Crop Productivity and Soil Health During Transition to Organic Grain

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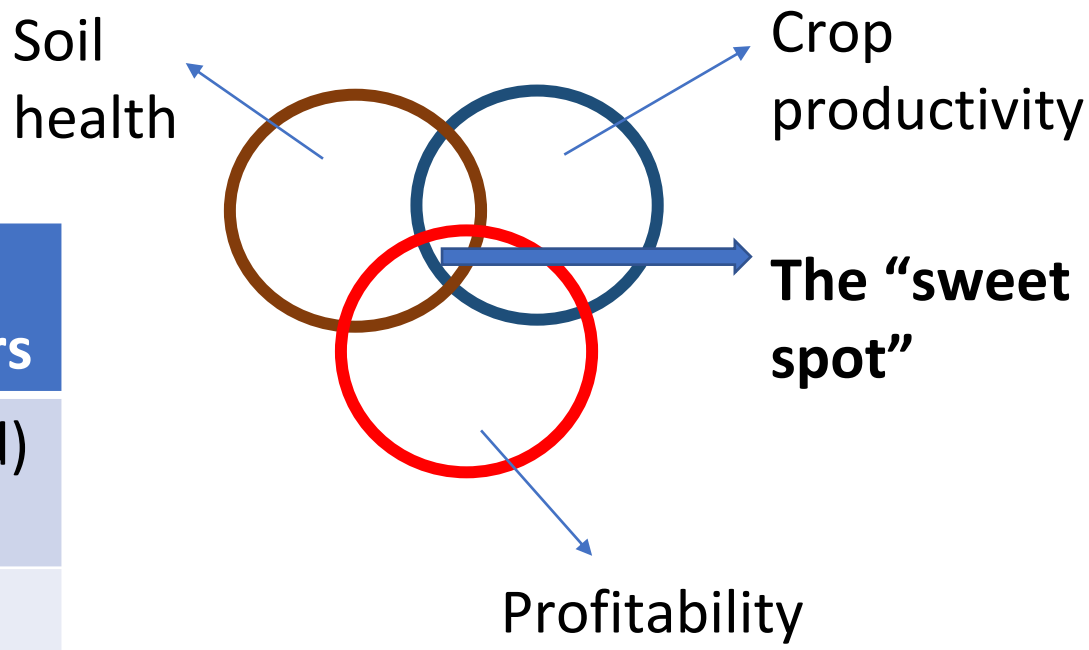
Background

Organic transition:

✓ Opportunities vs. Challenges

Typical organic grain farmers	"Conventional" Maryland grain farmers
Tillage for weed control, making seedbeds	No-till (74% of cropland)
Animal manures, legumes for soil fertility	Strict nutrient management plans, Chicken manure, Cover crops including legumes (41% of the cropland).



Study approach

Four transition strategies that differ in degree of soil disturbance, soil cover and input use intensity.

Treatment 1: Standard organic tillage, cultivation for weeds, maximize harvestable crops, minimal cover crops.

Treatment 2: Reduced-till Medium disturbance. Moderate cover crop intensity and biomass.

Treatment 3: Minimum-till with precision-zoned high biomass diverse cover crops.

Treatment 4: Perennial alfalfa-grass hay, untilled No soil disturbance after initial establishment. Multiple hay harvests per year.

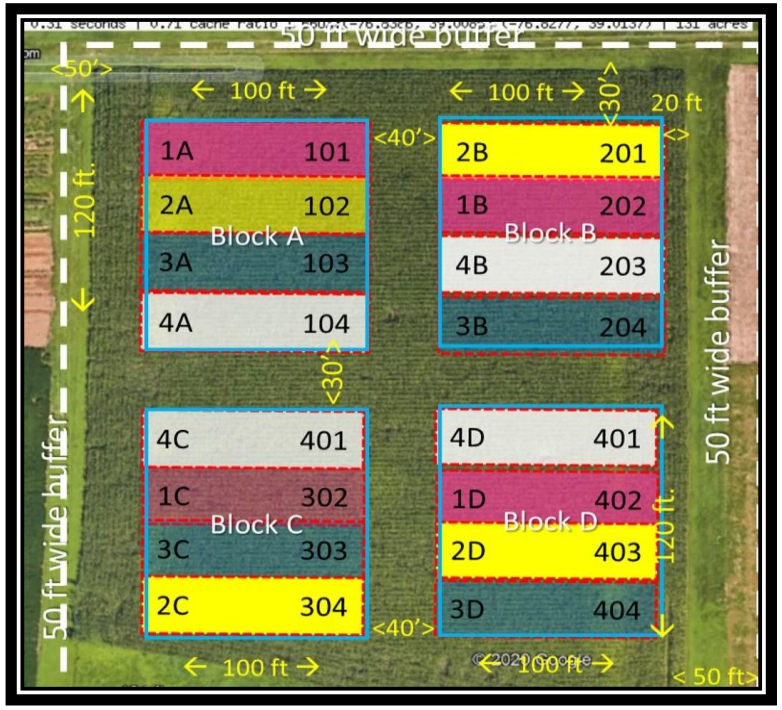
Crop rotation:

Spring oats (2020)- Corn (2021) – Soybean (2022)- Organic certified corn (2023)

Materials and Methods

- Organic transition initiated in Spring 2020 and will be completed in Spring 2023.
- RCBD with 4 replications of each treatment at each study location.

Farm name	Soil description	Individual plot size	Treatments
CMREC (UMD research station)	Moderately well drained sandy loam	100 ft x 30 ft	1,2,3,4
LESREC (UMD research station)	Moderate-well drained silt loam	300 ft x 15 ft	1,2,3,4
Commercial farm – A	Moderate-poorly drained sandy loam	250 ft x 30 ft	1,2,3
Commercial farm – B	Well drained silt loam	150 ft x 60 ft	1,2,3



Experimental plot design at CMREC, Beltsville, MD

Crop Data collection

1) Cover crop biomass, 2) Weed biomass, 3) Stand count, and 4) Crop yield (machine and hand harvest)

1) Cover crop biomass

Trt 1: Cereal rye
Trt 2: Cereal rye + Crimson clover
Trt 3: Cereal rye + Crimson clover + Radish

2 to 3 quadrants (50 cm x 50 cm) per plot

Fall (Before winter kill) and Spring (Before termination) sampling

Drying and biomass calculation

2) Weed Biomass

Sampled at V4-V5 stage of soybean

2 to 4 quadrants (50 cm x 50 cm) per plot

Drying and biomass calculation

3) Plant stand count

10-20 ft rows at 2-3 locations per plot

Hand count

After emergence and during hand harvest

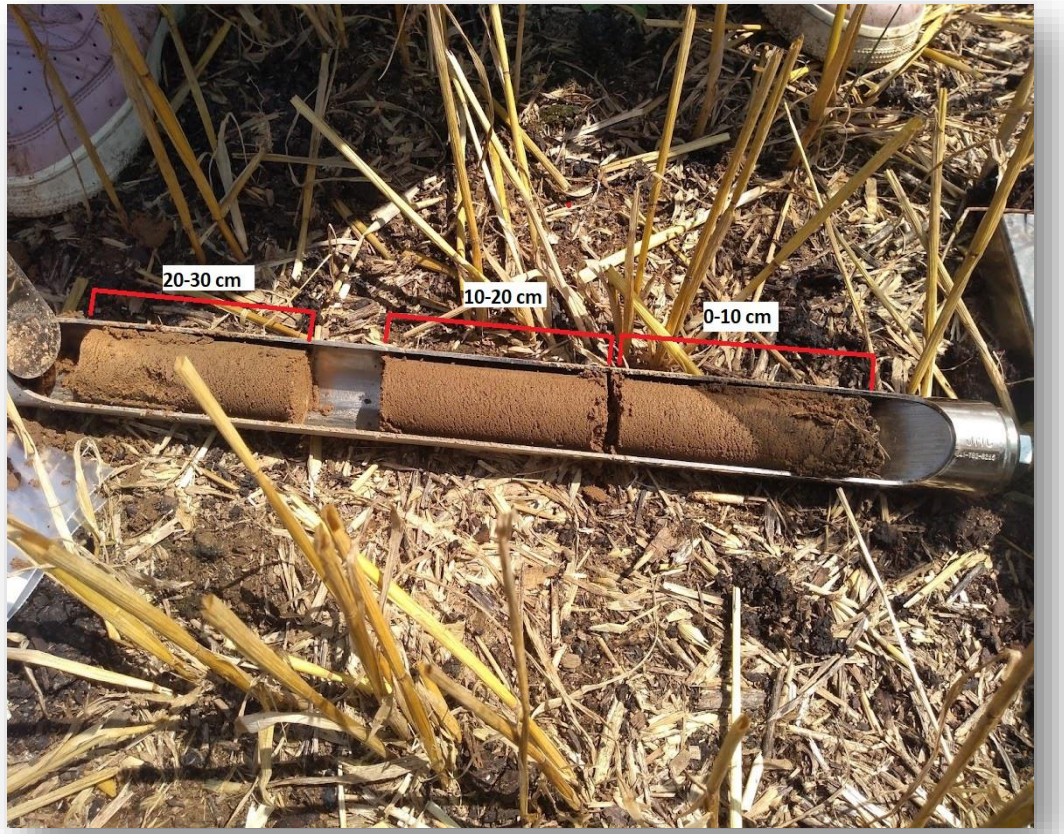
4) Crop yield (machine and hand harvest)

- Hand harvesting prior to machine harvest by calibrated combine yield monitor
- 2 x 10 ft rows per plot
- Cutting → Biomass measurement → Subsampling → Drying → Threshing → Grain weight determination

Soil Health Data collection

1) Soil bulk density, 2) Labile Carbon (POXC)

- **Soil bulk density (Summer-Fall 2020, Fall 2022)**
    - 10 to 12 cores per plot
    - 3.1 cm diameter soil probe
    - Three depths (0-10, 10-20, 20-30 cm)
    - Composite samples



Data collection

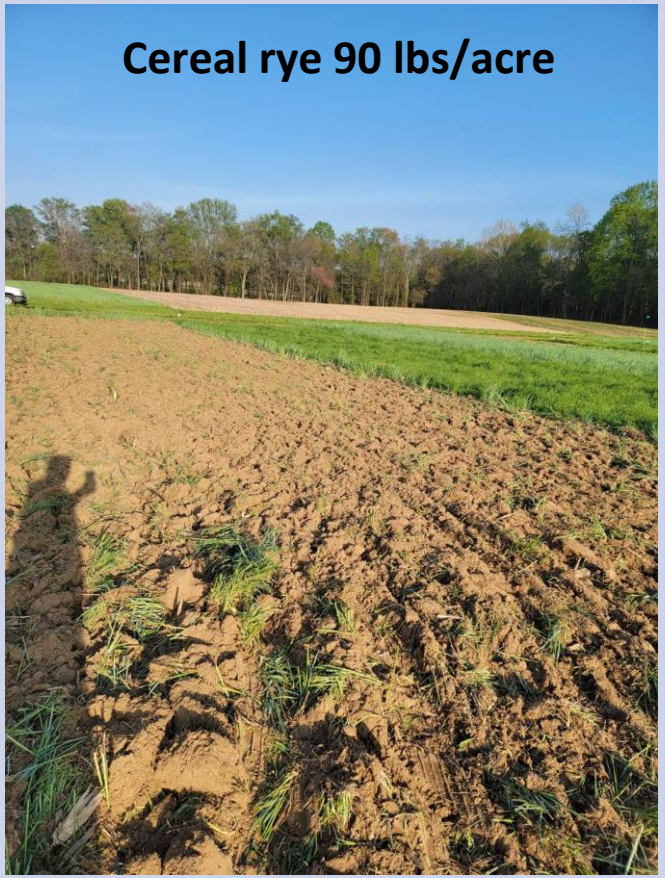
- **Labile soil carbon (Fall-Summer 2020, Fall 2022)**

  - Fraction of soil organic carbon with most rapid turnover times
  - Sensitive indicator of changes in soil quality
  - Permanganate Oxidizable Carbon (POXC) method (Weil et al., 2003)
  - CMREC and Commercial Farm A only

Results

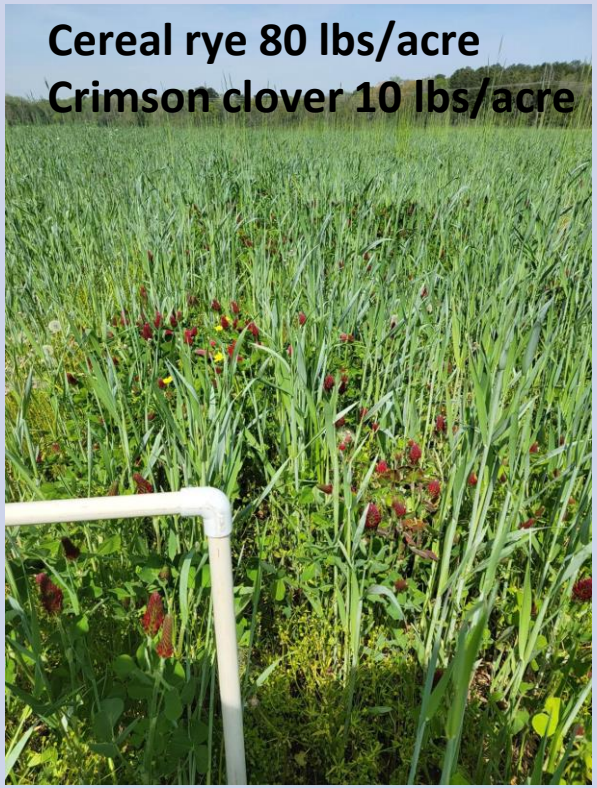
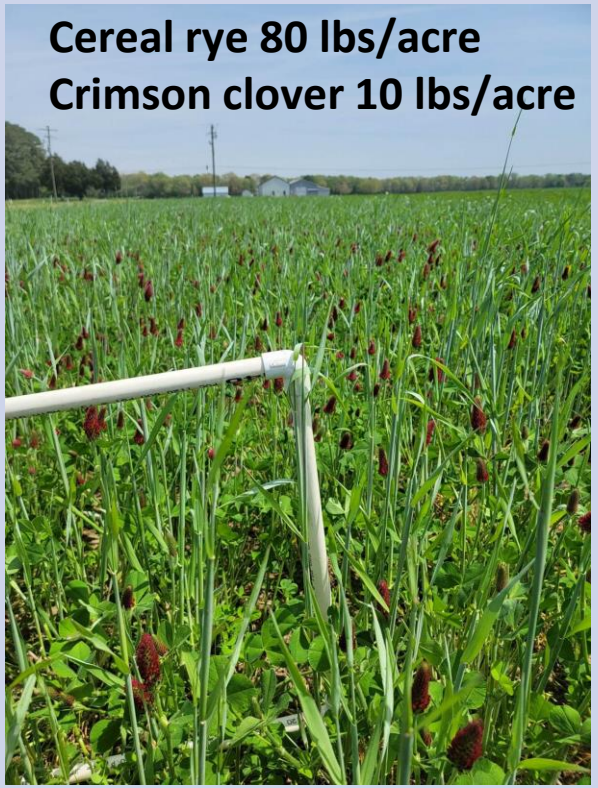
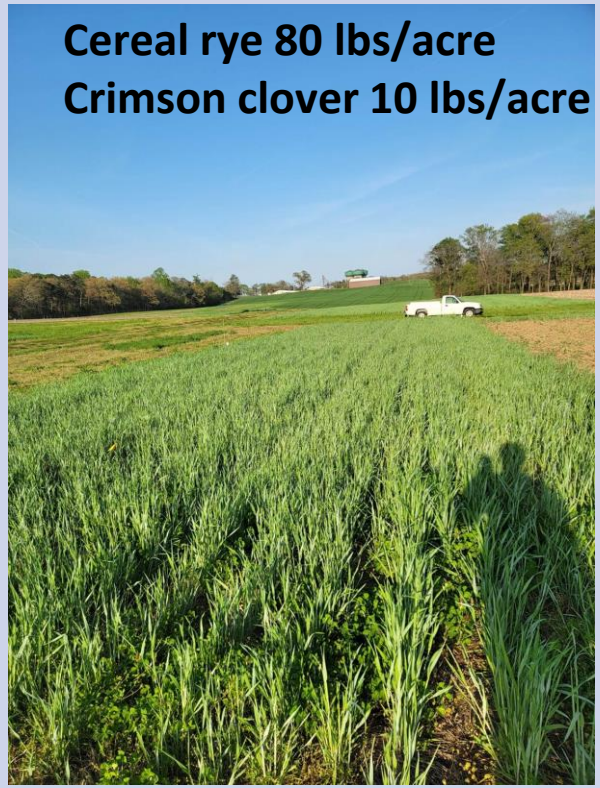
Cover crops in Treatment 1

Farm A	LESREC	CMREC
Pic taken: April 25, 2022 Date terminated: May 1, 2022 Average DM: 790.56 lb/acre	Pic taken: April 25, 2022 Date terminated: April 26, 2022 Average DM: 2014.05 lb/acre	Pic taken: April 25, 2022 Date terminated: April 24, 2022 Average DM: 1065.66 lb/acre
Cereal rye 90 lbs/acre	Cereal rye 90 lbs/acre	Cereal rye 90 lbs/acre



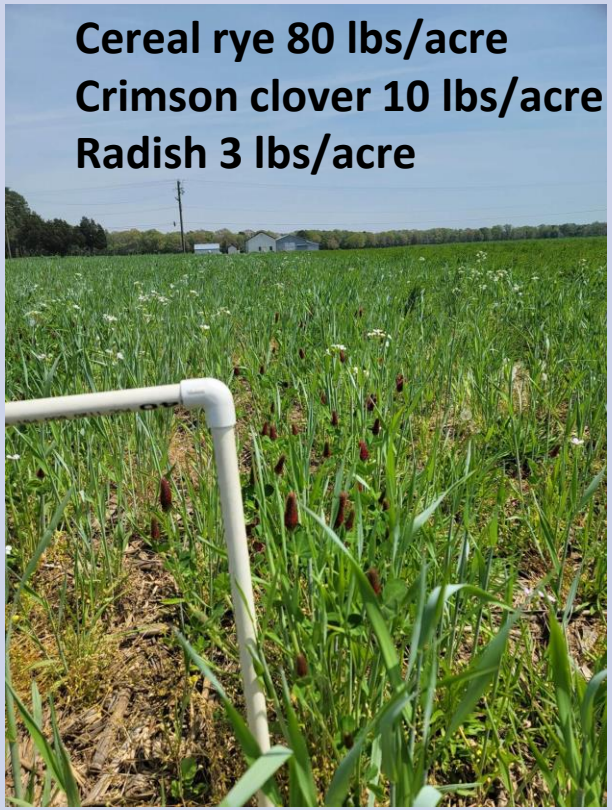
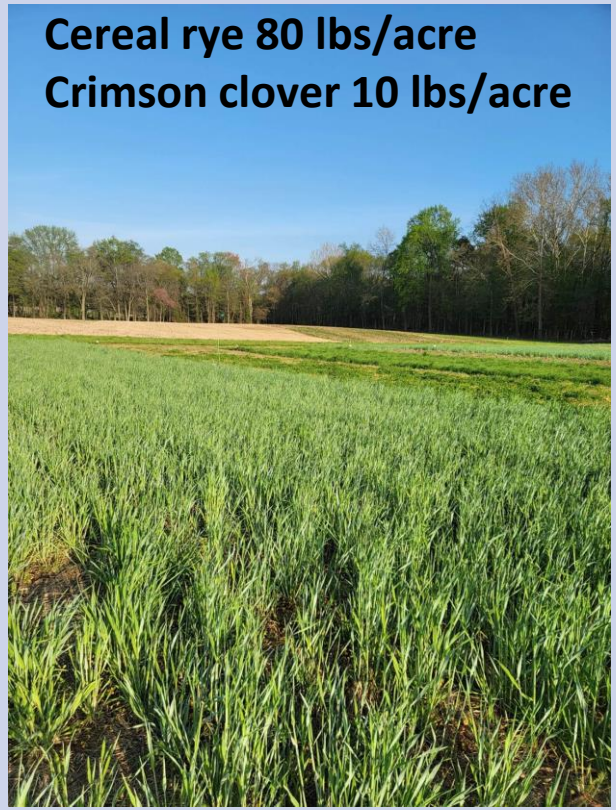
Results

Cover crops in Treatment 2

Farm A	LESREC	CMREC
Pic taken: April 25, 2022 Date terminated: May 27, 2022 Average DM: 7198.02 lb/acre	Pic taken: April 25, 2022 Date terminated: May 23, 2022 Average DM: 8864.03 lb/acre	Pic taken: April 25, 2022 Date terminated: May 17, 2022 Average DM: 5218.36 lb/acre
		

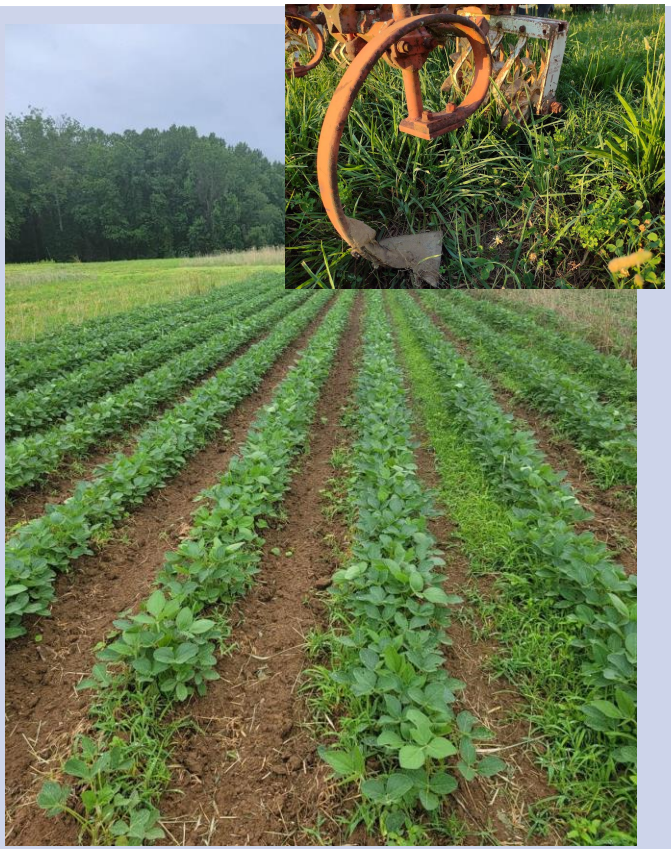
Results

Cover crops in Treatment 3

Farm A	LESREC	CMREC
Pic taken: April 25, 2022 Date terminated: May 27, 2022 Average DM: 5740.78 lb/acre	Pic taken: April 25, 2022 Date terminated: May 23, 2022 Average DM: 7631.71 lb/acre	Pic taken: April 25, 2022 Date terminated: May 17, 2022 Average DM: 4971.81 lb/acre
Cereal rye 80 lbs/acre Crimson clover 10 lbs/acre Radish 3 lbs/acre 	Cereal rye 80 lbs/acre Crimson clover 10 lbs/acre Radish 3 lbs/acre 	Cereal rye 80 lbs/acre Crimson clover 10 lbs/acre 

Results

Soybean plants in Trt 1 (June 2022)

Farm A	LESREC	CMREC
Pic taken: June 15 2022 Planting date: May 25 2022 Cultivated once between rows Disked twice before planting for stale seedbed preparation	Pic taken: June 15 2022 Planting date: May 4, 2022 No cultivation after planting Disked twice before planting for stale seedbed preparation	Pic taken: June 23, 2022 Planting date: May 18, 2022 Cultivated between rows twice Disked twice before planting for stale seedbed preparation
		

Results

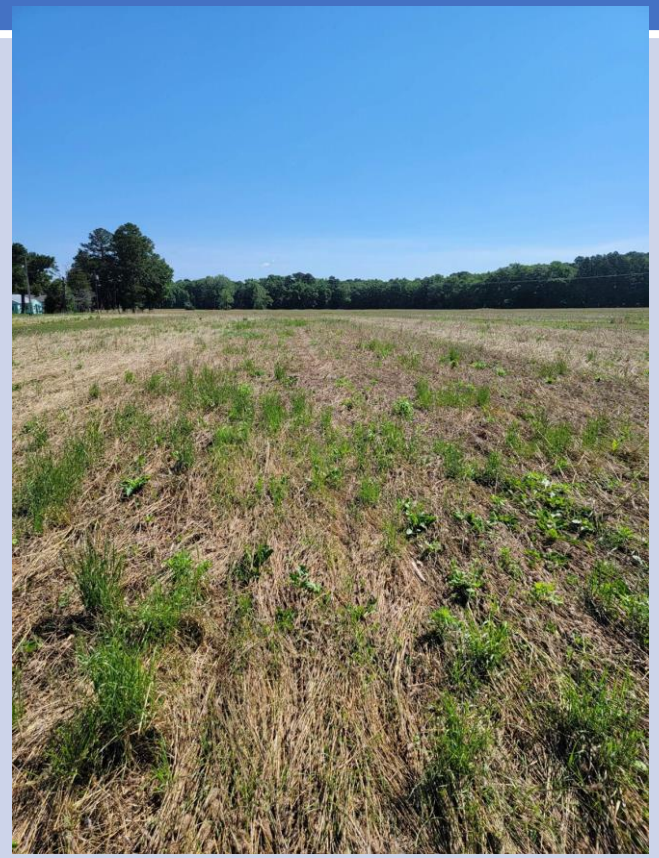
Soybean plants in Trt 2 (June 2022)

Farm A Pic taken: June 15 2022 Planting date: May 30 2022 No cultivation after planting	LESREC Pic taken: June 15 2022 Planting date: May 26, 2022 No cultivation after planting	CMREC Pic taken: June 23, 2022 Planting date: May 18, 2022 No cultivation after planting
		

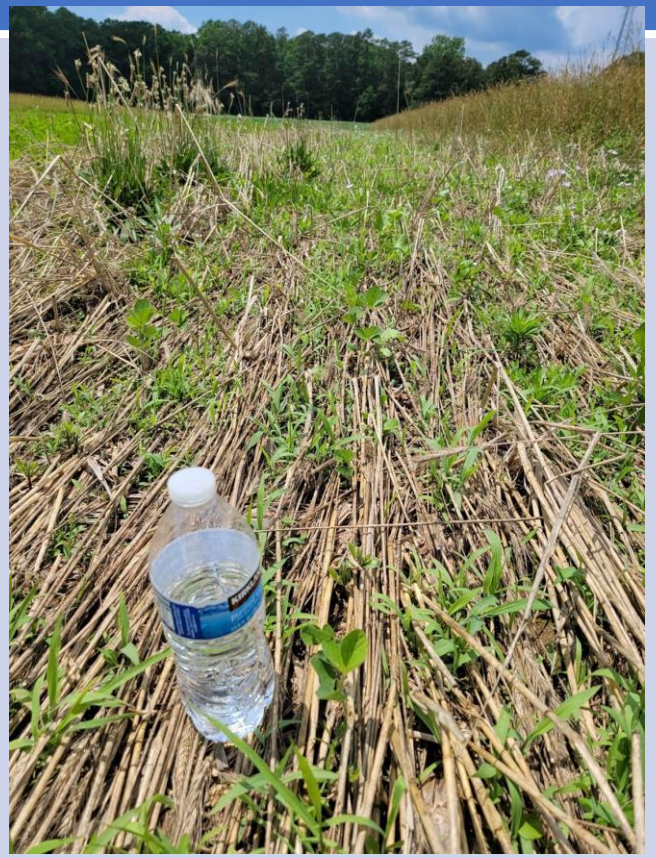
Results

Soybean plants in Trt 3 (June 2022)

Farm A
Pic taken: June 15 2022
Planting date: May 30 2022
No cultivation after planting
Narrow rows (15 inches)



LESREC
Pic taken: June 15 2022
Planting date: May 26, 2022
No cultivation after planting
Narrow rows (15 inches)

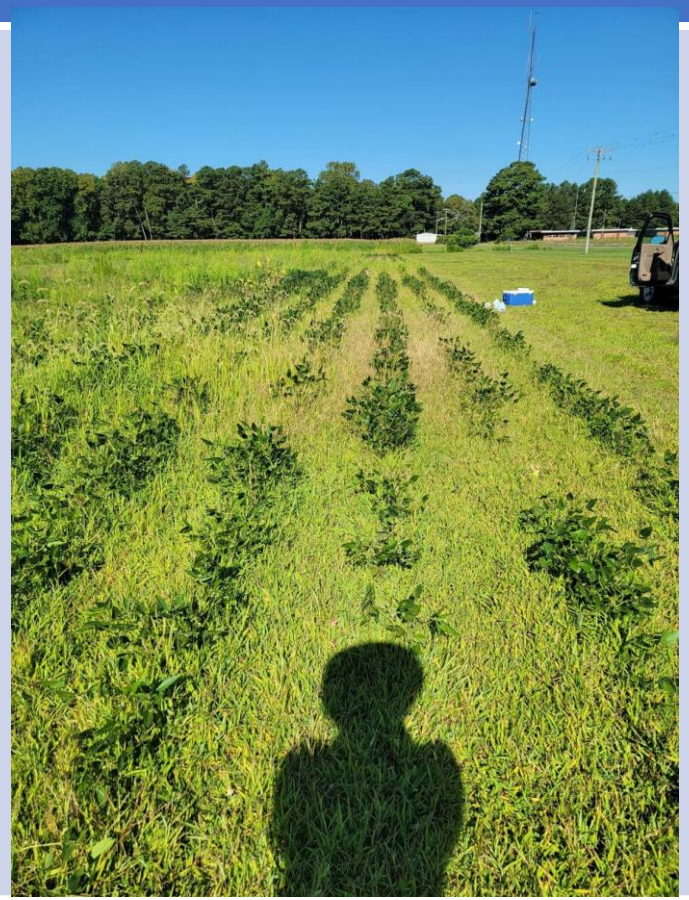


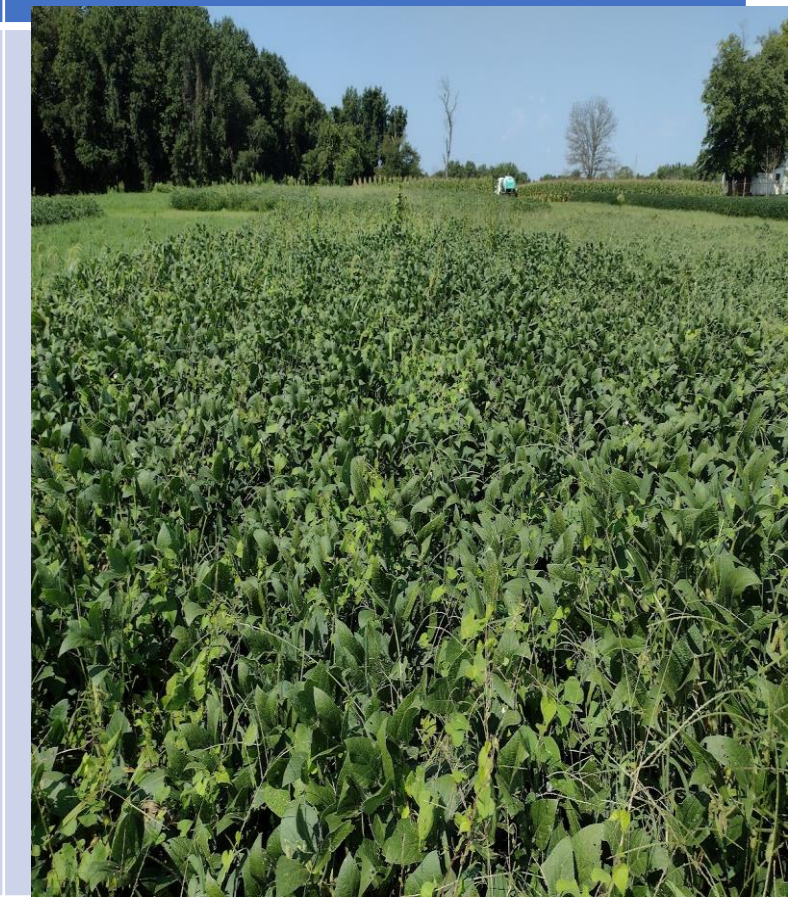
CMREC
Pic taken: June 23, 2022
Planting date: May 18, 2022
No cultivation after planting
Narrow rows (7.5 inches)

Results

Soybean plants in Trt 1 (August 2022)

Farm A	LESREC	CMREC
Pic taken: August 18, 2022 Planting date: May 25, 2022 Cultivated twice between rows Average yield: 54.46 Bu/acre	Pic taken: August 18, 2022 Planting date: May 4, 2022 No cultivation after planting Average yield: 8.56 Bu/acre	Pic taken: Aug 24, 2022 Planting date: May 18, 2022 Cultivated twice between rows Average yield: 77.78 Bu/acre





Results

Soybean plants in Trt 2 (August 2022)

Farm A
Pic taken: August 18 2022
Planting date: May 30 2022
Cultivation once, Weed zapping twice
Average yield: 49.27 Bu/acre

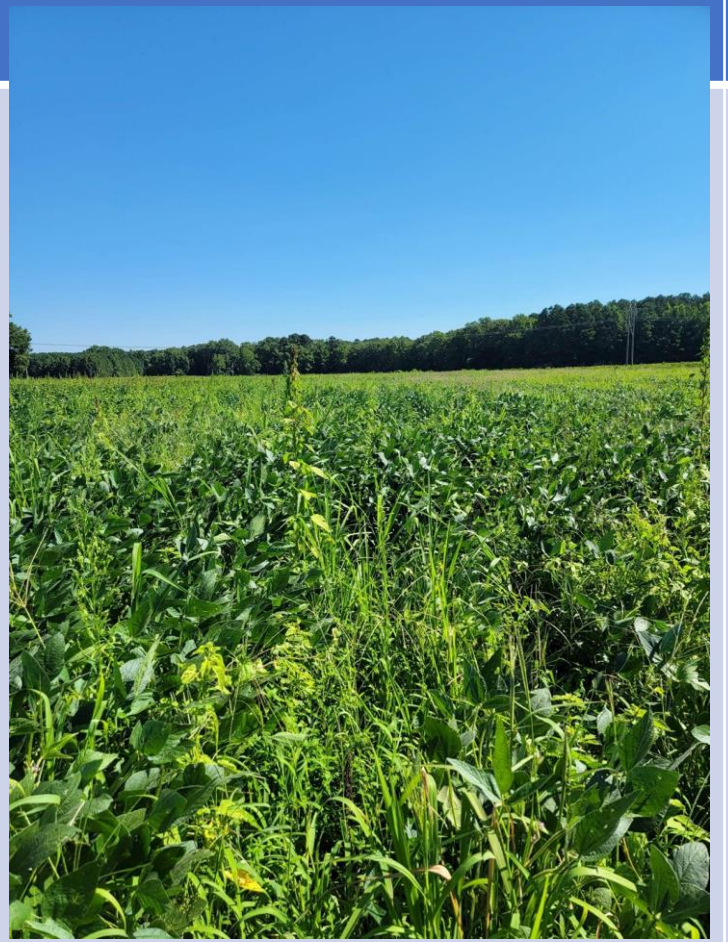
LESREC
Pic taken: August 18 2022
Planting date: May 26, 2022
No cultivation after planting
Average yield: 8.62 Bu/acre

CMREC
Pic taken: Aug 24, 2022
Planting date: May 18, 2022
No cultivation after planting
Average yield: 72.09 Bu/acre

Results

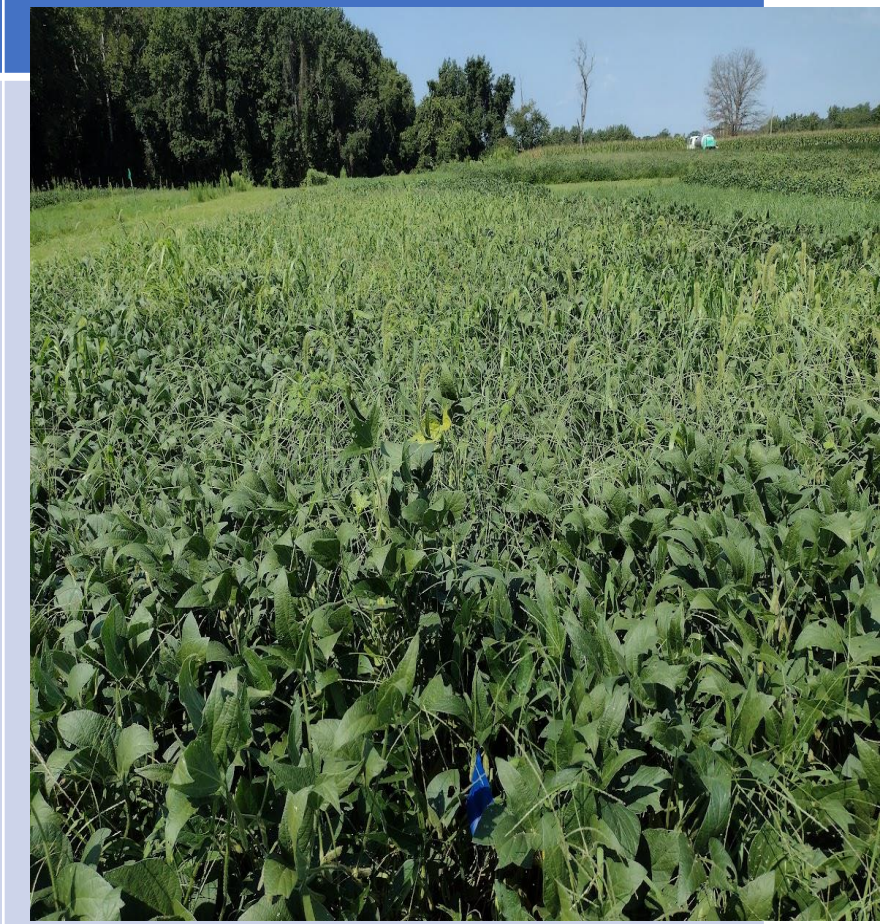
Soybean plants in Trt 3 (August 2022)

Farm A
Pic taken: August 18 2022
Planting date: May 30 2022
No cultivation, weed zapping twice
Average yield: 40.47 Bu/acre

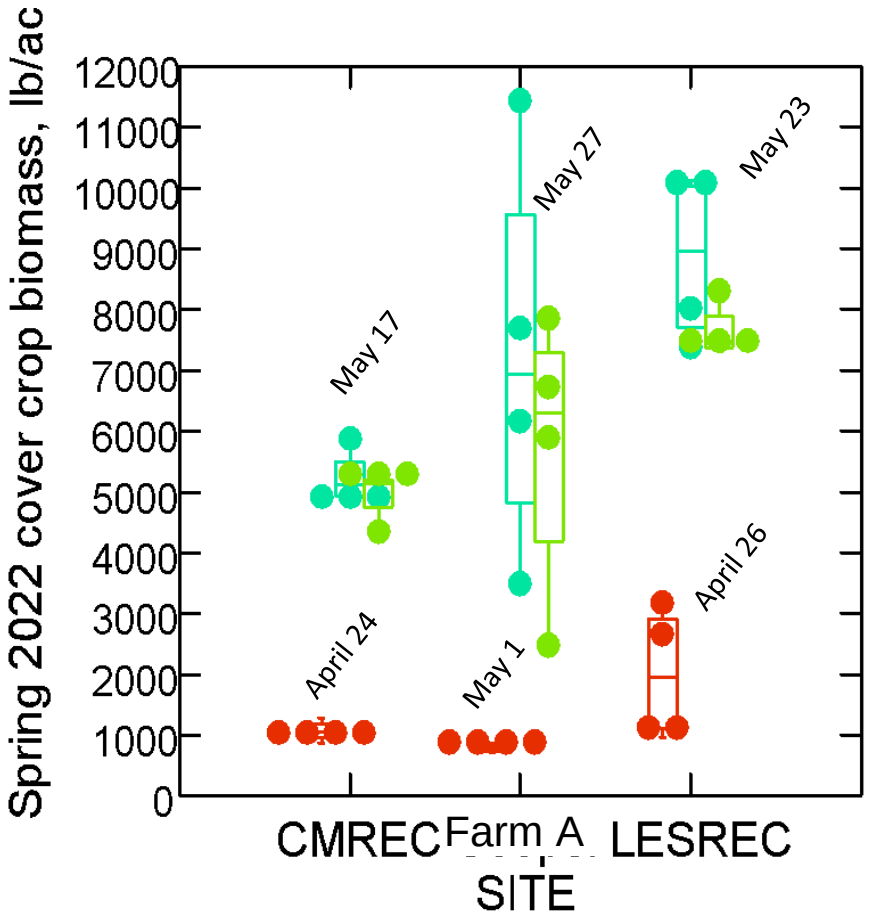


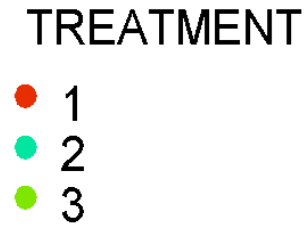
LESREC
Pic taken: August 18 2022
Planting date: May 26, 2022
No cultivation after planting
Average yield: 16.40 Bu/acre

CMREC
Pic taken: Aug 24, 2022
Planting date: May 18, 2022
No cultivation after planting
Average yield: 76.19 Bu/acre

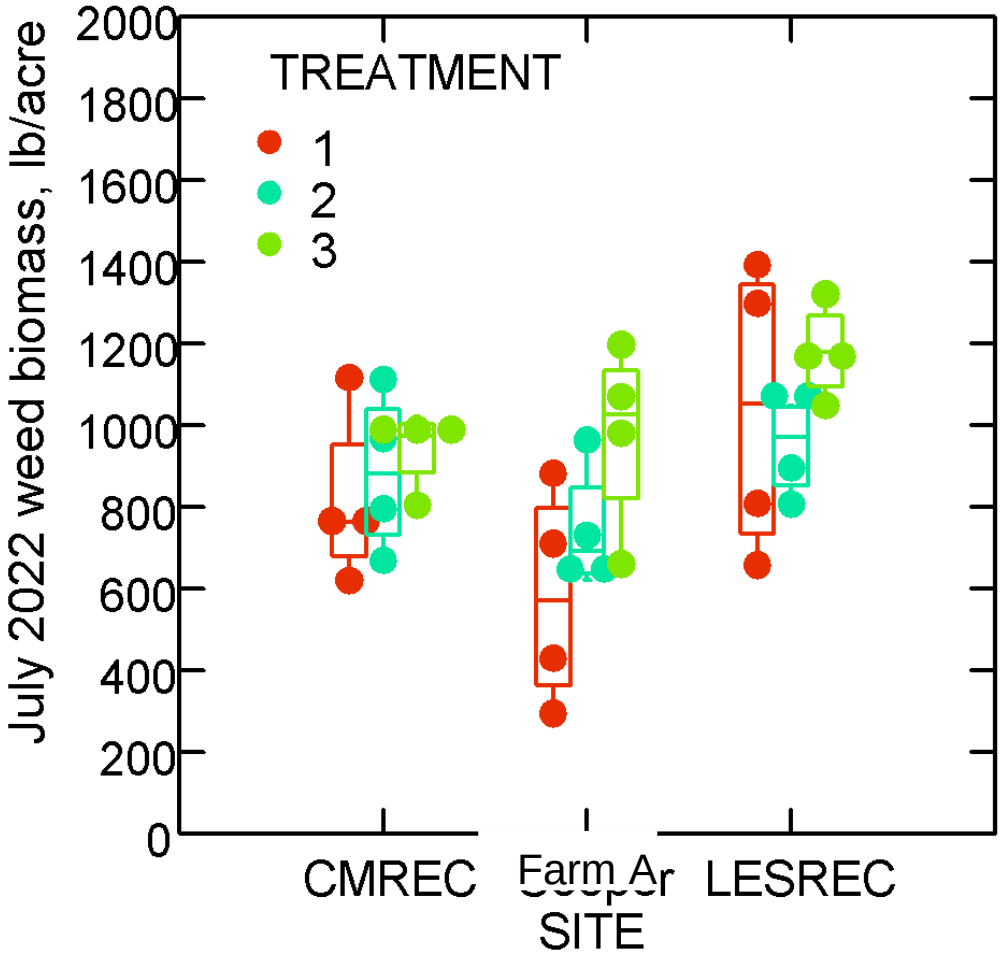


Spring 2022 cover crop biomass at three research sites

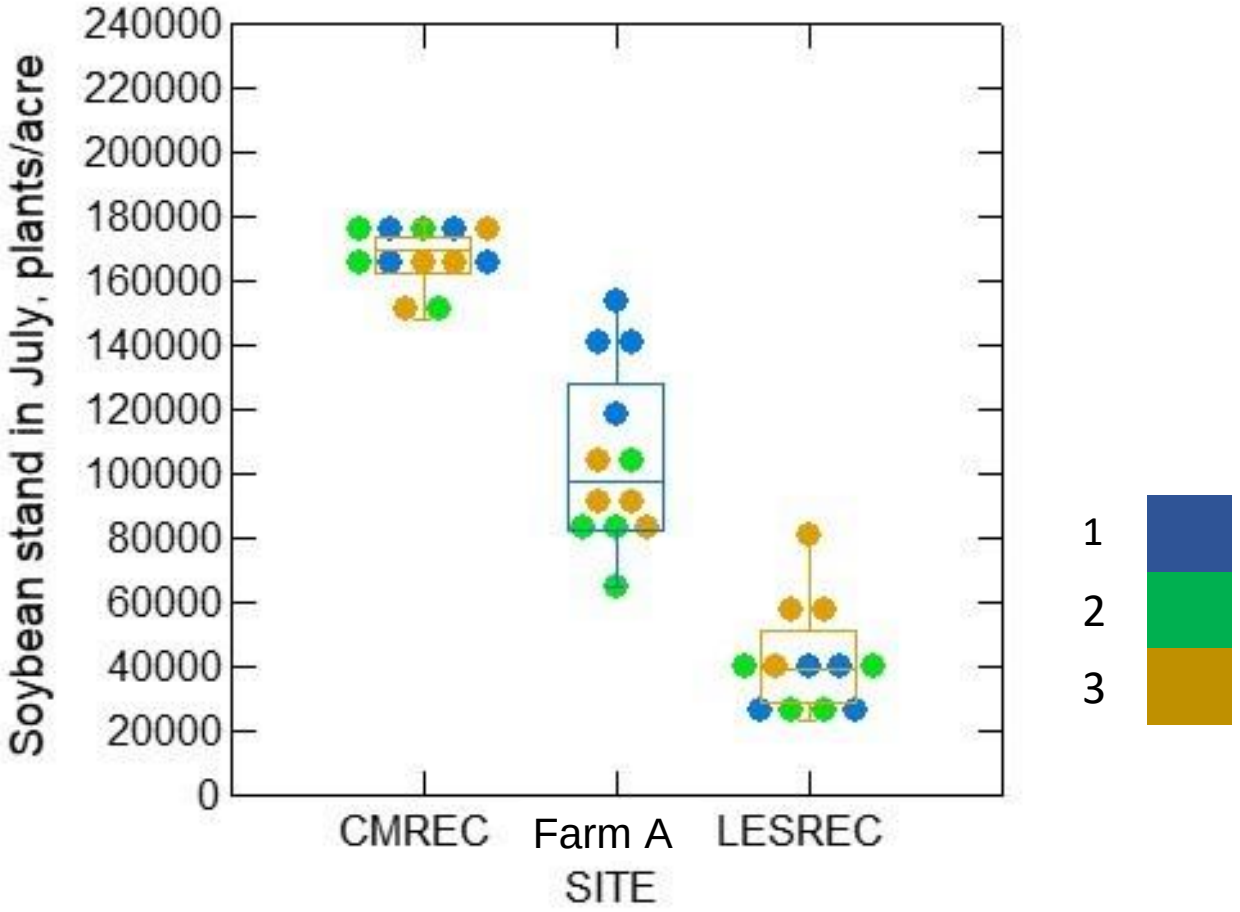




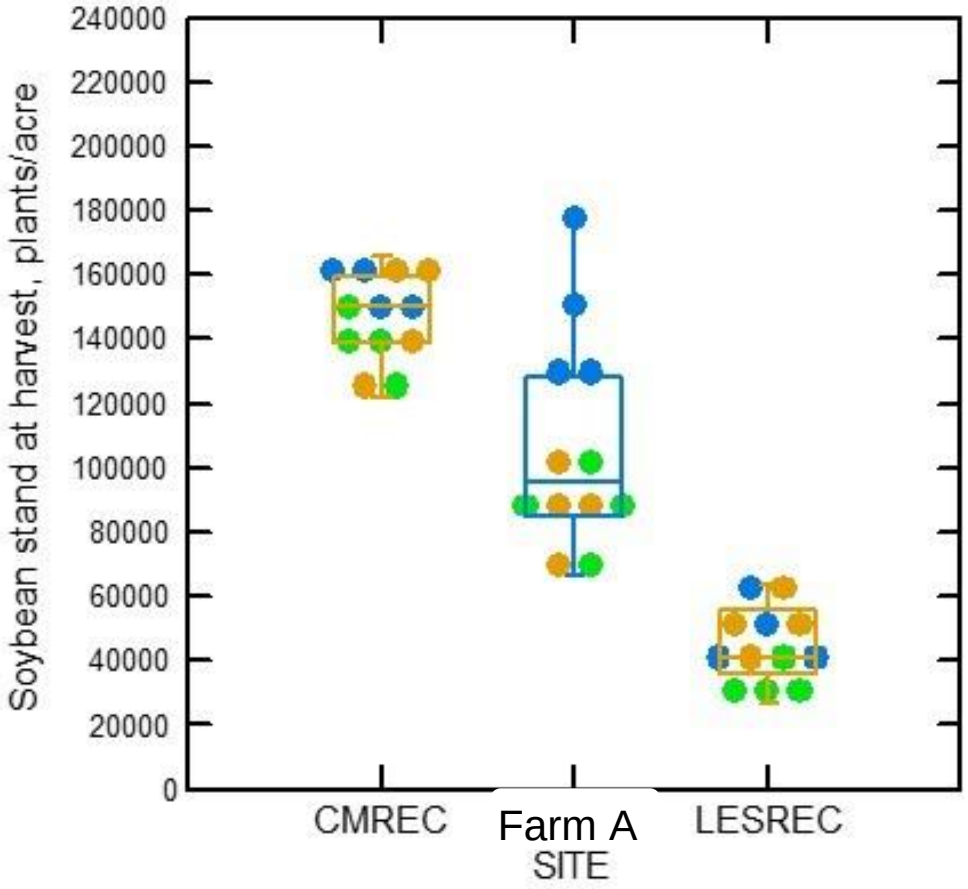
July 2022 weed biomass at three research sites



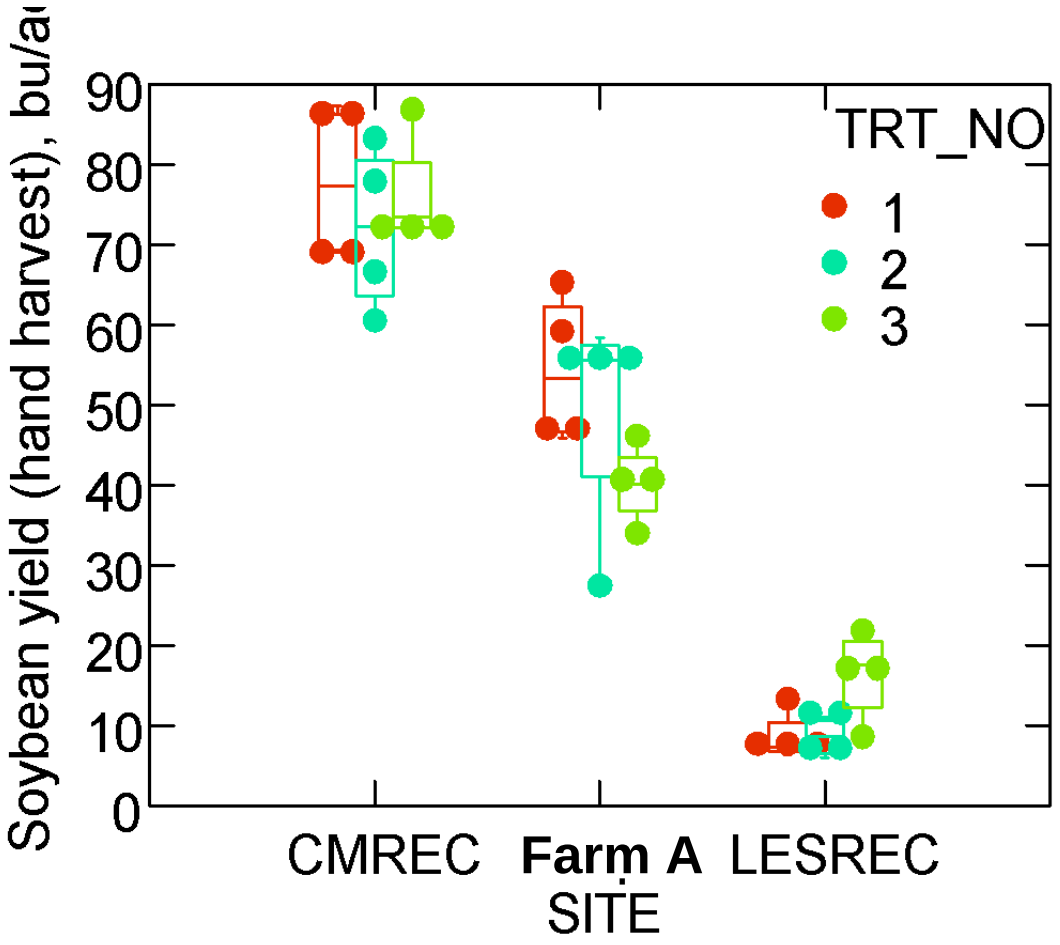
Soybean stand in July (Plants/acre)



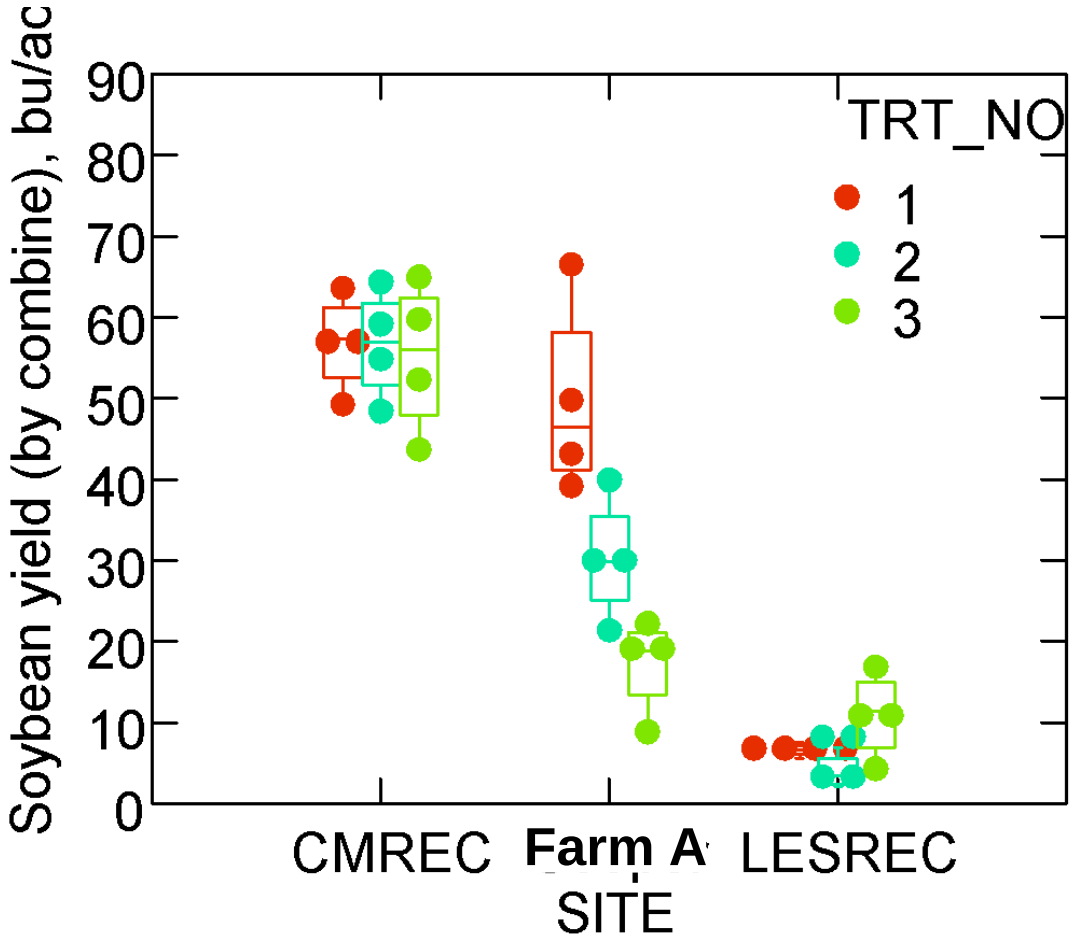
Soybean stand at harvest (Plants/acre)



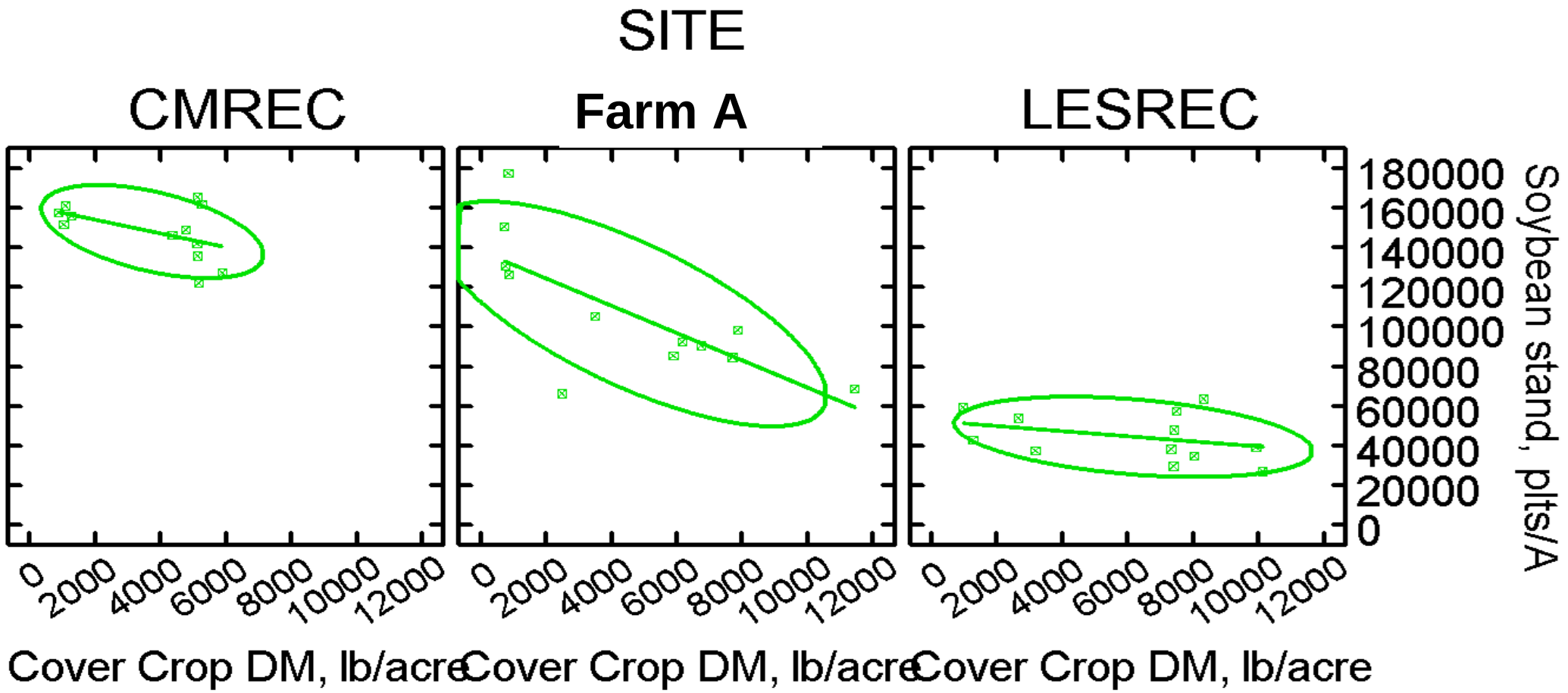
Soybean yield by hand harvest



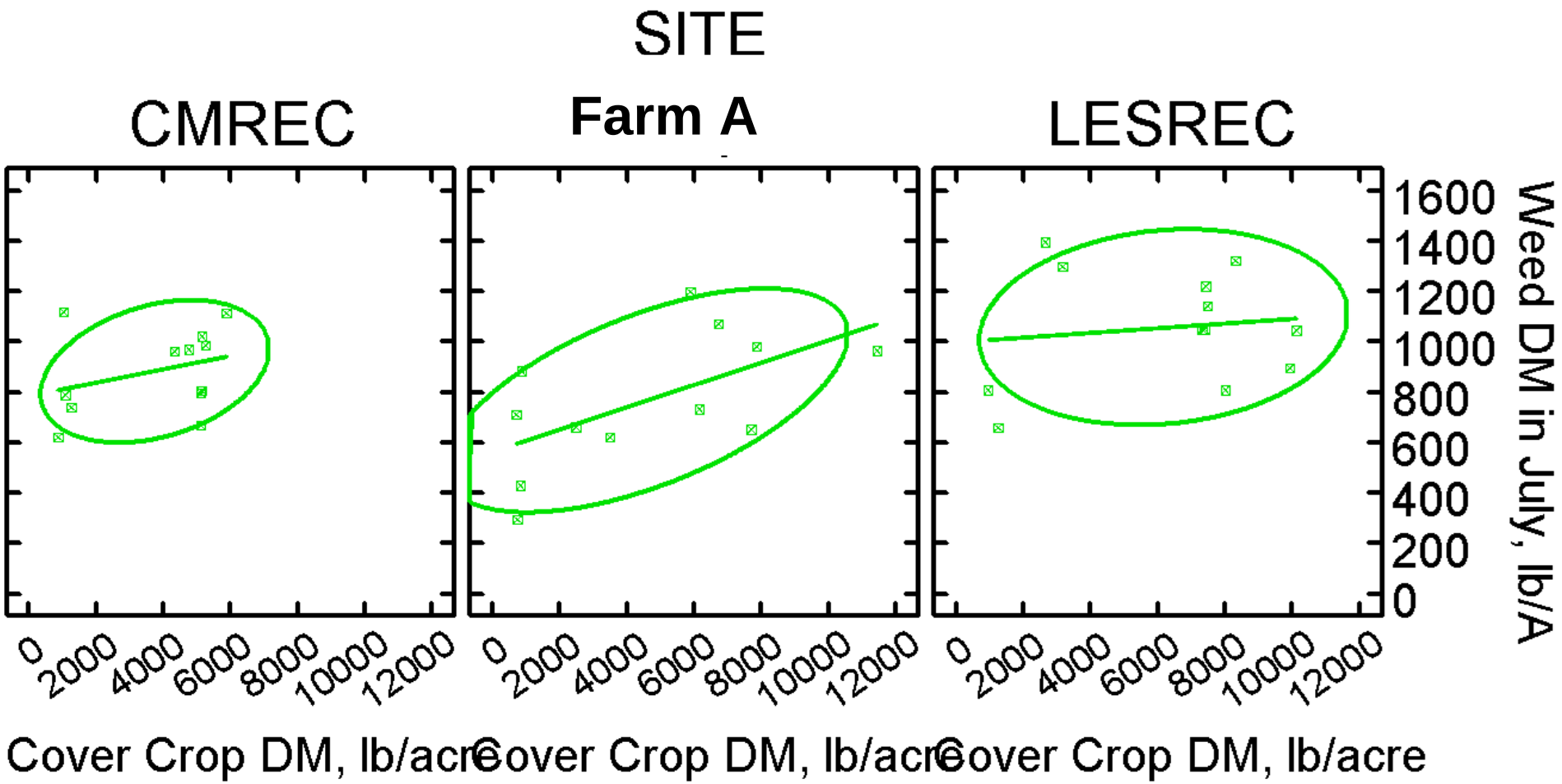
Soybean yield by machine harvest



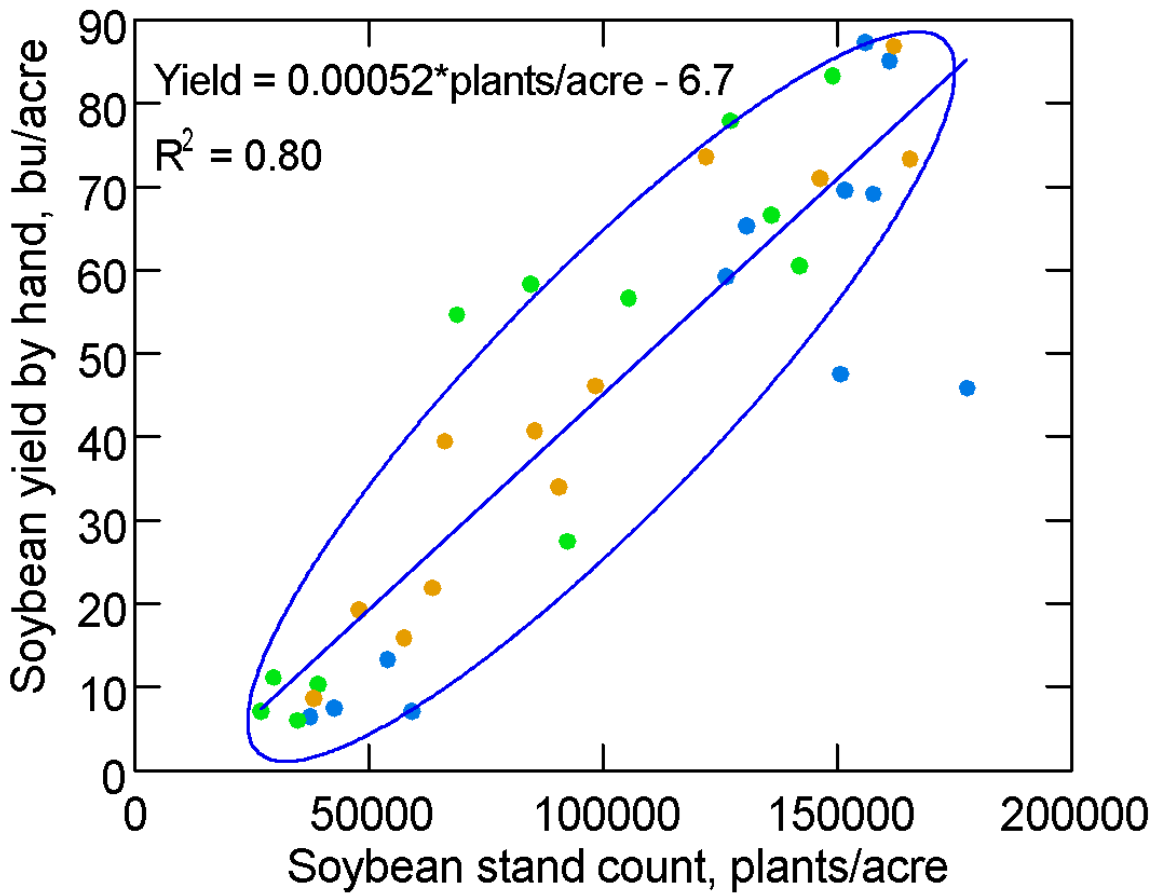
Relationship between soybean stand at harvest vs cover crop biomass



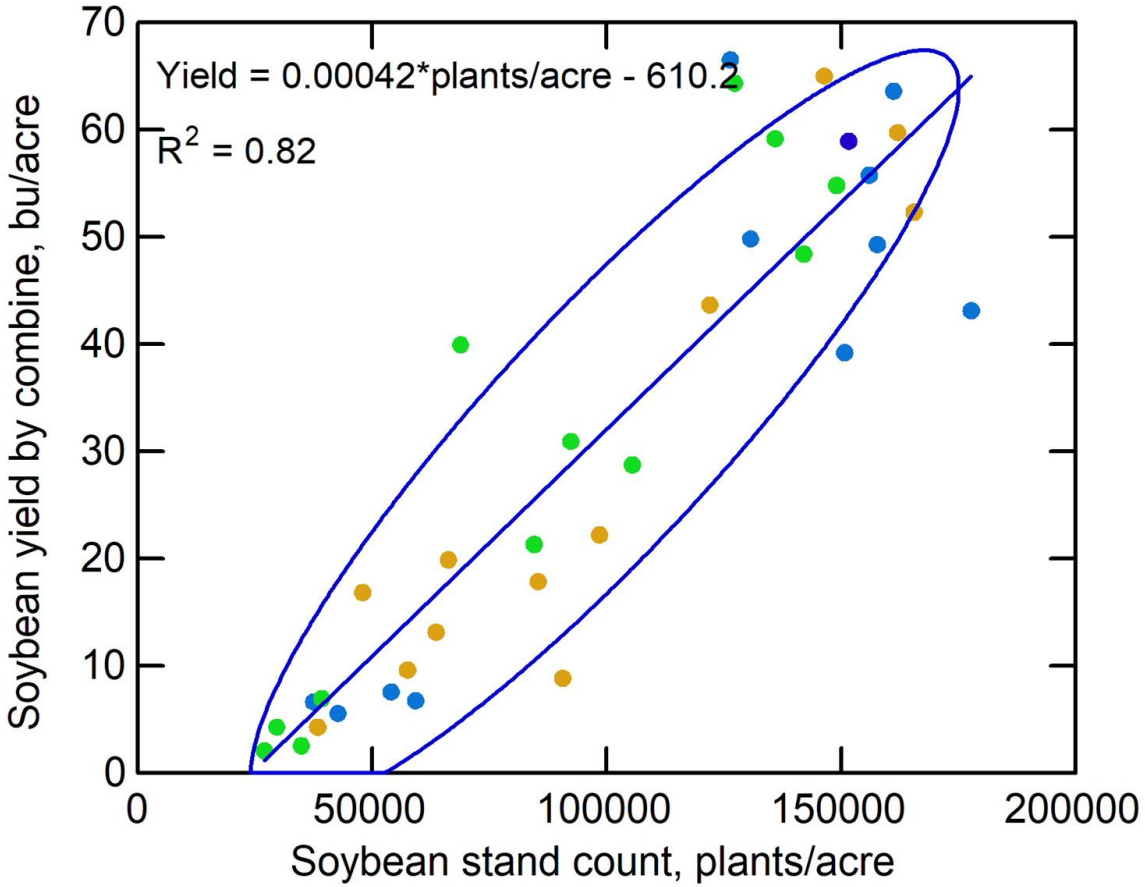
Relationship between weed biomass vs cover crop biomass



Relationship between soybean yield by hand vs soybean stand count



Relationship between soybean yield by combine harvester vs soybean stand count



Soil health results

Soil at CMREC

Soil at Farm A

Results and Discussion

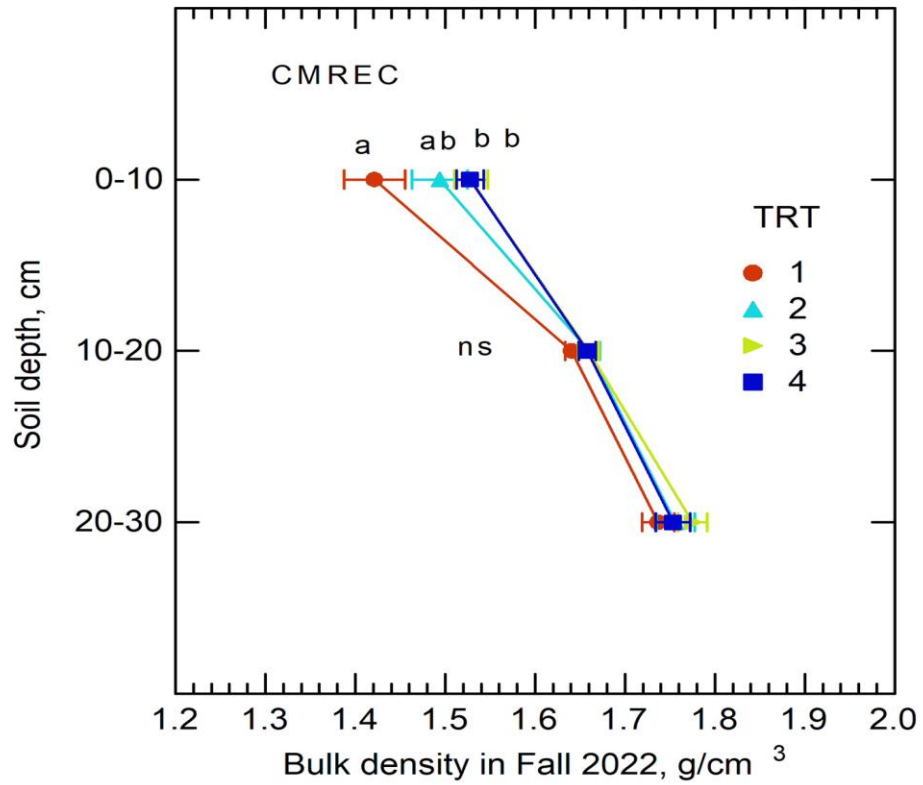
Soil erosion in Trt 1 at CMREC

Winter pea vs henbit root, Spring 2021, CMREC

Results and Discussion

Bulk density

Bulk density vs. soil depth in the four treatments at CMREC



Soil sampling date at CMREC: Aug 5, 2022

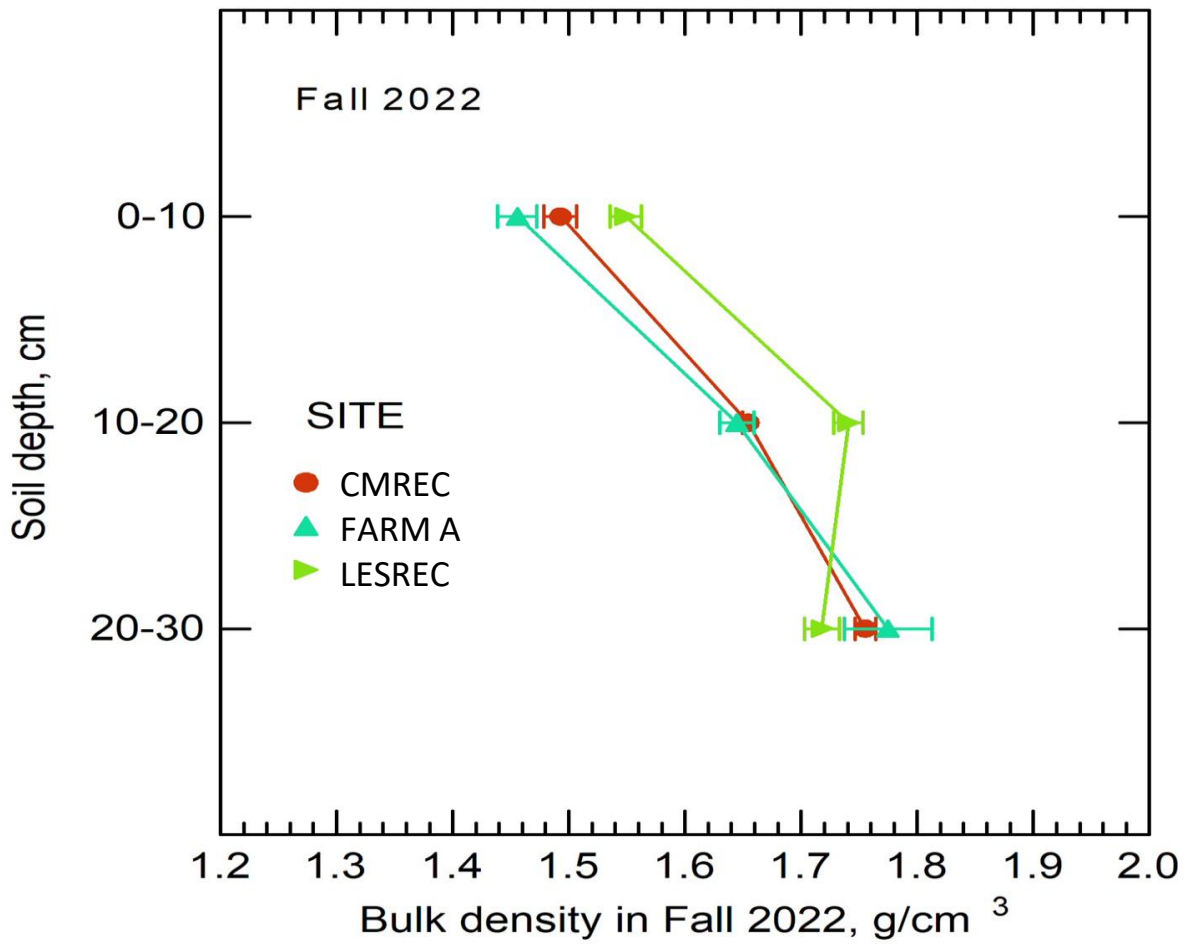
Most recent tillage date: June 25, 2022

✓ No significant difference between treatments at any depth except 0-10 cm at CMREC.
✓ Significant difference in bulk density between the depths.

Results and Discussion

Bulk density

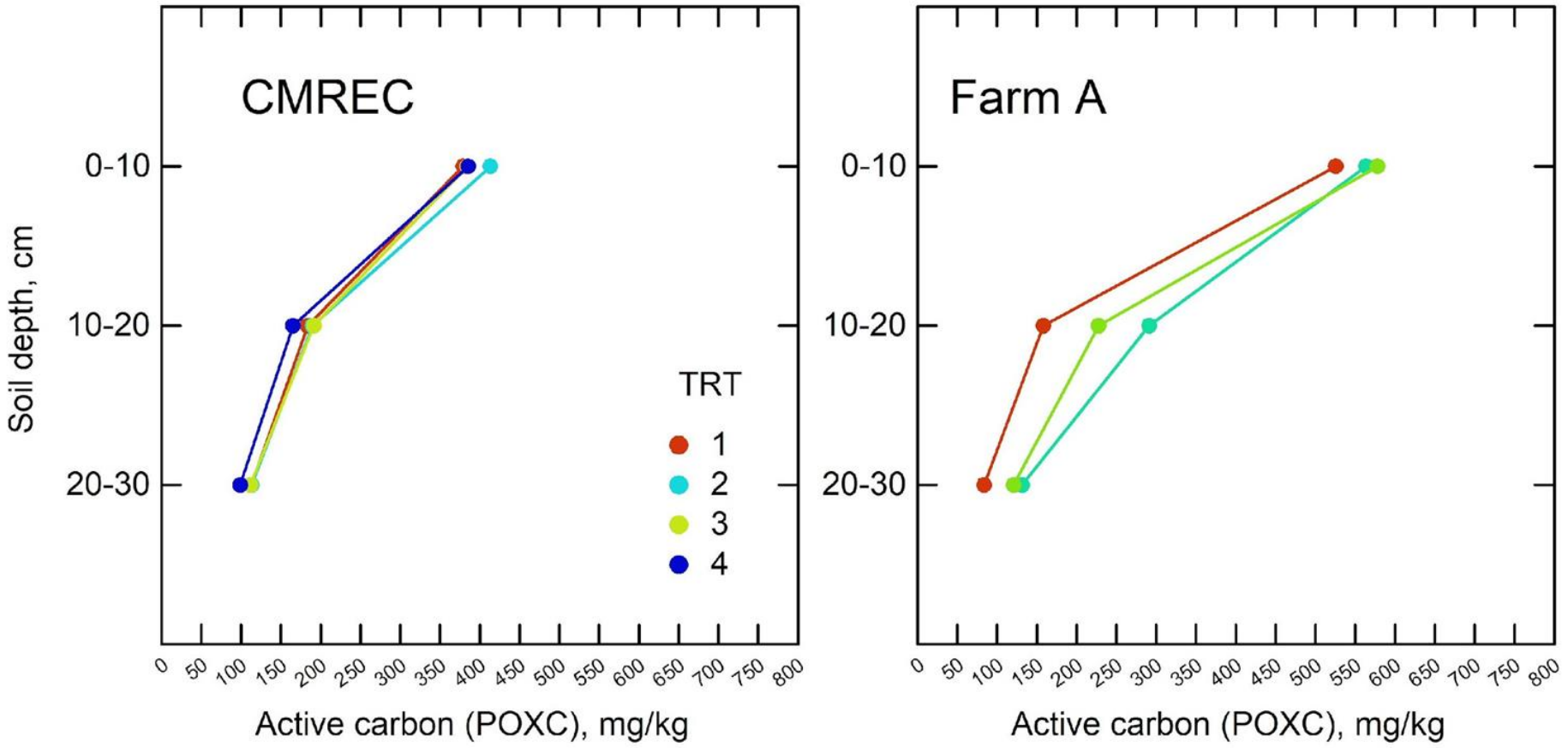
Bulk density vs. soil depth at three sites



✓ Significant difference in bulk density between the depths at all sites.

2. Labile Carbon

POXC vs soil depth at CMREC and Farm A (Fall 2022)



Significant difference between 3 depths at all treatments, Trt 1 significantly lower at Farm A

Future work

- Other soil physical, chemical, and biological properties, Soil Health Index
- Crop productivity
- Farm profitability

Acknowledgement

- USDA/NIFA Award 301326-00001
- NESARE Award GNE2125535383
- Soil quality lab team, ENST, University of Maryland-College Park
- Future Harvest: Chesapeake Alliance for Sustainable Agriculture
- UMD extension, Collaborating research stations and farmers

☺ Thank You! ☺

Cultivator used at CMREC

High residue cultivator

Weed cultivator for leaving cover crop on surface

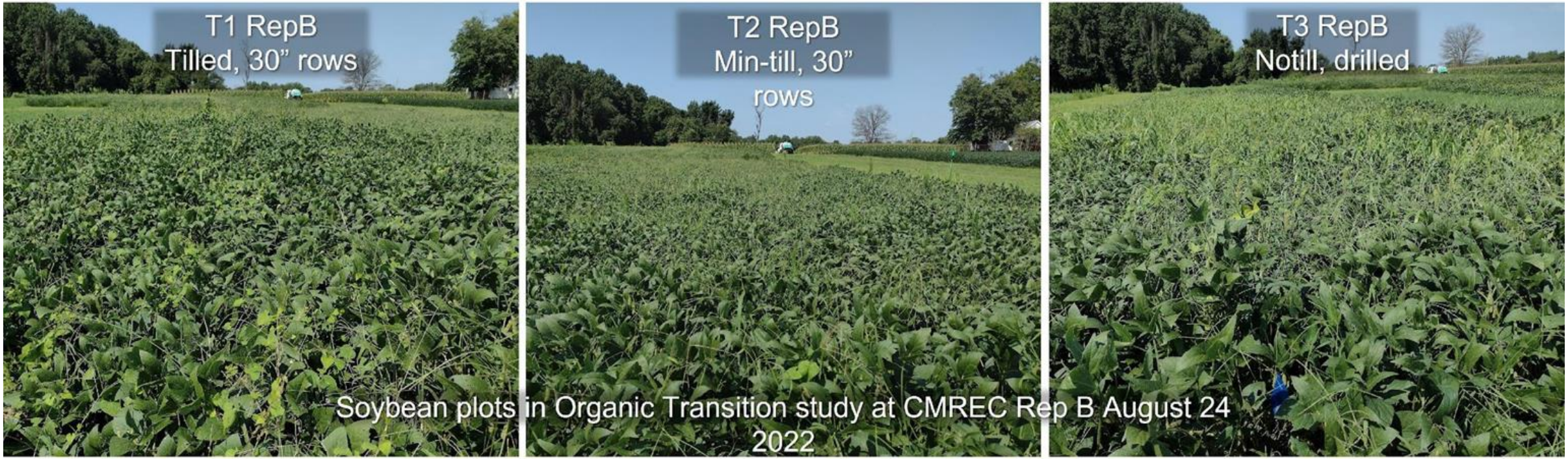
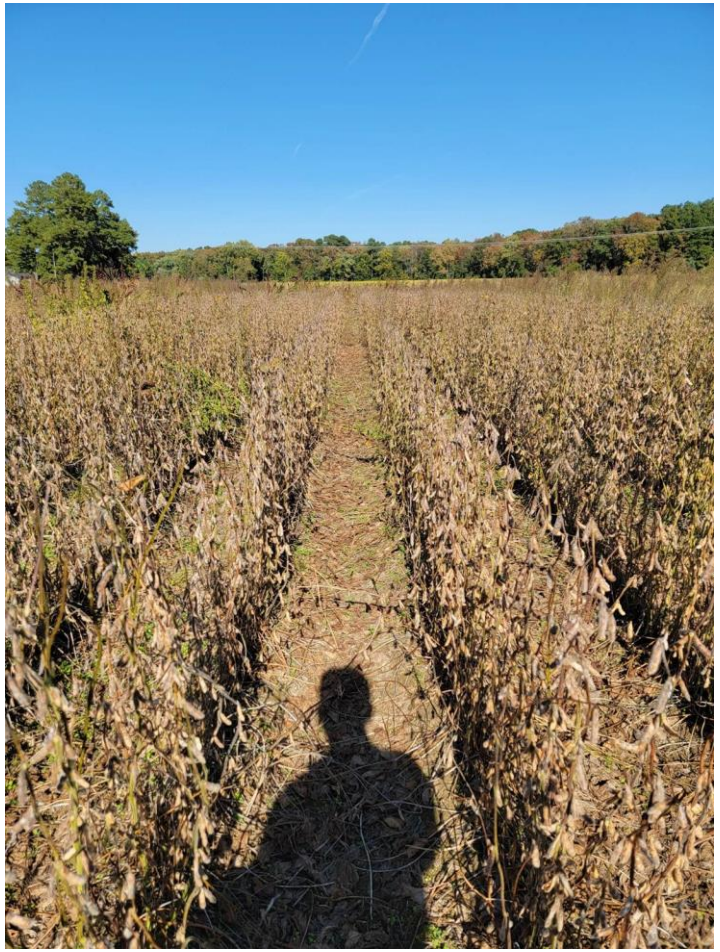


Image credit: Ray Weil

Nearing harvest at Farm A (October 15, 2022)

Trt 1
Planting: May 25, 2022
Disked twice for stale seedbed preparation before planting
Cultivated twice in June



Trt 2
Planting: May 30, 2022
Cultivated once in June
Weed zapping late July and late August

Trt 3
Planting: May 30, 2022
Weed zapping late July and late August

Nearing harvest at LESREC: October 17, 2022

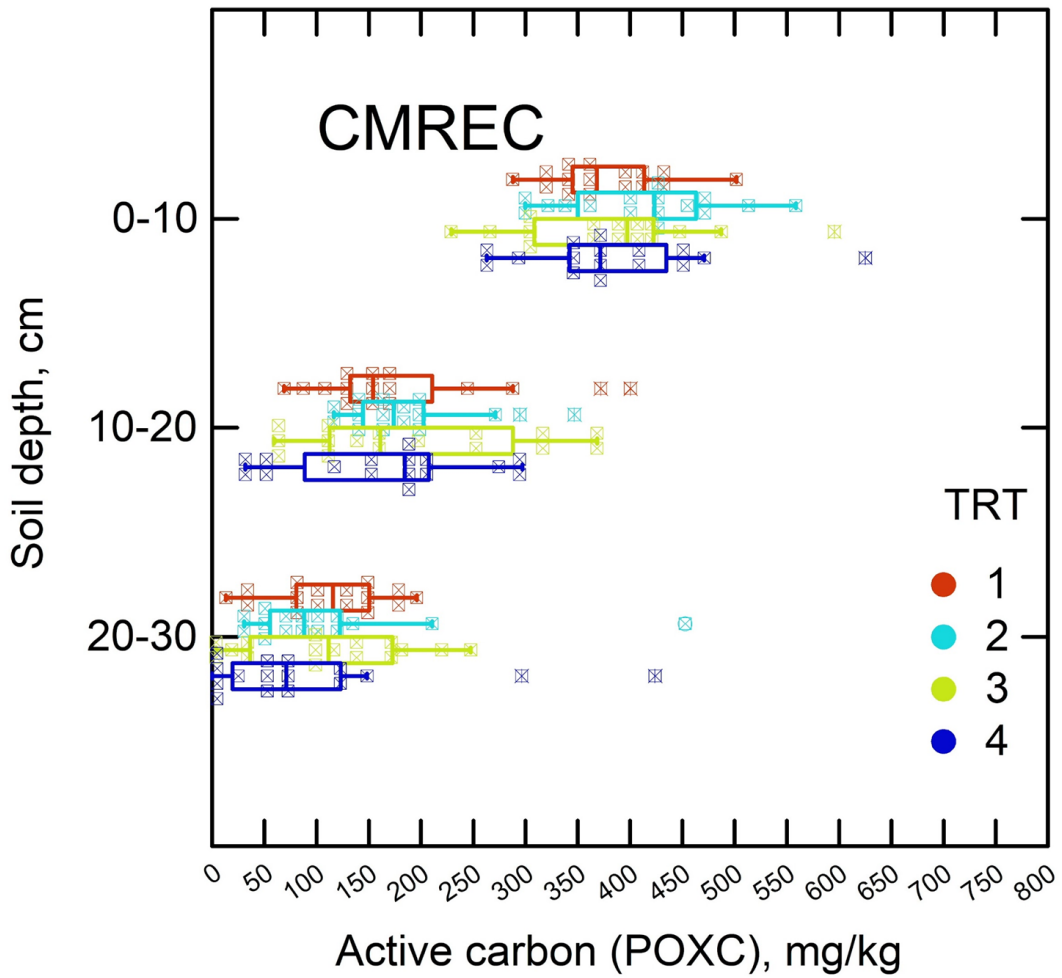
Trt 1
Disked twice before planting for stale seedbed preparation
Planted: May 4, 2022
No cultivation after planting

Trt 2
Planted: May 26, 2022

Trt 3
Planted: May 26, 2022

Winter pea roots early spring 2021

Fall 2022 labile C at CMREC



Fall 2022 labile C at Farm A