Exercise A (field): Infrared thermometers and ultrasonic proximity sensors

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Objectives

I. Introduce cart with ultrasonic and IRTs

II. Basic principles

A. Canopy temperature values, variability by sensor, targets, environmental conditions

B. Canopy height ultrasonic vs. hand observations: what is canopy height?

III. Compare measurements made by hand vs. cart

Activities

I. **Introduction to proximal sensing cart (PSC)** – This is mostly a demo to view components of the PSC and its operation.

A. Instruments

1. Three infrared thermometers with different view angles
2. Ultrasonic proximity sensor
3. GPS

B. Data logger and power supply

1. Campbell CR-3000
2. Battery pack (gel) to provide 12 and 24 VDC

C. Cart operation

1. Instrument positioning and adjustment
   a) Height and view angles
   b) Over rows or ??
   c) Shadowing considerations for thermometry
2. Pushing cart through field
   a) Volunteers to push plots to record temperatures and heights. Results collected and displayed in lecture session

b) Questions:

(1) How do you turn the PSC?

(2) Which direction should it be oriented?

(3) How do you relate measured height to height above the bed?

II. **Canopy height ultrasonic vs. hand observations** – This exercise introduces issues of variability in temperature as measured with infrared thermometers (IRTs). Each group is provided a hand-held IRT. These are not research quality, but are adequate for exploring plant-soil differences and the effects of shading and view angle.

A. Hand-held: Explore the variation in temperature found with a hand-held IRT by taking the measurements listed below in either soils or crops (record results on the attached sheet). For the soils, we will have umbrellas available to provide shade. For crops, work at a short range (e.g., 30 cm), so that you can see the laser spot indicating where the IRT is recording. The field of view is described as 1:8, so the area being sensed will be about 4 cm in diameter.

1. Soils:

a) Dry soil

b) Wet soil

c) Dry sand (in box)

2. Crops – in the Brassica

B. FLIR thermal camera: We regret that this has to be done as a demo due to the high cost of the camera ($20,000).

1. Brief over-view of the camera functions

a) Uncooled microbolometer, 7.5-13 micrometers, accuracy +/- 1 C, 640x480 pixels, f/1.0, 18mm, 25 deg FOV., GPS, Control by USB or WiFi, Movie recording capability, 4 hour operating time.

b) Listen for the internal calibration

c)

2. View the crops from four positions

a) South, West, North & East

b) soils. Range of temperatures observed.

3. View Brassica leaves close up.

a) Can you see veins?

C. Compare hand vs. PSC measurements of height

1. Measure height in the Brassicas.
2. Five plots are marked (A-E) by flags on wooden stakes.
3. Decide within your group your criteria for maximum height.
4. Along each plot take six measurements from the top of the bed.
5. Return the datasheet when completed, so we can enter and compare to other groups and the Proximal Sensing Cart.

DATA SHEET Exercise A, Infrared thermometry:

Team _____ Crop _____

Conditions Clouds _____

Wind _____

		Temp (°C)		
Target	**No.**	**Sunlit**	**Shade**	**Notes (e.g, exact time, changes in weather)**
Start time:				
Dry soil	**1**			
Wet soil	**2**			
Dry sand	**3**			
Canopy/leaves	**1**			
	2			
	3			
	4			
	5			
	6			
	7			
	8			
	9			
	10			
End time:				

DATA SHEET Exercise A, Canopy height:

Team _____ Start time_____

Hand-measure height of both crops from top of bed to "top" of foliage.

Plot	No	Height (cm)	Notes
A	**1**		
	2		
	3		
	4		
	5		
	6		
B	**1**		
	2		
	3		
	4		
	5		
	6		
C	**1**		
	2		
	3		
	4		
	5		
	6		
D	**1**		
	2		
	3		
	4		
	5		
	6		
E	**1**		
	2		
	3		
	4		
	5		
	6		

Logistics for organizers

1. IRTs
2. Meter sticks/folding rules
3. Field maps or marked plots
4. FLIR
5. Sand box
6. Wet soil
7. Raised platform
8. Plot markers for height (A-E)
9. Tripod for FLIR
10. Blocks to provide stable viewing stations for FLIR