Lab Meeting 6/25/19

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Sorghum QTL Mapping - Background

1. Calculate phenotypic parameters from hyperspectral and RGB images

2. Match phenotypic variations with presence/absence of markers in DNA (SNPs)

Result: Identification of areas of sorghum genome which control for economically valuable traits

Hyperspectral Image Analysis

- **Problem:** hyperspectral images only include top part of plant

  - Can't be used to segment plant organs

- Use hyperspectral images to measure panicle properties

  - Size

  - Openness/compactness

  - Seed pigment levels

Hyperspectral Image Analysis

- **Seed pigment levels determine:**

  - Color

  - Physical properties

  - Resistance to stresses

  - Nutritional content

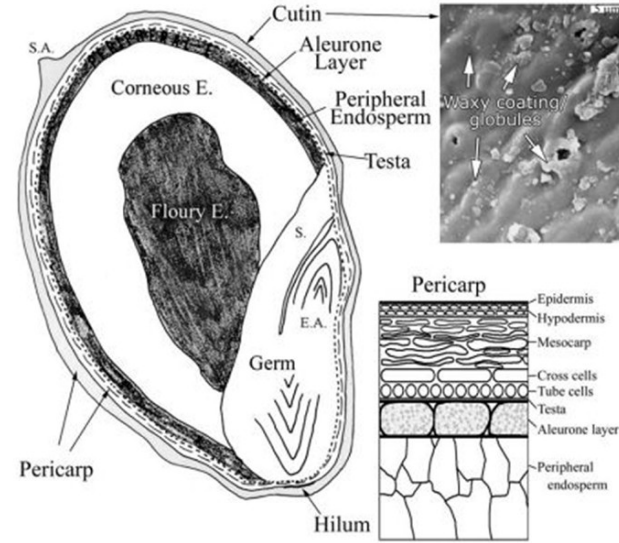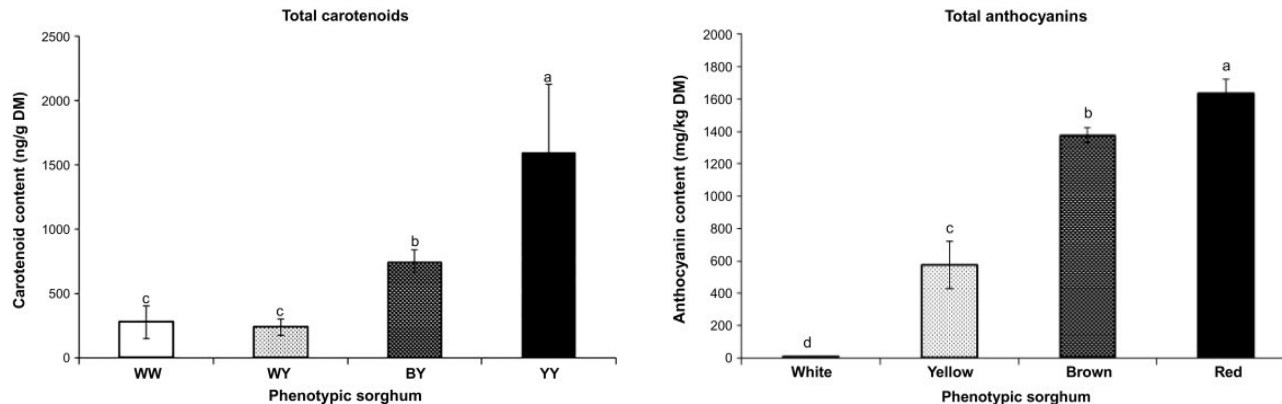- Majority of pigments accumulate in pericarp

Fig. 1 from Bean et al (2016)

Hyperspectral Image Analysis

- **Sorghum seed pigments:**
  - Anthocyanins – antioxidants
  - Carotenoids – vitamin A precursors
  - Tannins – digestibility
  - Phenolic acids – grain hardness

Figs. 2 and 3 from Davis et al (2019)

Hyperspectral Image Analysis

- Pigment measurement is possible with near-infrared spectroscopy (NIRS)
    - Not yet demonstrated with hyperspectral imaging

- **Problem:** sorghum pericarp thickness is variable
    - Thick – opaque
    - Thin – translucent (testa and endosperm are visible)

- Pericarp thickness must be determined before predicting pigment levels
    - Possible to predict pericarp thickness from images?

Hyperspectral Image Analysis

- **Problem:** # of ground-truth measurements required

  - From NIRS papers, estimate 150 – 250

- Use phenotypic measurements from previous papers with same recombinant inbred lines (RILs)

  - Plant genotypes will be nearly identical

  - Match pigment data from other papers to reflectance data from hyperspectral images
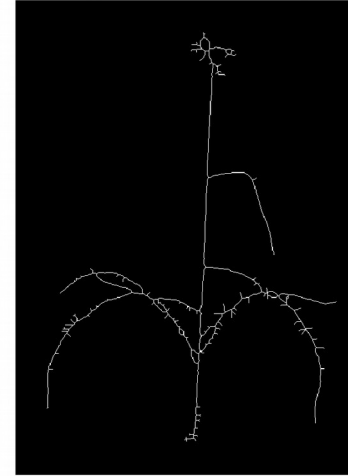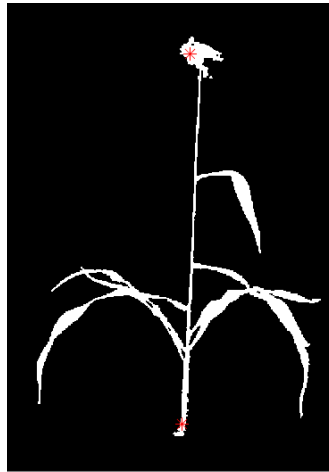
RGB Image Analysis

- RGB images contain entire plant

- Use to measure:

  - Number of leaves

  - Leaf angle

  - Plant height

- Unlike hyperpsectral, unable to segment leaves from stem

RGB Image Analysis

- Background removal – thresholding in L*a*b* color space

- Identify bottom of stalk and panicle

- Skeletonize image

RGB Image Analysis

- Trace line on skeleton – bottom of stalk to panicle

- Fit line to skeleton points – represents stalk

- Segment leaves from stem based on proximity to line

- Calculate phenotypic parameters

RGB Image Analysis

- With already segmented images:

Left Leaf Count: 3
Right Leaf Count: 5
Average Leaf Angle: 41.9215 deg
Leaf Angle Standard Deviation: 11.5301

Left Leaf Count: 4
Right Leaf Count: 4
Average Leaf Angle: 50.1957 deg
Leaf Angle Standard Deviation: 9.9431

Left Leaf Count: 4
Right Leaf Count: 5
Average Leaf Angle: 50.1428 deg
Leaf Angle Standard Deviation: 9.5097