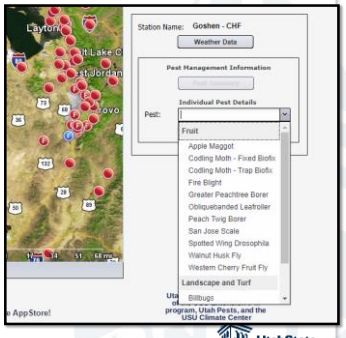


Overview

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

Weather Based Decision Support

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



Apple Carbohydrate Model

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

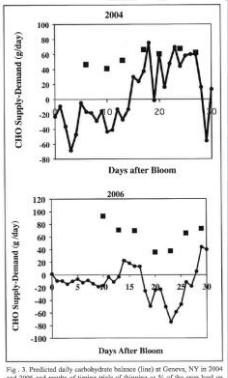


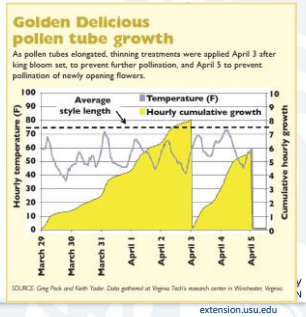
Fig. 3. Predicted daily carbohydrate balance (line) at Geneva, NY in 2004 and 2006 and results of timing trials of thinning as % of the crop load on unthinned trees (square data points).

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 -60 g/day	Decrease Chemical Thinning Rate by 20%
-60g/day to -80 g/day	Decrease Chemical Thinning Rate by 30%
< than -80g/day	Do not thin (many fruits will fall off naturally)

Pollen Tube Growth Model

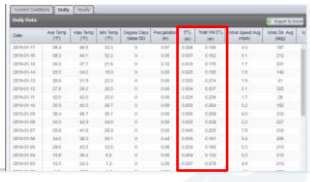
- Predicts time to pollination
- Used to time bloom thinners

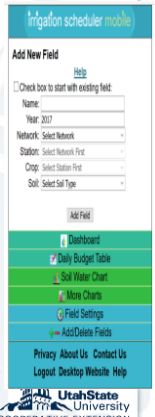


Improved ET estimates

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

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





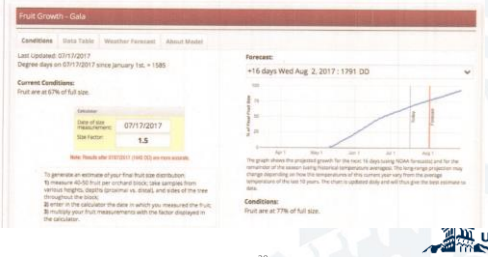
Crop Phenology

- 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

Fruit Growth Model - Apple

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



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Honey Bee Foraging Activity

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

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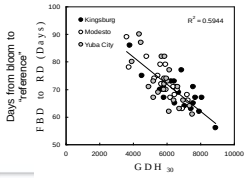
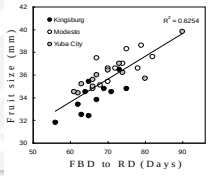
Peach fruit development

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





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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.

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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

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