EXPERIMENT STATION
College of Agriculture, Forestry and Life Sciences

ANAEROBIC SOIL DISINFESTATION AS A SUSTAINABLE WEED MANAGEMENT PRACTICE IN ORGANIC WATERMELON PRODUCTION IN SOUTH CAROLINA

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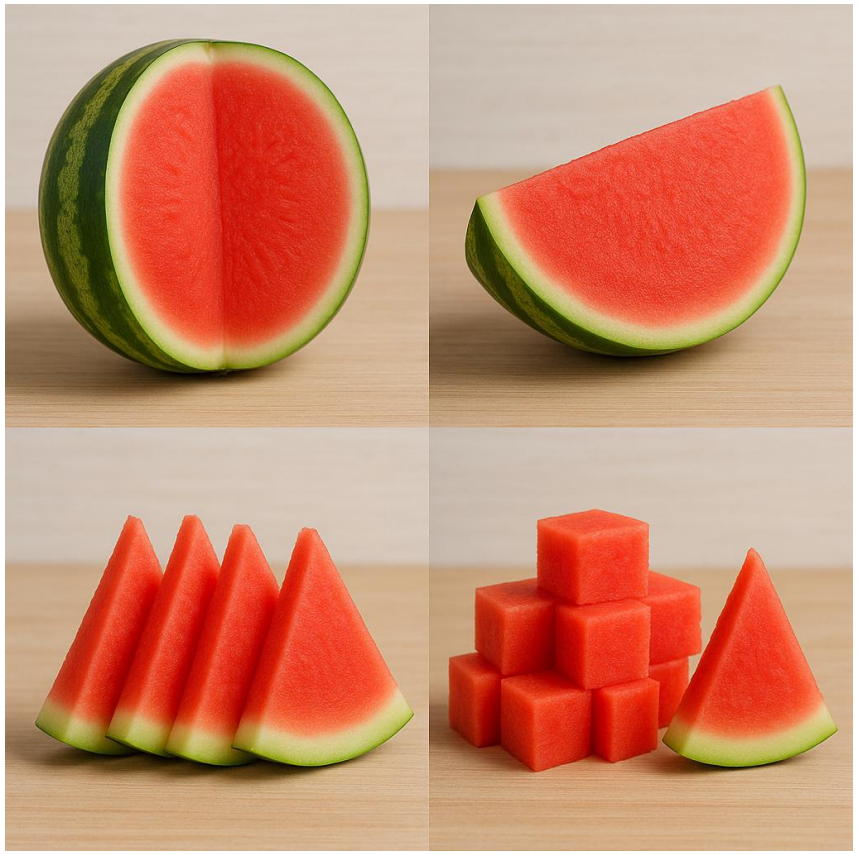
Committee members: Drs. Michael Marshall, Bhupinder Farmaha, William Bridges

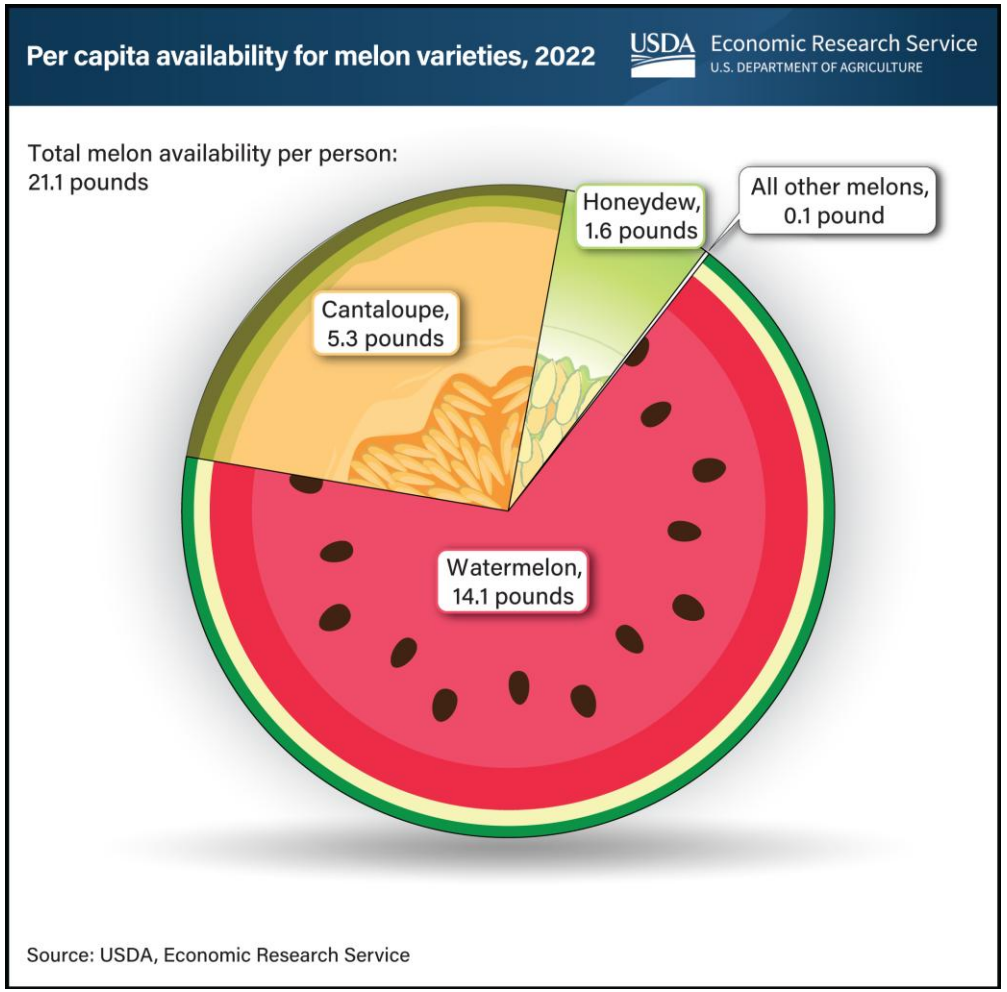
Exit Seminar:06/30/2025

SOUTHERN SARE
Sustainable Agriculture Research & Education
LS22-369

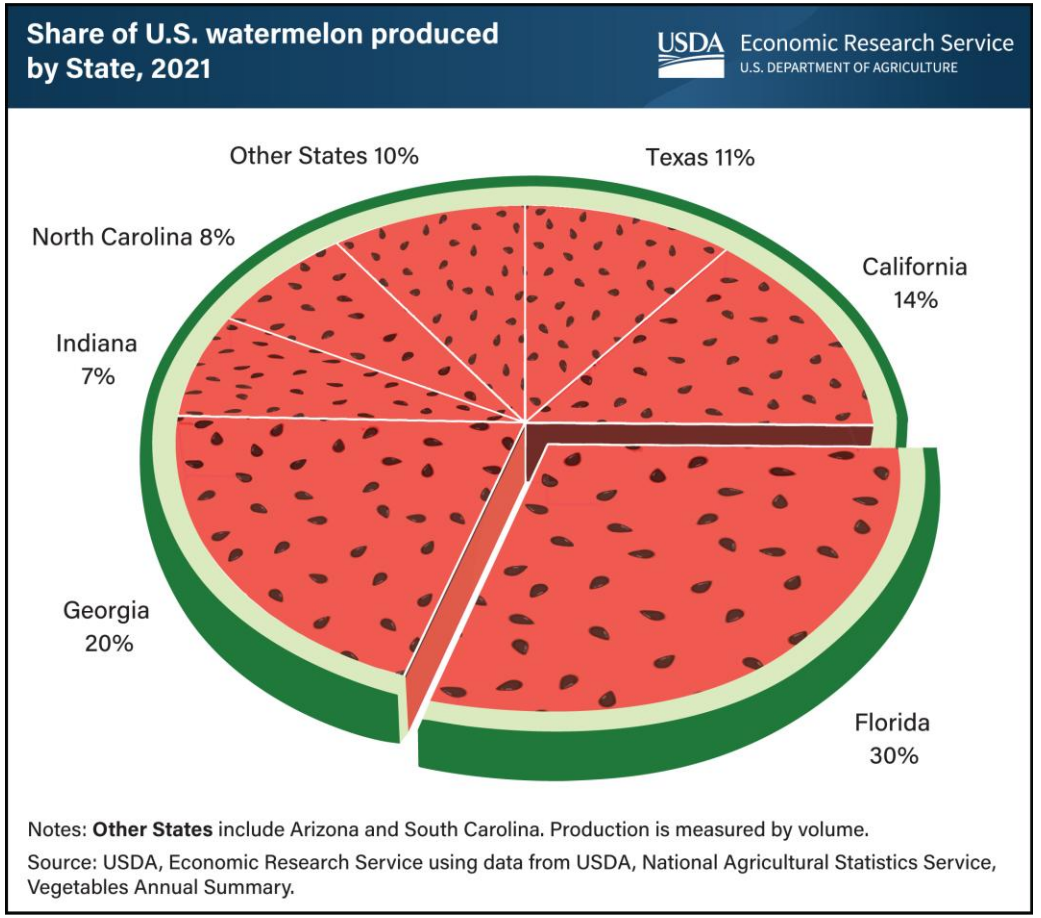


Watermelon production

- Watermelon is commonly grown cucurbit worldwide.
- 100 million tons of watermelon production globally and 1.5 million tons in the United States (U.S.) (FAO, 2021).
- In U.S. watermelon availability per capita recorded as 14.1 pounds/person (USDA, ERS, 2024).
- In past 10 years, watermelon demand has risen due to desirable agronomic qualities inclusive of sweet flavor, hydrated pulp, vibrant color, presence of antioxidant and amino acids (Perkins-Veazie et al., 2012; Petrou et al., 2013).



- South Carolina produced 122 million pounds in 2023 (USDA, NASS, 2024).
- Approximately, 1,828 acres of organic watermelon harvested in 2021 (USDA, NASS, 2021)
- 7% of organic watermelon produced in Southeastern U.S. (USDA, 2016).
- Since 2007, organic watermelon sales increased more than 80% and wholesale price is twice of conventional watermelon (USDA, 2014).



Major issues in watermelon production

- Soil-borne diseases and weed pose a serious threat in both organic and conventional watermelon (Macdonald, 2000).
- Polyethylene plastic mulch is commonly used in watermelon production to prevent weeds emergence (Buker et al., 1998).
- Yellow nutsedge (*Cyperus esculentus* L.) is a major pest in Southeastern plasticulture vegetable production systems (Van Wychen, 2016).
- Plant populations of 2 and 17 plants m^{-2} of yellow nutsedge decreased watermelon yield by 10 and 40%, respectively (Buker et al., 2003).

Current weed management practices in organic production

Organic herbicides

Hand weeding

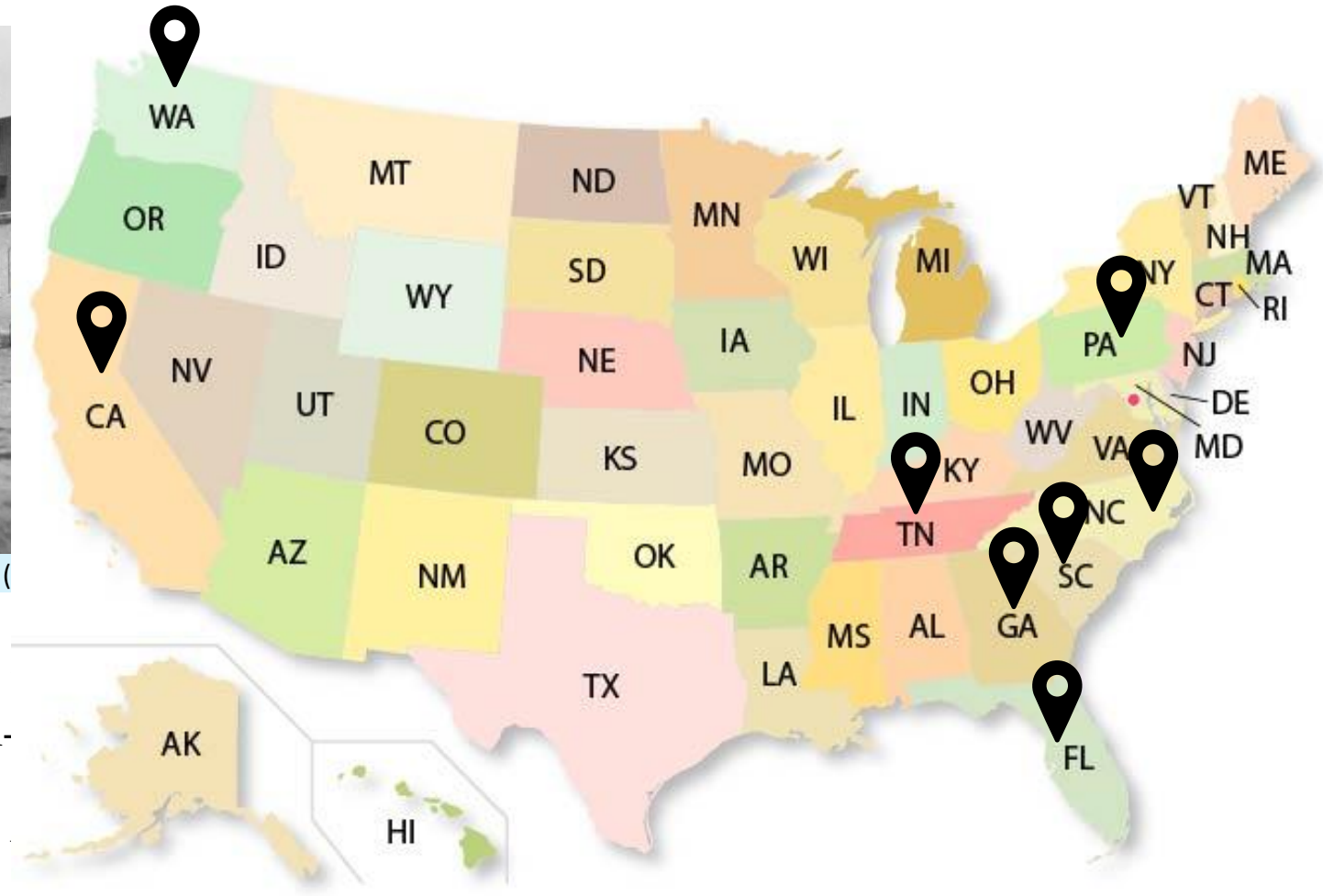
Soil solarization

Stale bed technique

Silage Tarp

Anaerobic soil disinfestation: history

1944-45 Wieringermeer flood (



- In The Netherlands, flooding controlled soil-

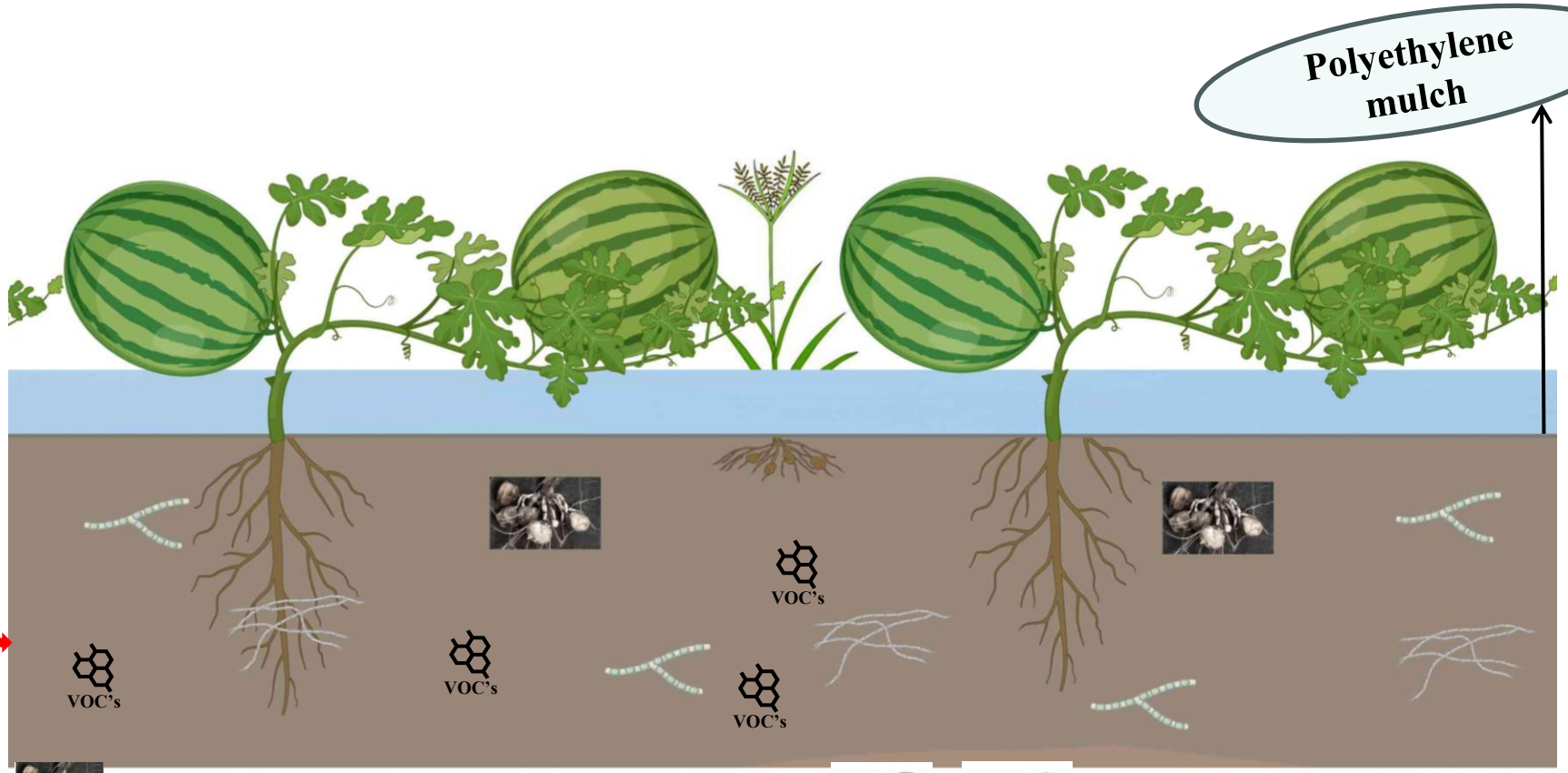
- Controlled nematodes flooding.

was developed from paddy-on system.

Principle of anaerobic soil disinfestation

- ASD is preplant non-chemical approach to manage weed and disease in wide range of specialty crops.
- Incorporation of labile carbon source (chicken manure, molasses, cottonseed meal, and cover crops) into the soil.
- Cover the soil with polyethylene plastic mulch.
- Irrigate the soil to saturation.
- ASD run for 3 to 7 weeks.

Anaerobic soil disinfestation: modes of action



Dead/inactivated weed seed

- Microbial degradation
- Depletion of oxygen
- Release of gases (methane, ethylene)
- Production of volatile organic compounds

Dead plant pathogens

- Change in soil pH
- Hypoxic condition
- Ethanol production during seed germination

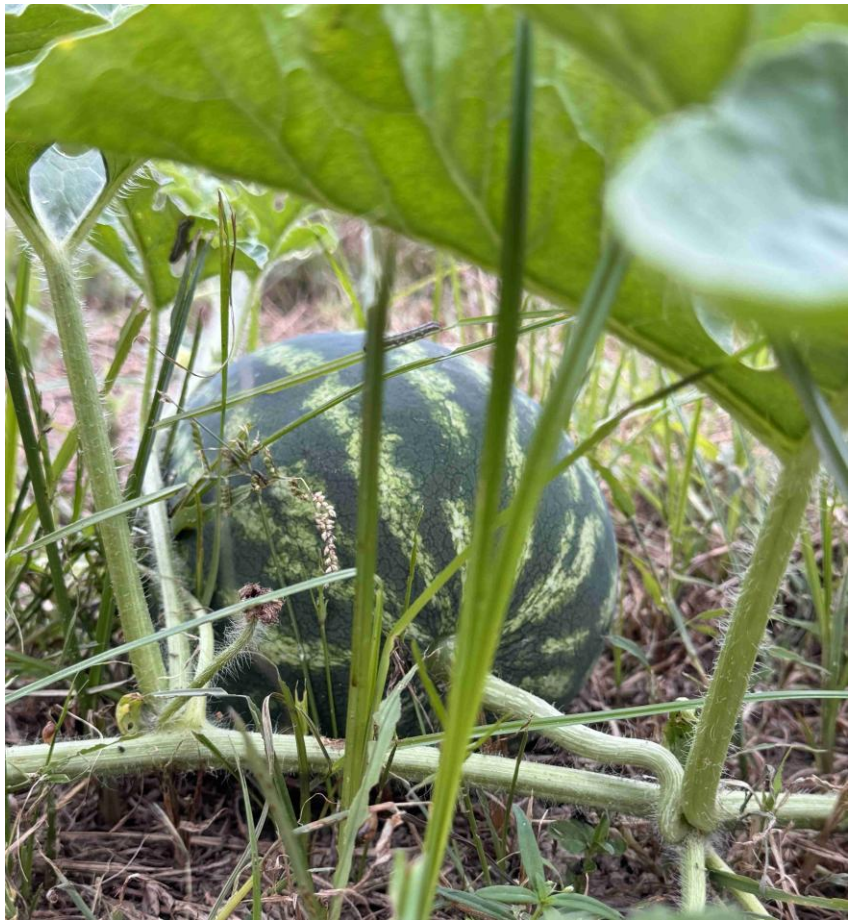
Research questions

Q1: Could we provide a guide for genotype selection in organic watermelon production in South Carolina?

Q2: Could we select the best plastic mulch which improves efficacy of ASD for weed management?

Q3: Could we use rhizobacteria and optimize planting time for watermelon production in ASD?

Q4: Could we utilize locally available carbon sources, such as locally available cottonseed meal, broccoli waste, to replace with Florida standard carbon source chicken manure, molasses for ASD?



Chapter I

Watermelon genotypes and weed response to chicken manure and molasses-induced anaerobic soil disinfestation in high tunnels

Objective 1: To evaluate the impact of CMM-induced ASD on percent weed control, emergence of yellow nutsedge and Palmer amaranth.

Hypothesis: CMM-induced ASD will improve percent weed control, suppress yellow nutsedge and Palmer amaranth emergence.

Objective 2: To evaluate the impact of CMM-induced ASD on watermelon plant vigor, fresh biomass, and plant length.

Hypothesis: CMM-induced ASD will enhance plant vigor, fresh biomass, and plant length.

Material & methods

Genotypes	Abbreviation	Type
Tri-X-313	TRI	Triploid
Captivation	CAP	Triploid
Dark Knight	DK	Triploid
Estrella	EST	Triploid
Extazy	EX	Triploid
Excursion	EXC	Triploid
Exclamation	EXL	Triploid
Fascination	FAS	Triploid
Melody	MEL	Triploid
Powerhouse	PH	Triploid
Calhoun Gray	CAL	Diploid
Black Diamond	BD	Diploid
Charleston Gray	CHS	Diploid
Crimson Sweet	CS	Diploid
Sangria	SAN	Diploid
Sugar Baby	SB	Diploid
Top Gun	TG	Diploid
Ojjakkyo	OJJ	Watermelon (rootstock)
USVL-351	351	Bottle gourd (rootstock)
USVL-482	482	Bottle gourd (rootstock)

Carbon sources rate: CM:8232.7 kg/Ac, M: 1452.0 gallons/Ac

- Location: USDA Vegetables Laboratory, Charleston, SC
- Date: 07/27/2022 & 08/01/2022
- Experimental design: RCBD with three replications
- Carbon source: Nontreated check (CK), chicken manure + molasses (CMM)
- Genotypes: 20
- Weed: Yellow nutsedge, Palmer amaranth
- ASD run for 4 weeks

Data collection: cumulative anaerobicity, weed control %, individual count of yellow nutsedge and Palmer amaranth, watermelon plant vigor, plant length, plant biomass

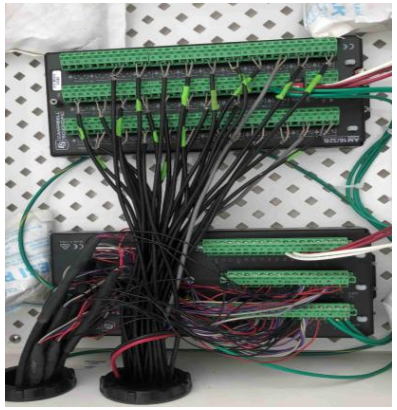
Data analysis: using JMP PRO 18

Experimental layout

Carbon source application

Seeded weeds

Installation of ORP sensors and irrigation



Sensors connected to data logger

Covered with polyethylene plastic mulch

ASD termination and watermelon transplantation

Results & discussion

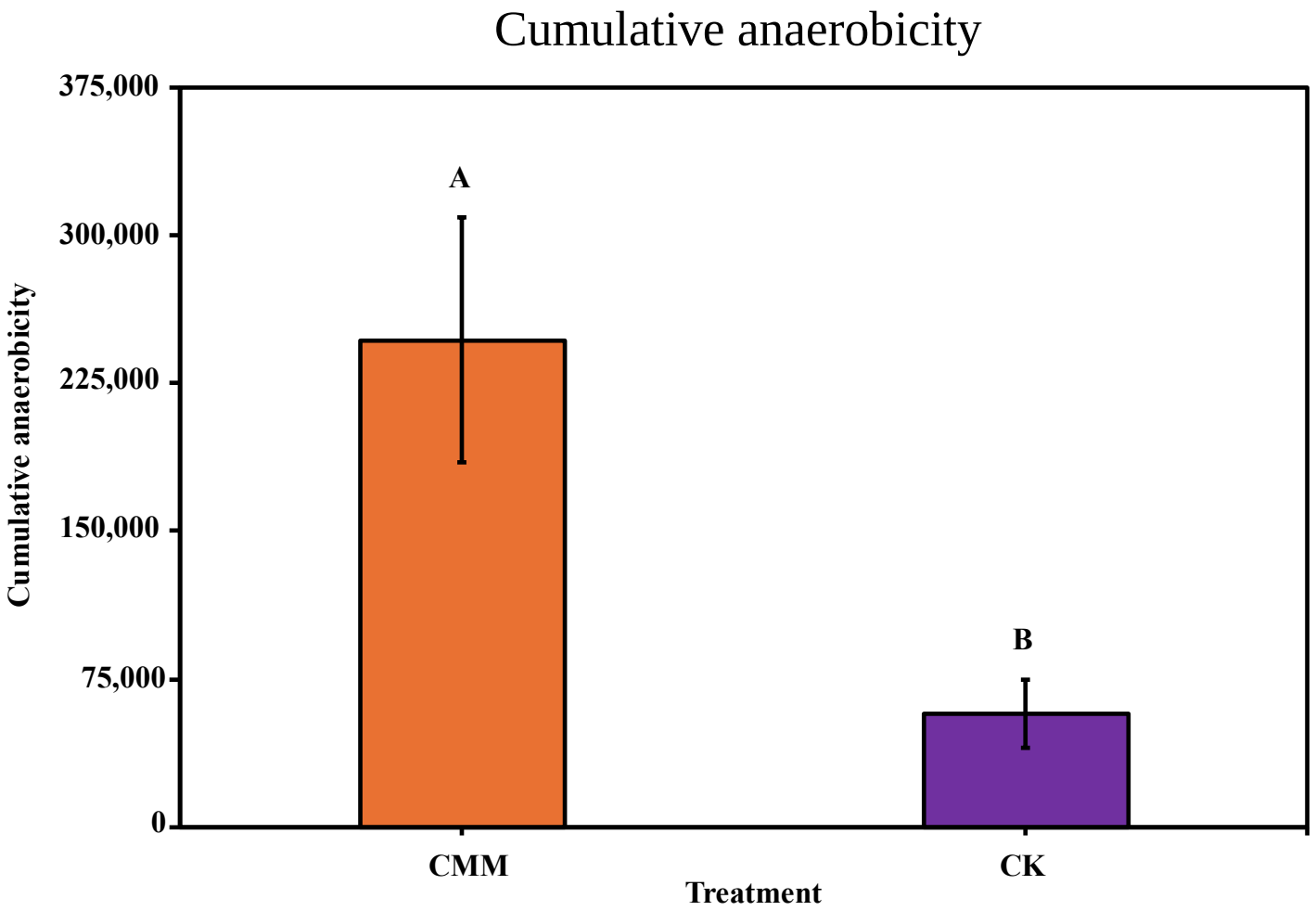
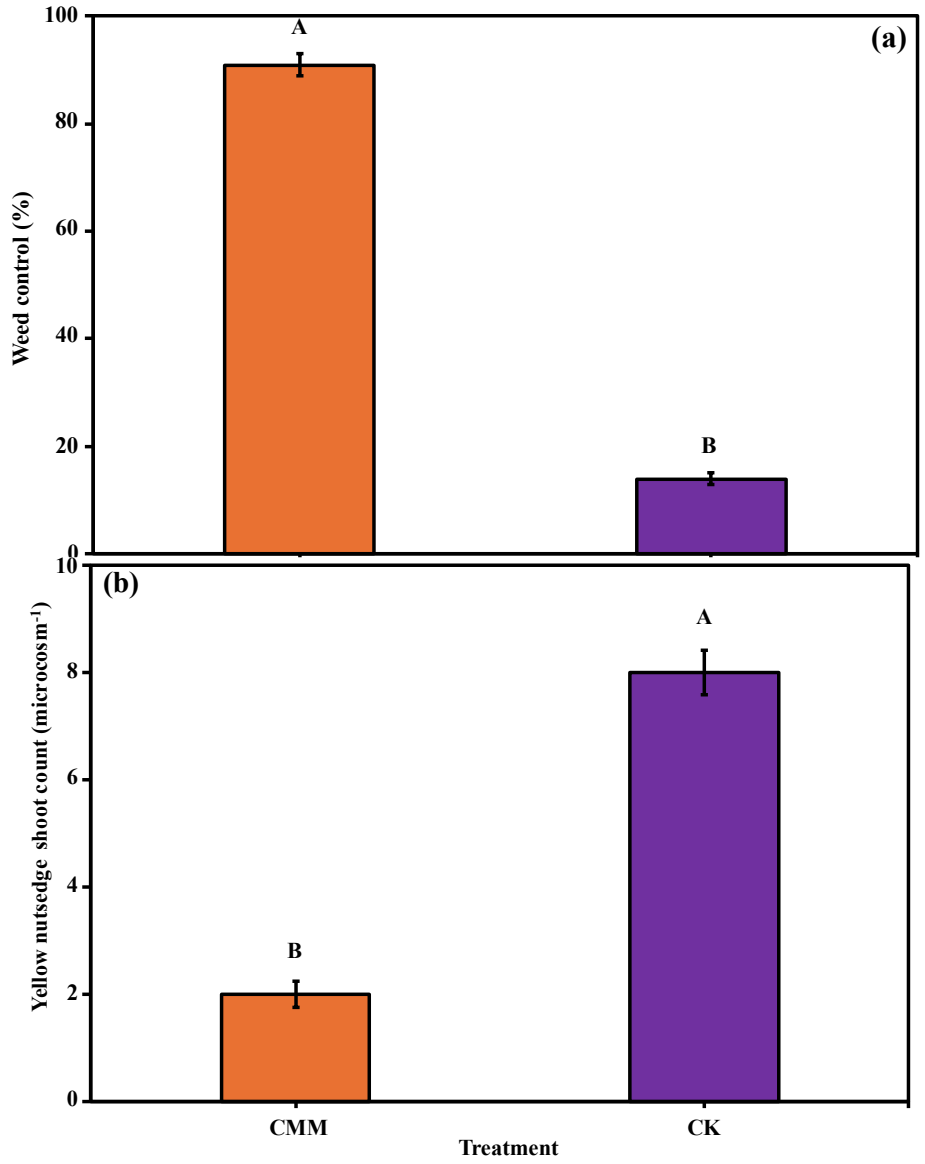


Figure: Impact of chicken manure and molasses (CMM)-induced anaerobic soil disinfestation on cumulative anaerobicity in microcosms under high tunnel conditions.

- CMM-induced ASD significantly improved anaerobic conditions in the soil.
- Higher cumulative anaerobic (246,963) in CMM compared to CK (57,372).

Weed control



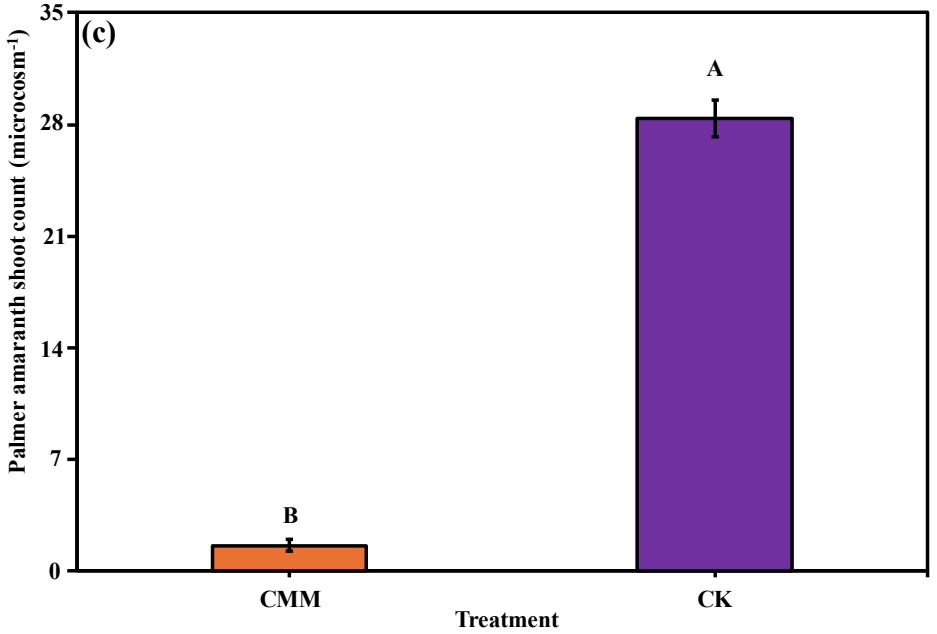
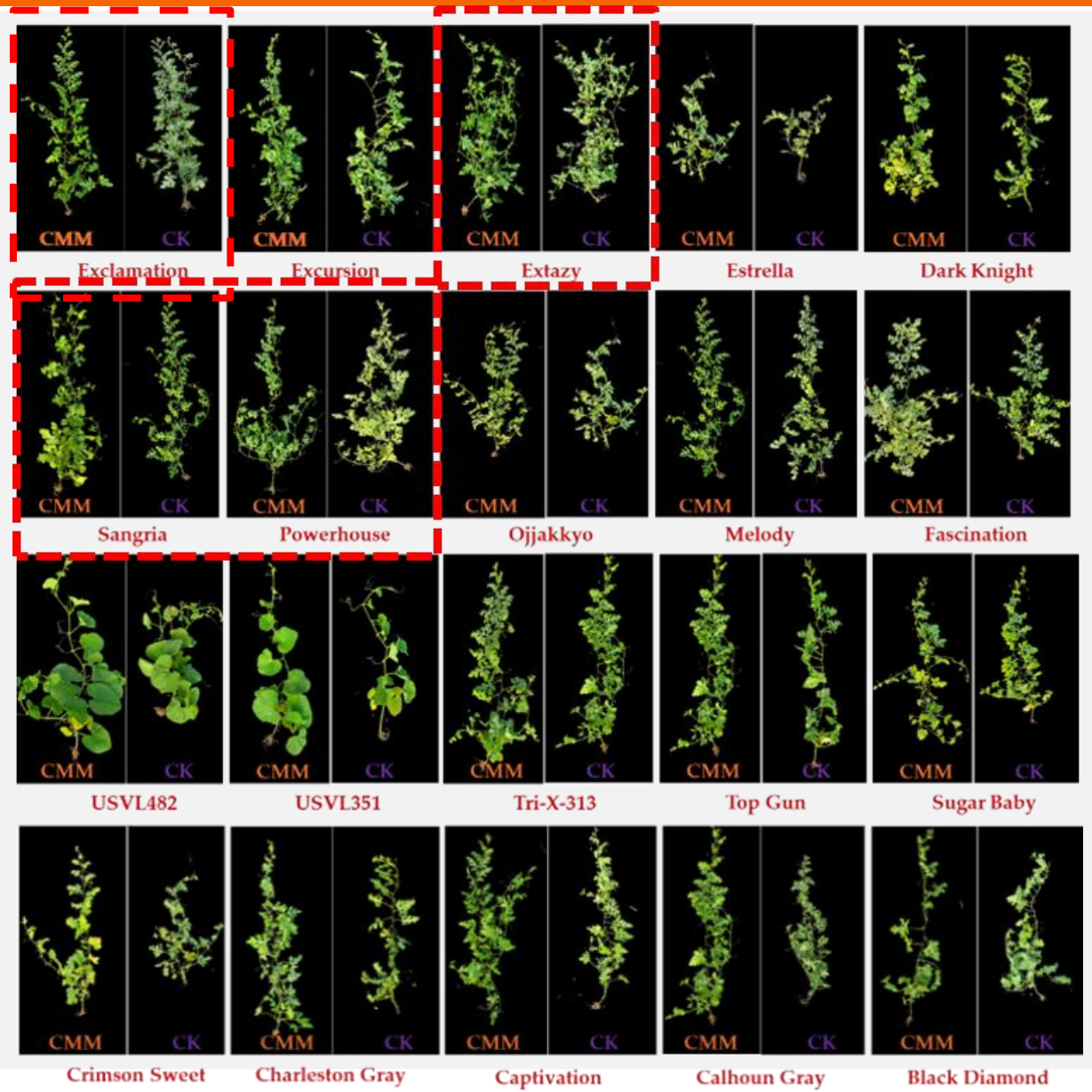


Figure: Impact of chicken manure and molasses (CMM)-induced anaerobic soil disinfestation) on (a) percent weed control, (b) *Cyperus esculentus* L., (c) *Amaranthus palmeri* S. Wats. taken after 4 weeks of ASD in microcosms under high tunnel conditions.

- 91% weed control in CMM compared to CK.
- 1.7 and 8.3 yellow nutsedge in CMM and CK respectively.
- CMM reduced Palmer amaranth germination by 96%.


CMM
CK
Exclamation
Excursion
Extazy
Estrella
Dark Knight
Sangria
Powerhouse
Ojjakkyo
Melody
Fascination
USVL482
USVL351
Tri-X-313
Top Gun
Sugar Baby
Crimson Sweet
Charleston Gray
Captivation
Calhoun Gray
Black Diamond

Plant length

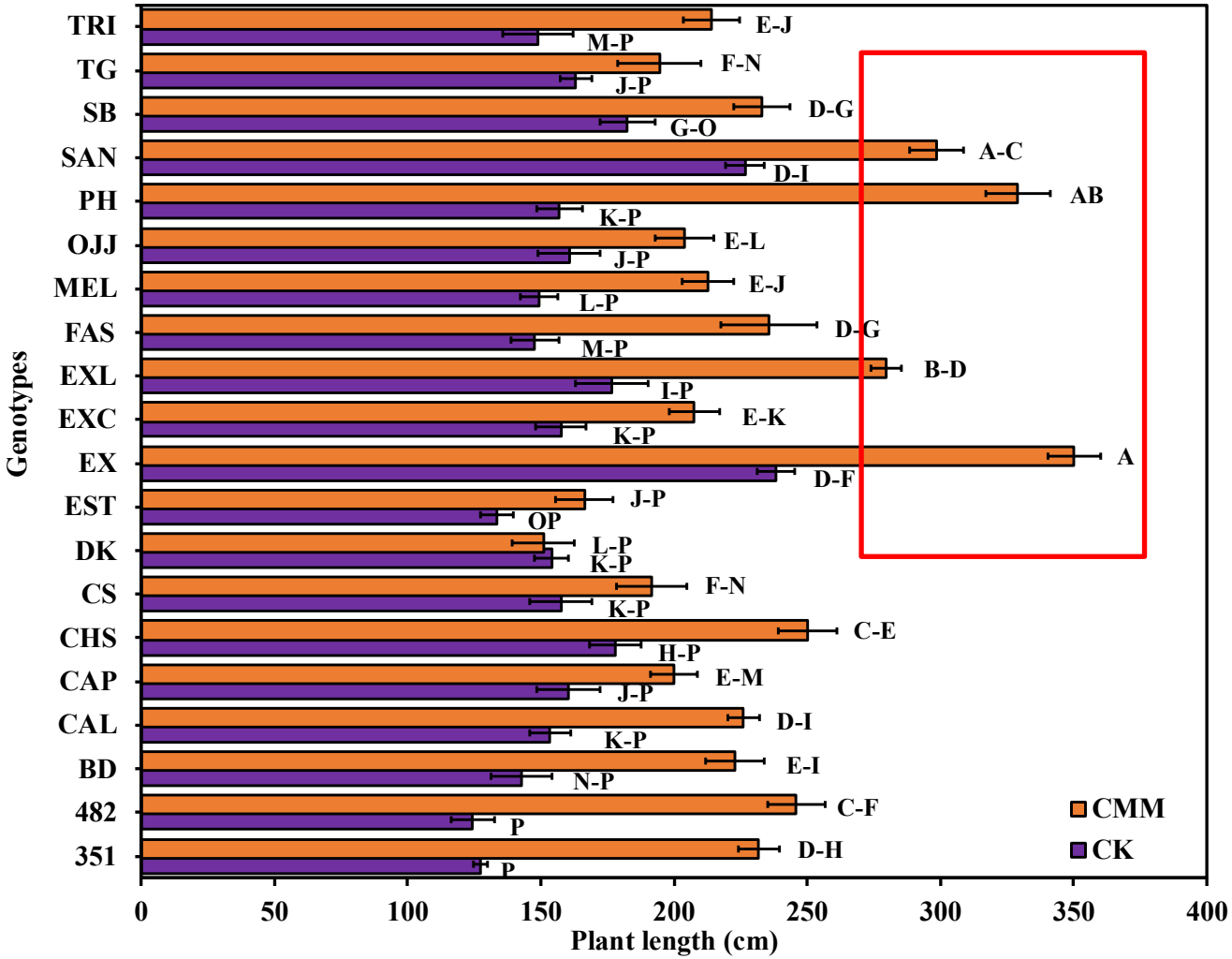


Figure: Impact of chicken manure and molasses (CMM)-induced anaerobic soil disinfestation on plant length of different watermelon genotypes and rootstocks at 28 days after transplant under high tunnel conditions.

- Higher watermelon plant length was recorded in soil treated with CMM.
- Extazy, Powerhouse, Sangria, and Exclamation had the higher plant length compared to CK treatment

Plant above ground fresh biomass

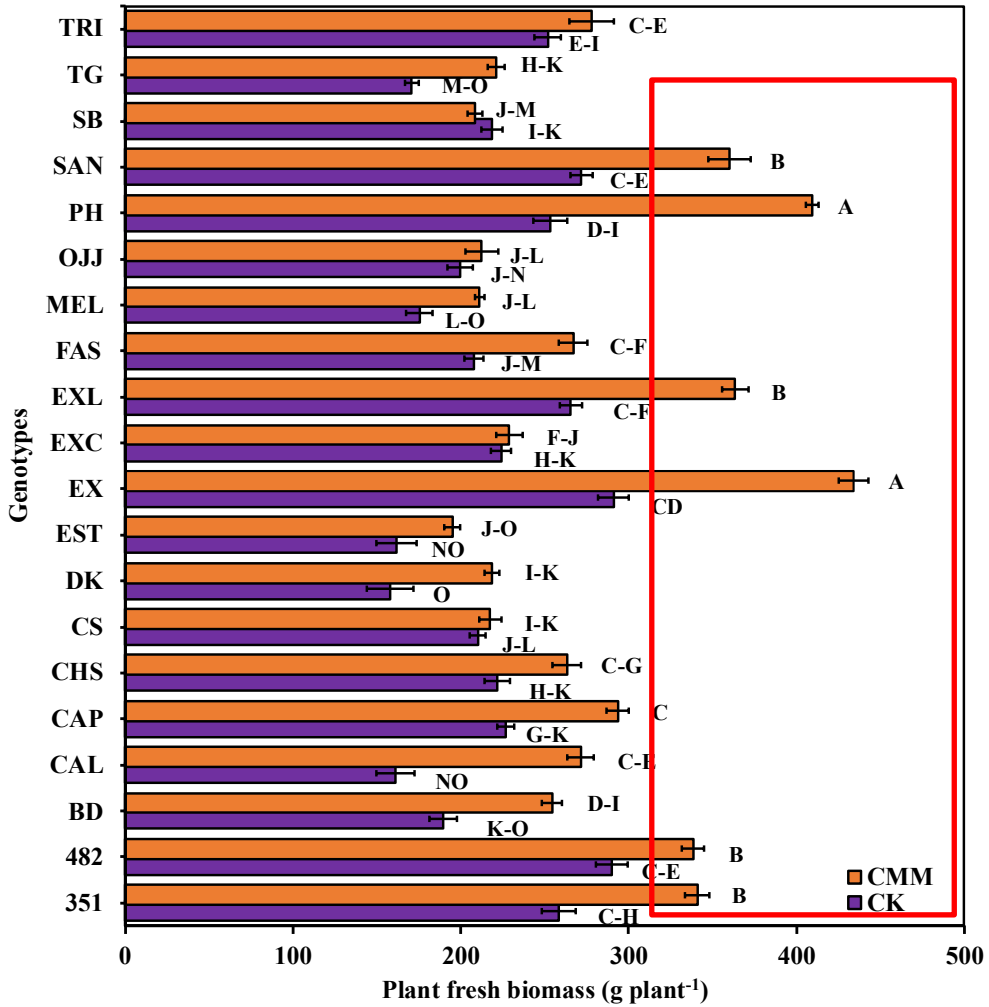


Figure: Impact of chicken manure and molasses (CMM)-induced anaerobic soil disinfestation on plant fresh biomass of different watermelon genotypes and rootstock at 28 days after transplant under high tunnel conditions.

- CMM-induced ASD treatment significantly improved watermelon plant above ground fresh biomass.
- Extazy, Powerhouse, Sangria, Exclamation, 351 and 482 had greater plant fresh biomass compared to CK treatment.
- Extazy, Powerhouse, Exclamation and Sangria produced the highest fresh biomass at 434, 409, 364, and 360 g, respectively.

Summary

Hypothesis: CMM-induced ASD will improve percent weed control, suppress yellow nutsedge and Palmer amaranth emergence.

- CMM-induced ASD significantly improved percent weed control and suppressed emergence of yellow nutsedge and Palmer amaranth. (Hypothesis accepted)

Hypothesis: CMM-induced ASD will enhance plant vigor, fresh biomass, and plant length.

- CMM-induce ASD significantly enhanced watermelon plant vigor, fresh biomass, and plant length. (Hypothesis accepted)

Conclusions

- Soil amended with carbon source CMM increased cumulative anaerobicity (hence soil anerobic conditions).
- Sangria, Powerhouse, Extazy were more resilient genotypes among others under ASD.
- CMM-induced ASD improved percent weed control, and decreased emergence of yellow nutsedge, and Palmer amaranth.

agronomy

MDPI

Article

Watermelon Genotypes and Weed Response to Chicken Manure and Molasses-Induced Anaerobic Soil Disinfestation in High Tunnels

Muhammad Sohaib Chattha [1], Brian K. Ward [1], Chandrasekar S. Kousik [2], Amnon Levi [2], Bhupinder S. Farmaha [3], Michael W. Marshall [3], William C. Bridges [4] and Matthew A. Cutulle [1,*]

https://www.mdpi.com/3224236

Chapter II

Evaluation of mulch type and anaerobic soil disinfestation for weed management in organic watermelon production

Objective 1: To evaluate the impact of mulch type and ASD on weed control and suppression of yellow nutsedge and grasses.

Hypothesis: Mulch type and ASD will improve weed control and suppression of yellow nutsedge and grasses.

Objective 2: To evaluate the impact of mulch type and ASD on watermelon plant vigor, marketable yield, and quality.

Hypothesis: Mulch type and ASD will increase plant vigor, marketable yield, and quality.

Material & methods

- Location: CREC, Charleston, SC
- Date: 03/17/2023 & 03/19/2024 (Spring/Summer watermelon crop)
- Experimental design: RCBD with four replications
- Carbon source: nontreated check (CHK), chicken manure + molasses (CMM) and broccoli waste (BRC)
- Mulch type: Clear, Black and Solar Shrink (CNG-plastic)
- Cultivars: Extazy and Sangria (5 plants/plot)
- Pollinizer: SP-7 (2 plants/plot)
- ASD run for 4 weeks

Data collection: Yellow nutsedge and grasses shoot count, watermelon plant vigor, watermelon yield, soluble solid contents (%)

Data analysis: using JMP PRO 18

Experimental layout

Carbon source

Control

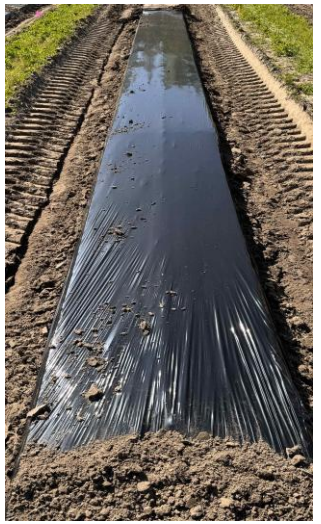
Broccoli waste

Chicken manure + molasses

Preplant fertilizer

Mulch type

Clear mulch



Solar shrink mulch

Black mulch

Sprayed black paint

Watermelon transplanted

- Carbon sources rate: BRC: 3157.46 kg/Ac, CM:8232.7 kg/Ac, M: 1452.0 gallons/Ac
- Fertilizer: 10-2-8 (150 units of N/Ac)

Results & discussion

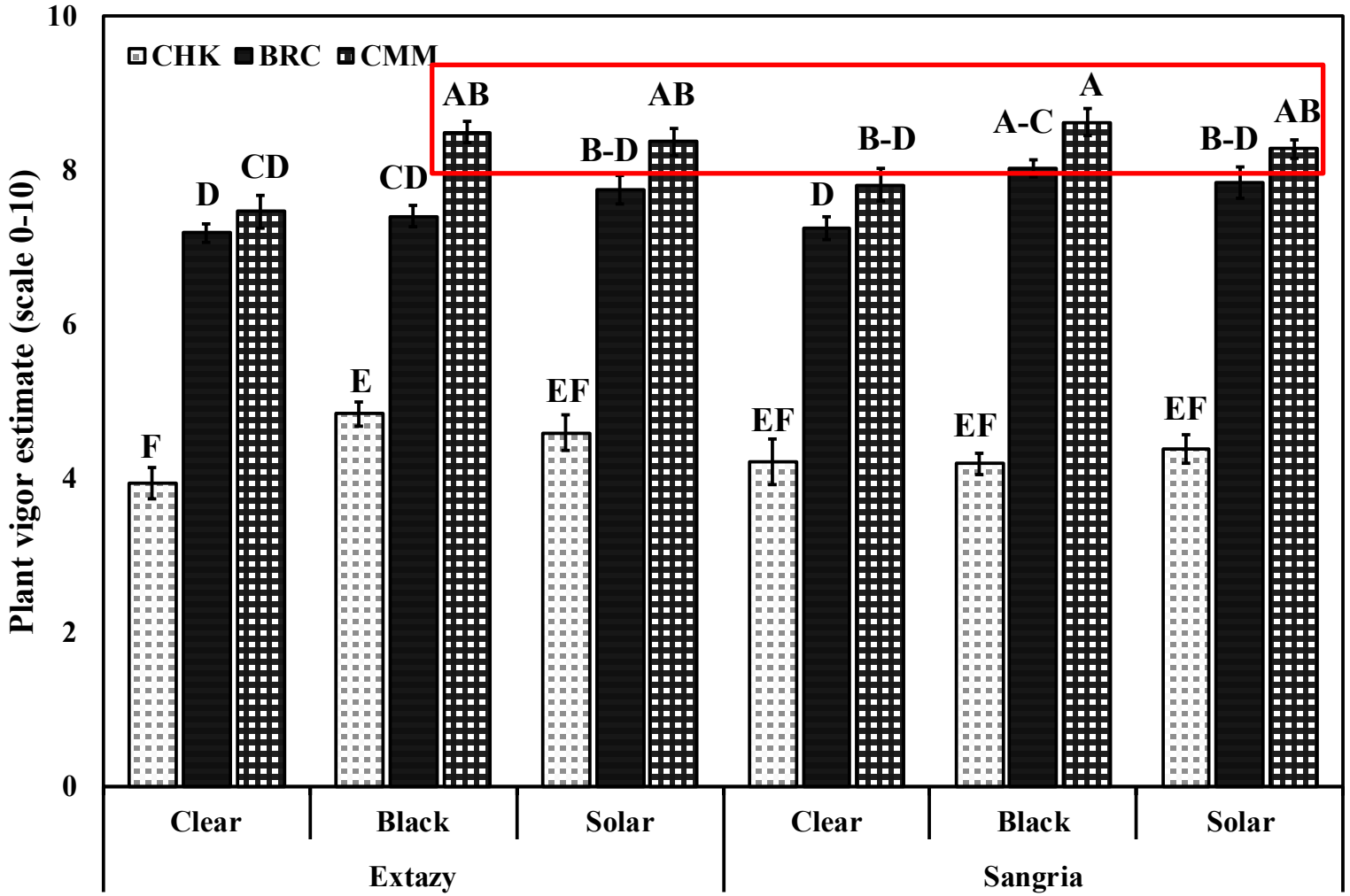
Weed population per plot

Table: Effect of mulch and anaerobic soil disinfestation (ASD) carbon sources: nontreated check (CHK), broccoli waste (BRC), and chicken manure, molasses (CMM)) on yellow nutsedge and grasses shoot count in field experiments in Charleston, SC.

Treatment		Weed Population Per Plot (9 × 1.2 m)				
		Yellow Nutsedge			Grasses	
Mulch	Carbon Source	0 d	42 d	70 d	42 d	70 d
Clear	CHK	14.1 A	24.2 A	35.6 B	8.6 B	13.5 A
	BRC	3.1 C	12.8 C	18.8 C	1.8 C	8.2 A
	CMM	1.1 C	6.1 D	8.7 D	1.5 C	8.3 A
Black	CHK	6.6 B	17.3 B	40.0 A	8.7 B	14.2 A
	BRC	2.3 C	11.1 C	18.0 C	1.7 C	8.8 A
	CMM	1.2 C	5.0 D	9.0 D	1.5 C	8.2 A
Solar Shrink	CHK	7.8 B	20.1 B	35.8 B	11.5 A	15.6 A
	BRC	2.5 C	12.2 C	16.8 C	2.0 C	8.0 A
	CMM	1.8 C	5.7 D	7.7 D	1.8 C	9.1 A
		p-value				
Mulch		<0.0001*	<0.0001*	0.0135*	0.0131*	0.2713
Carbon Source		<0.0001*	<0.0001*	<0.0001*	<0.0001*	<0.0001*
Mulch × Carbon Source		<0.0001*	0.0082*	0.0468*	0.0415*	0.3304

- Soil treated with BRC and CMM significantly suppressed yellow nutsedge and grasses emergence.
- Lower yellow nutsedge count was recorded in Solar Shrink, and Black mulch compared to Clear.
- At 70 d, soil treated with CMM had the lowest yellow nutsedge shoot count regardless of the mulch type.

Plant vigor estimate (scale 0-10) at 42 days after transplant (DAT)



- Soil treated with BRC and CMM significantly improved plant vigor.
- Greater plant vigor was observed in Sangria (8.6, 8.2 and Extazy (8.5, 8.3) in CMM in Black and Solar Shrink mulch respectively.
- CHK treatment had the least vigorous plants in Sangria and Extazy cultivars.

Figure: Effect of mulch (Clear, Black, and Solar) and anaerobic soil disinfestation (ASD) carbon sources: nontreated check (CHK), broccoli waste (BRC), and chicken manure, molasses (CMM), on watermelon plant vigor estimate (scale 0-10) at 42 DAT in field trials in Charleston, SC 2023-2024.

Watermelon marketable yield

Watermelon soluble solid contents (%)

Table: Effect of mulch and anaerobic soil disinfestation (ASD) carbon sources: nontreated check (CHK), broccoli waste (BRC), and chicken manure, molasses (CMM)) on watermelon soluble solid contents (%) in field experiments in Charleston, SC.

Mulch	Carbon Source	Cultivar	Soluble Solid Contents (%)
Clear	CHK	Sangria	9.3 E
		Extazy	8.7 E
	BRC	Sangria	11.1 CD
		Extazy	10.9 D
	CMM	Sangria	11.7 A-D
		Extazy	11.8 A-C
Black	CHK	Sangria	9.3 E
		Extazy	9.1 E
	BRC	Sangria	11.2 CD
		Extazy	11.5 B-D
	CMM	Sangria	12.5 A
		Extazy	11.8 A-C
Solar Shrink	CHK	Sangria	8.8 E
		Extazy	9.1 E
	BRC	Sangria	11.8 A-C
		Extazy	11.5 B-D
	CMM	Sangria	12.1 AB
		Extazy	12.1 AB
p-value		Mulch	0.0017*
		Carbon	<0.0001*
		Cultivar	0.0873
		Mulch × Carbon × Cultivar	0.0240*

- Carbon treated soil had higher soluble solid contents (SSC) (%) relative to CHK treatment.
- Higher SSC (%) were recorded in CMM treatment compared to BRC and CHK.
- Comparatively higher SSC (%) were recorded in CMM in Black and Solar shrink mulch respectively.

Summary

Hypothesis: Mulch type and ASD will improve weed control and suppression of yellow nutsedge and grasses.

- Mulch type and ASD improved weed control and suppression of yellow nutsedge and grasses. (Hypothesis accepted)

Hypothesis: Mulch type and ASD will increase plant vigor, marketable yield, and quality.

- Mulch type and ASD enhanced watermelon plant vigor, yield and fruit quality. (Hypothesis accepted)

Conclusions

- Among plastic mulch, Solar Shrink comparatively increased more weed control, and improved suppression of yellow nutsedge and grasses.
- Soil amended with CMM and BRC improved watermelon plant vigor, yield, and fruit quality.
- Integration of ASD with Solar Shrink mulch may provide significant weed control, enhanced watermelon plant vigor, marketable yield, and fruit quality.

Chapter III

Evaluation of rhizobacteria and transplant timing of watermelon planted into bio-fumigated soil

SC-27 is a mix of Streptomyces spp., including Streptomyces janthinus, Streptomyces cinerochromogenes, Streptomyces chromofuscus, Streptomyces atratus, Streptomyces aurantiogriseus, Streptomyces rimosus, Streptomyces venezuelae, Streptomyces violaceus, Streptomyces violascens, Streptomyces viridodiasticus, Streptomyces griseus, Streptoverticillium rectiverticillatum, and Bacillus subtilis.

Greenhouse experiments

Material & methods

- Location: CREC, Charleston, SC
- Date: 01/03/2023 & 01/09/2023
- Experimental design: RCBD with three replications
- Carbon source: nonamended check (CHK), chicken manure + molasses without polyethylene mulch (CMMU), chicken manure + molasses with polyethylene mulch (CMMC)
- Cultivars: Extazy, Powerhouse
- Rootstock: USVL351, USVL482, Carolina Strongback

Data collection: cumulative anaerobicity, weed control %, individual count of yellow nutsedge, Palmer amaranth, and barnyard grass, watermelon plant vigor, plant length, plant biomass.

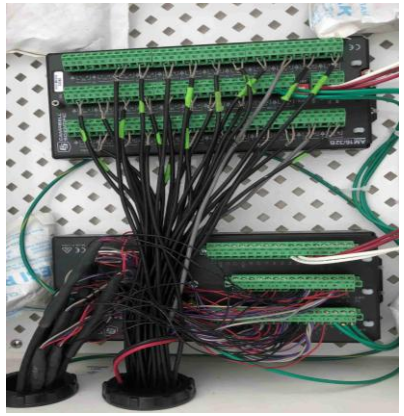
Data analysis: using JMP PRO 18

Experimental layout

Carbon source application

Seeded weed

Installation of ORP sensors and irrigation



Sensors connected to data logger

Covered with polyethylene plastic mulch

ASD termination and watermelon transplanted

Results and discussion

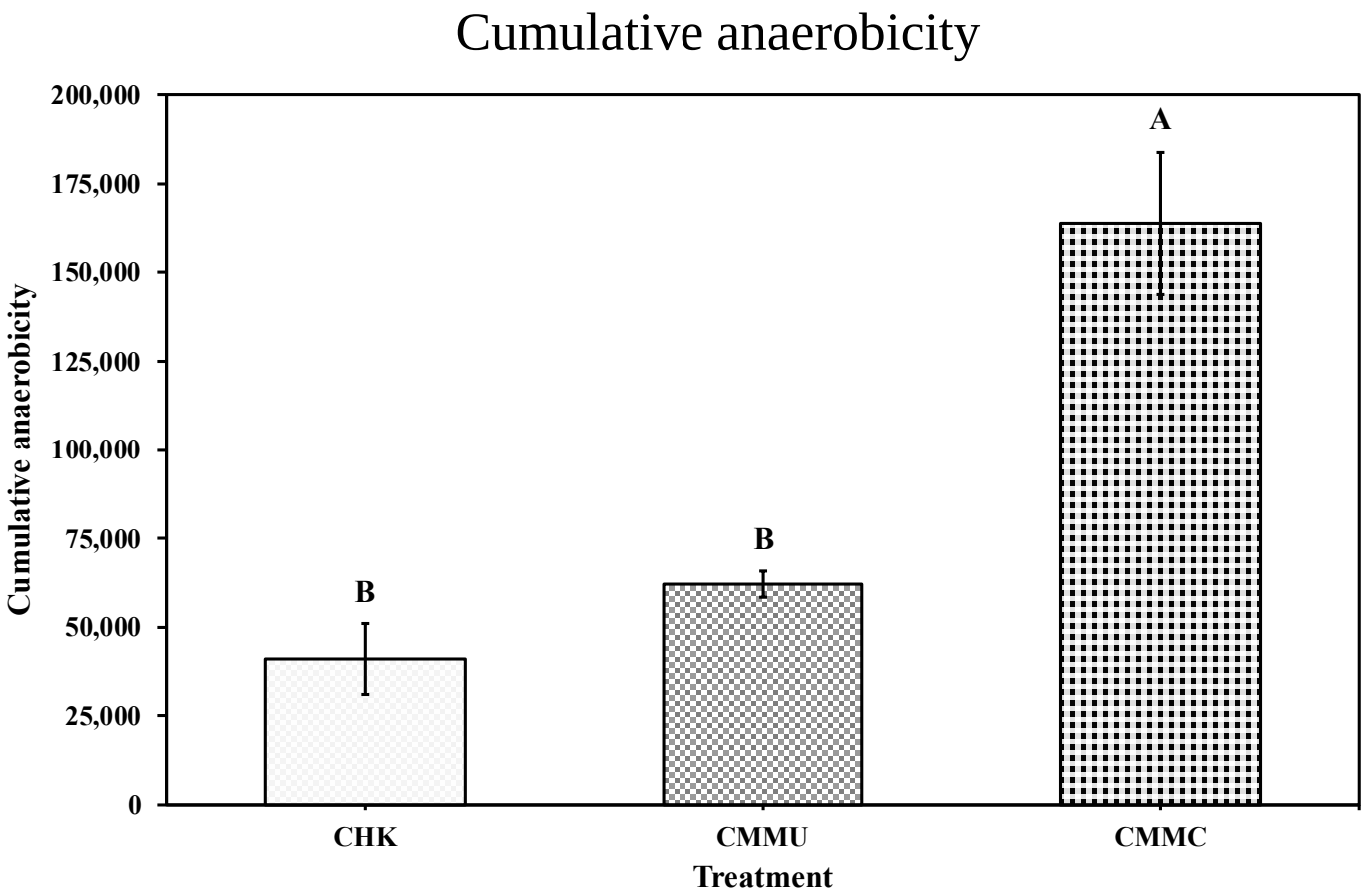


Figure: Effect of anaerobic soil disinfestation (ASD) carbon source: nonamended check (CHK), and chicken manure, molasses without polyethylene plastic mulch (CMMU), and chicken manure, molasses with polyethylene mulch (CMMC) on cumulative anaerobicity (soil anaerobic condition) in greenhouse experiments in Charleston, SC.

- CMMC significantly enhanced cumulative anaerobicity; hence soil anaerobic conditions.
- CHK and CMMU treatments were statistically similar.
- CMMC (163,778) had greater cumulative anaerobicity compared to CMMU (62052) and CHK (40927), respectively.

Weed control

Table: Effect of anaerobic soil disinfestation (ASD) carbon source: nonamended check (CHK), and chicken manure, molasses without polyethylene plastic mulch (CMMU), and chicken manure, molasses with polyethylene mulch (CMMC) on yellow nutsedge, barnyard grass, and Palmer amaranth shoot count in greenhouse experiments in Charleston, SC.

Treatment	Weed control (%)	Yellow nutsedge	Barnyard grass	Palmer amaranth
		Plants microcosm^{-1}		
CHK	8.1 C	9.6 A	54.4 A	18.6 A
CMMU	54.2 B	5.5 B	18.8 B	3.1 B
CMMC	85.8 A	1.1 C	2.7 C	0.0 C
p-value <0.0001*				

CHK CMMU CMMC

- Greater percent weed control was recorded in CMMC treatment.
- CMMC treatment had the lowest shoot count for yellow nutsedge, barnyard grass, and Palmer amaranth.

Watermelon plant vigor estimate (scale 0-10)

Table: Effect of anaerobic soil disinfestation (ASD) carbon source: nonamended check (CHK), and chicken manure, molasses without polyethylene plastic mulch (CMMU), and chicken manure, molasses with polyethylene mulch (CMMC) on watermelon plant vigor estimate (scale 0-10) in greenhouse experiments in Charleston, SC.

Treatment	Cultivar	Plant vigor estimate (scale 0-10)			
		7 DAT	14 DAT	21 DAT	28 DAT
CHK		5.2 C	5.3 FG	5.0 GH	4.7 E
CMMU	EX	6.0 BC	6.2 A-E	6.3 F	6.7 B-D
CMMC		5.7 BC	6.5 A-C	7.2 A-C	7.5 AB
CHK		4.8 C	5.7 C-G	5.5 G	5.4 DE
CMMU	EX+351	5.3 C	5.7 C-G	6.8 B-F	7.4 AB
CMMC		5.3 C	6.1 A-F	6.9 B-F	7.3 AB
CHK		5.5 BC	5.1 G	4.9 GH	4.4 E
CMMU	EX+482	5.8 BC	6.6 AB	7.0 A-D	7.7 AB
CMMC		5.9 BC	6.4 A-D	7.3 AB	8.4 A
CHK		4.9 C	5.5 E-G	5.5 G	5.5 C-E
CMMU	EX+CSB	5.6 BC	6.5 A-C	7.1 A-C	7.7 AB
CMMC		6.2 ABC	6.6 A	7.6 A	7.8 AB
CHK		4.6 C	5.1 G	5.1 GH	4.4 E
CMMU	PH	5.7 BC	5.6 D-G	6.4 D-F	6.9A-D
CMMC		5.6 BC	6.0 A-F	6.8 B-F	7.5 AB
CHK		5.2 C	5.8 B-G	4.8 H	4.1 E
CMMU	PH+351	5.6 BC	6.1 A-F	6.4 EF	7.0 A-C
CMMC		5.7 BC	6.1 A-F	7.0 A-E	7.7 AB
CHK		5.2 C	6.1 A-E	5.6 G	4.5 E
CMMU	PH+482	5.8 BC	6.4 A-D	6.5 C-F	6.7 B-D
CMMC		6.0 BC	6.4 A-D	7.3 AB	8.0 AB
CHK		5.2 C	5.2 G	4.9 H	4.5 E
CMMU	PH+CSB	7.2 A	6.7 A	7.0 A-F	7.2 AB
CMMC		6.7 AB	6.5 A-C	7.5 A	8.5 A
		p-value			
Treatment		<0.0001*	<0.0001*	<0.0001*	<0.0001*
Cultivar		<0.001*	<0.0001*	<0.0001*	0.0112*
Treatment × Cultivar		0.0350*	<0.0001*	<0.0001*	0.0437*

- CMMC treatment had more vigorous plant followed by CMMU treatment.
- Nontreated CHK had the least healthy plants.
- Among cultivar and rootstock, Powerhouse when grafted onto rootstock Carolina Strongback had higher plant vigor under CMMC treatment at 28 days after transplant.

Watermelon plant length

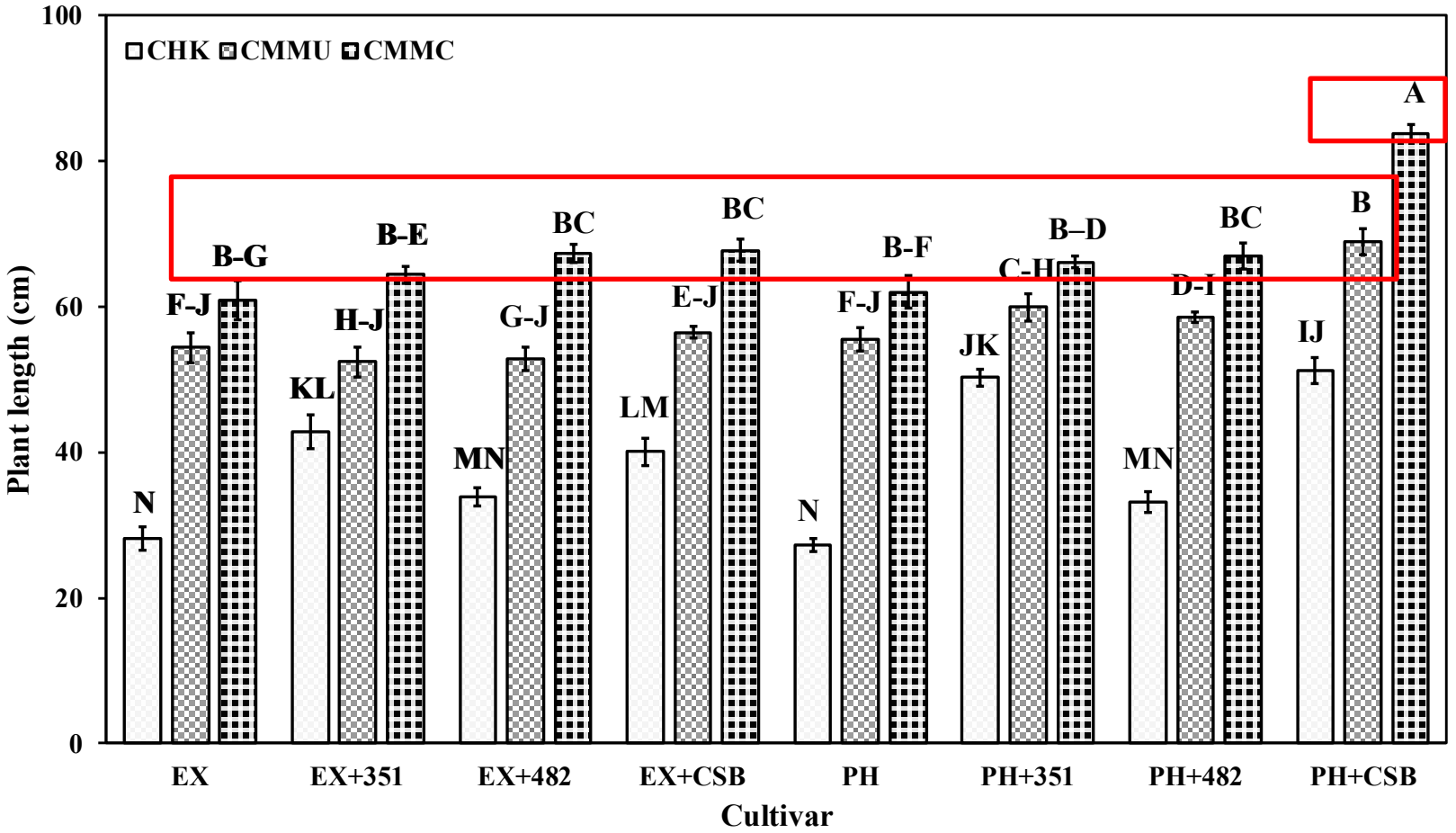
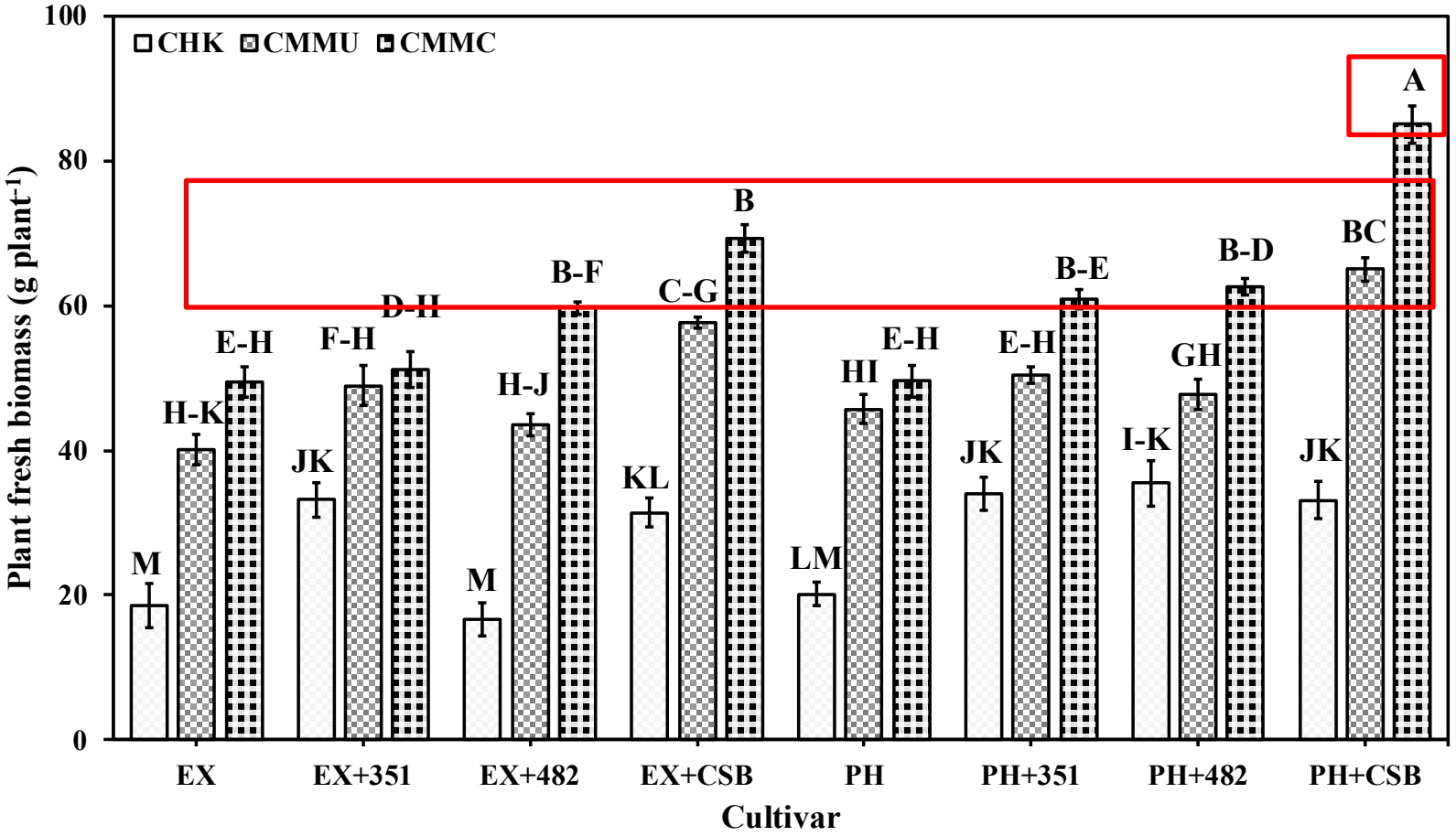


Figure: Effect of anaerobic soil disinfestation (ASD) carbon source: nonamended check (CHK), and chicken manure, molasses without polyethylene plastic mulch (CMMU), and chicken manure, molasses with polyethylene mulch (CMMC) on watermelon cultivars plant length in greenhouse experiments.

- Higher plant length were recorded in CMMC treatment compared to CMMU and CHK, respectively.
- Powerhouse when grafted onto Carolina Strongback had greater plant length compared to other cultivar and rootstocks.

Watermelon plant above ground fresh biomass



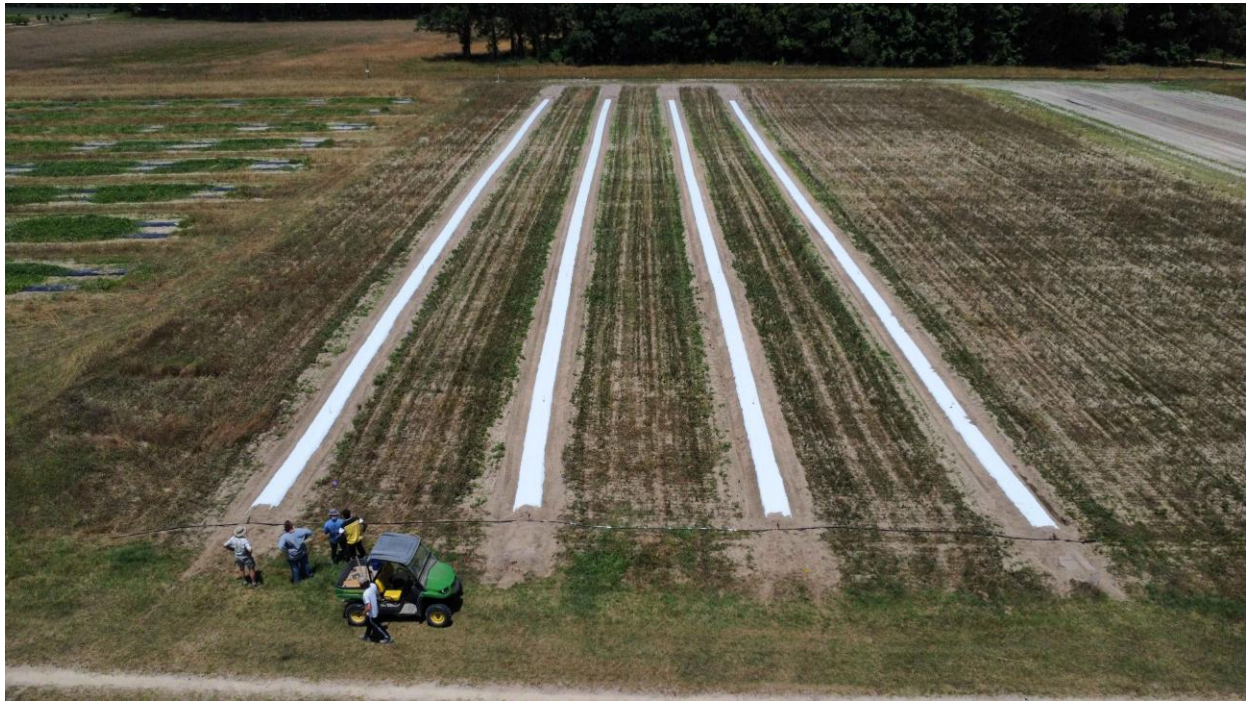
- Higher watermelon above ground fresh biomass was recorded in CMMC treatment.
- Powerhouse and Extazy when grafted onto rootstock Carolina Strongback had greater plant above ground fresh biomass.
- Low above ground fresh biomass was recorded in Extazy in CHK treatment.

Figure: Effect of anaerobic soil disinfestation (ASD) carbon source: nonamended check (CHK), and chicken manure, molasses without polyethylene plastic mulch (CMMU), and chicken manure, molasses with polyethylene mulch (CMMC) on watermelon cultivars plant fresh biomass in greenhouse experiments.

Field experiments

Material & methods

- Location: EREC, Blackville, SC
- Date: 06/01/2023 & 05/28/2024 (Summer/Fall watermelon crop)
- Experimental design: RCBD with four replications
- Carbon source: nonamended check (CHK), chicken manure + molasses (CMM)
- Cultivar: Powerhouse (non-grafted), Carolina Strongback (grafted) (5 plants/subplot)
- Transplant time: week 1 (T1) & week 2 (T2)
- Pollinizer: SP-7 (2 plants /subplot)
- Rhizobacteria: SC-27



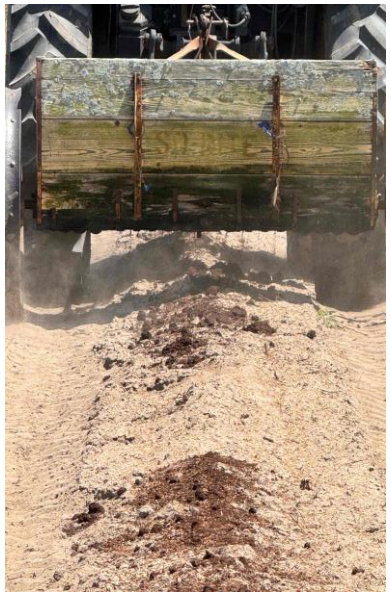
Data collection: Plant vigor, individual weed count at different time intervals, IRIS paint removal (%), watermelon yield.

Data analysis: using JMP PRO 18

Experimental layout

CHK

CMM



Preplant Fertilizer

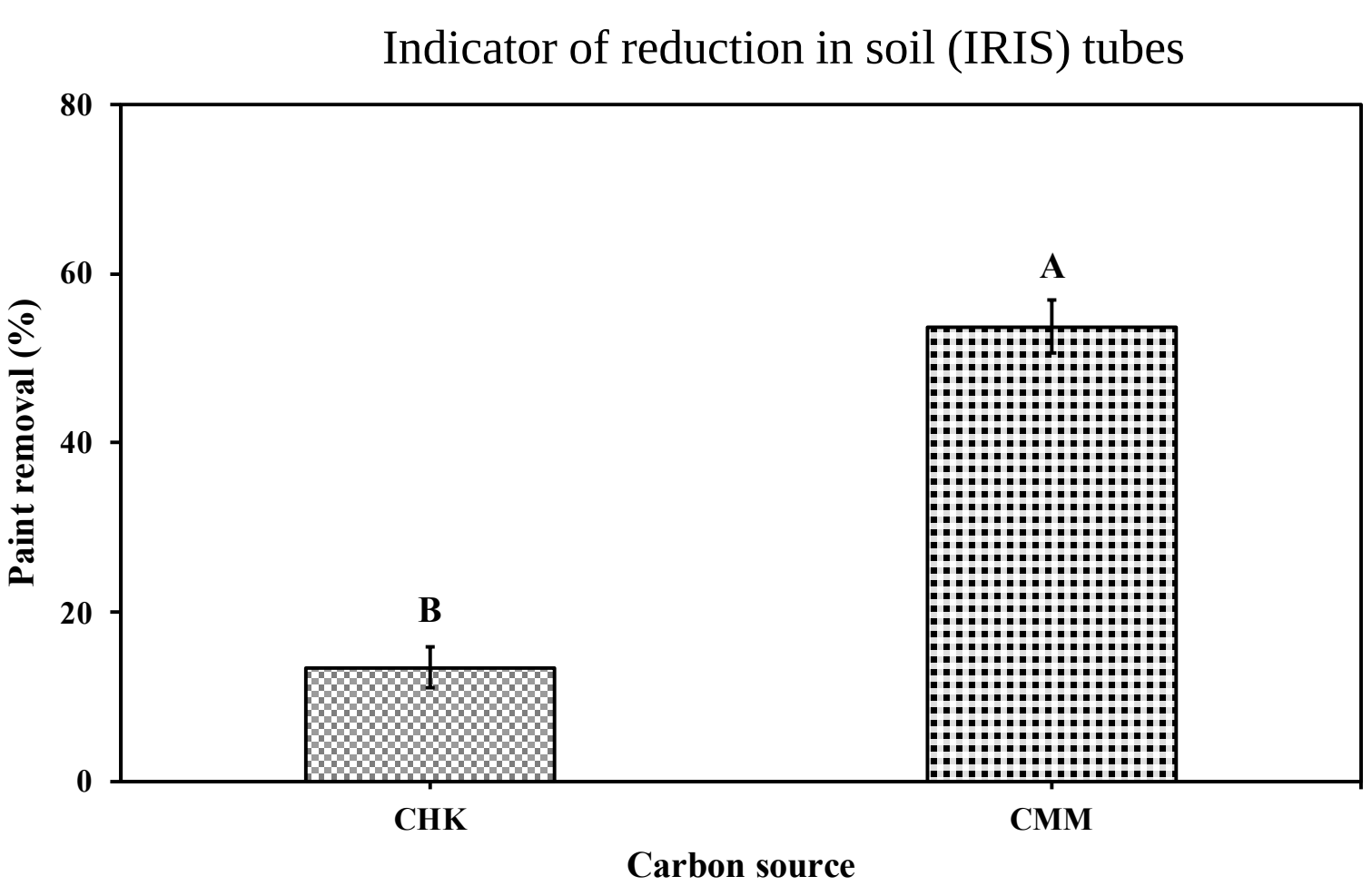
Regular polyethylene mulch

Installation of IRIS tubes

Application of SC-27

- Carbon sources rate: CM:8232.7 kg/Ac, M: 1452.0 gallons/Ac
- Preplant fertilizer: 10-2-8 (150 units of N/Ac)

Results and discussion



- CMM treatment removed 54% iron oxide paint from IRIS tubes compared to CHK (13%).
- Higher paint removal (%) indicates greater anaerobic conditions in the soil.

Figure: Effect of anaerobic soil disinfestation (ASD) carbon source: nonamended check (CHK), and chicken manure, molasses (CMM) on indicator of reduction in soil (IRIS) tubes at the time of ASD termination in field trials in Blackville, SC 2023-2024.

Yellow nutsedge shoot count at ASD termination

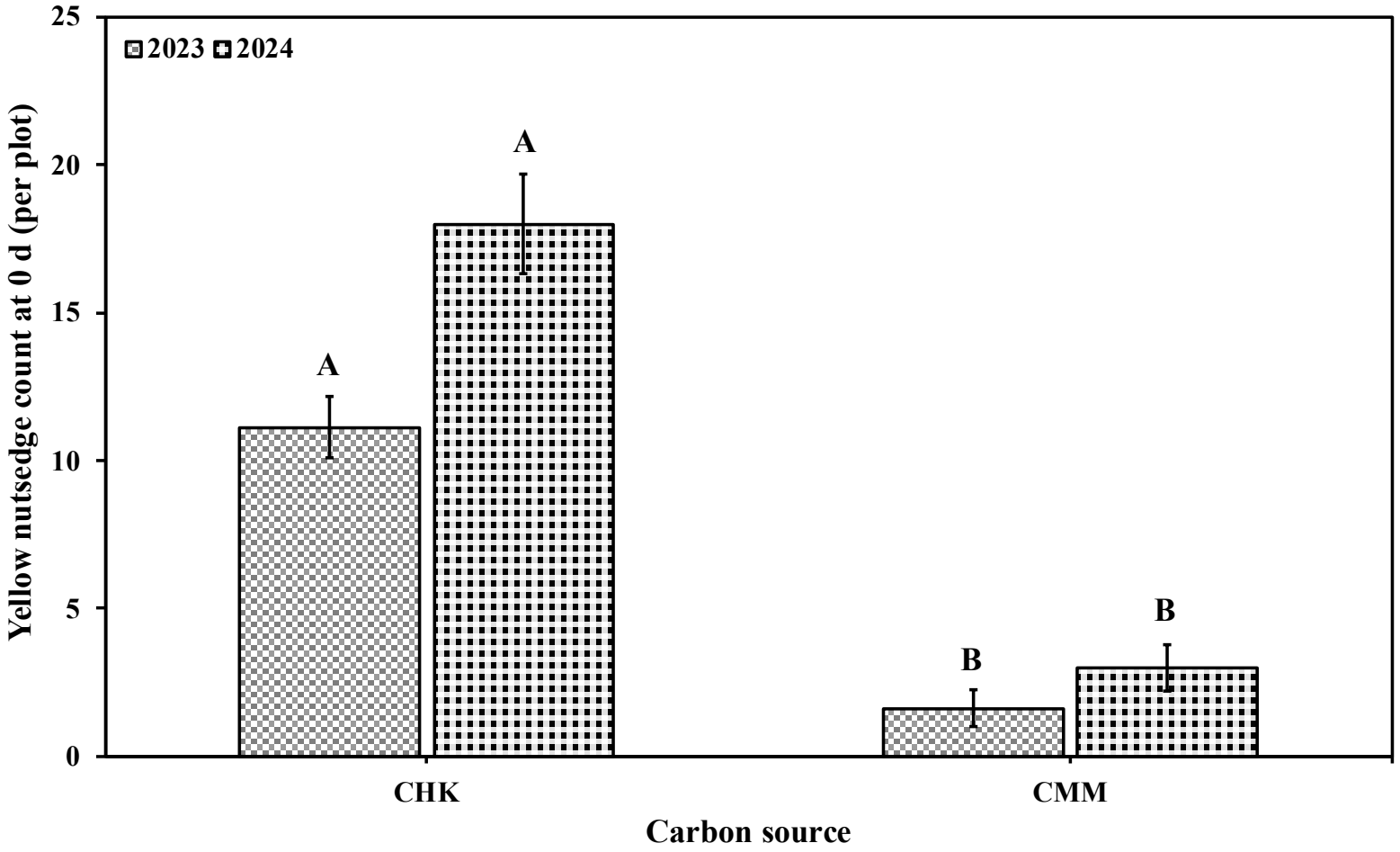
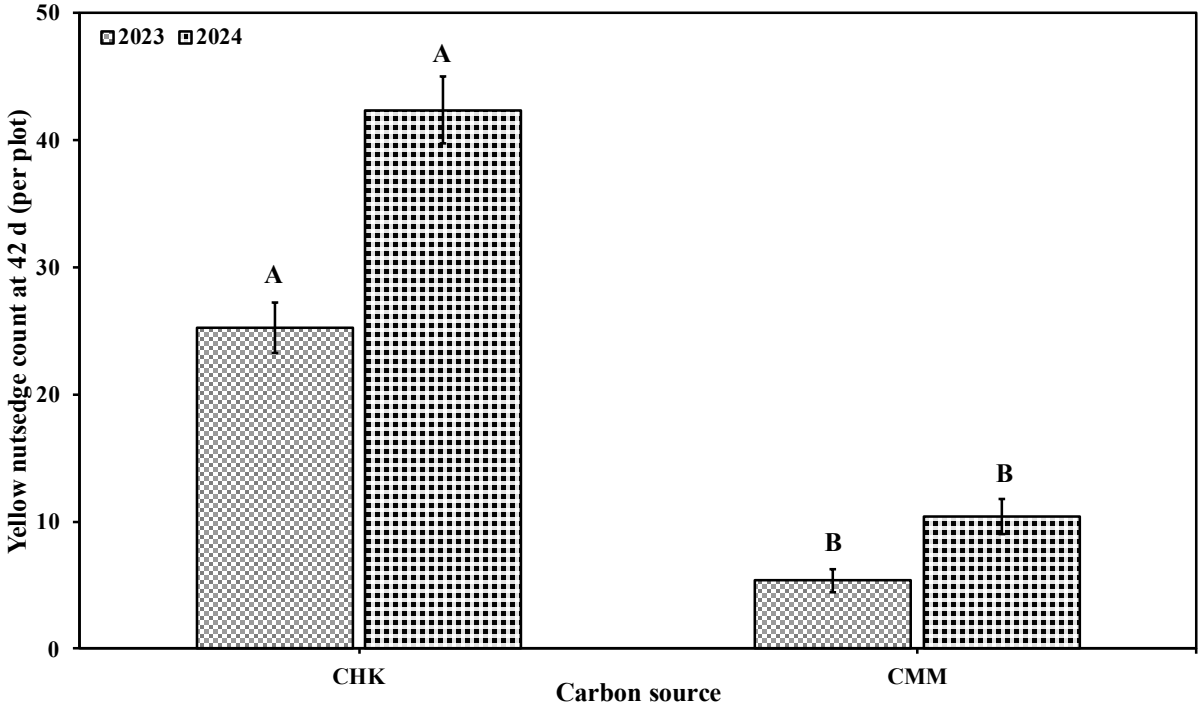


Figure: Effect of anaerobic soil disinfestation (ASD) carbon source: nonamended check (CHK), and chicken manure, molasses (CMM) on yellow nutsedge shoot count per plot at ASD termination 0 days (d) in field trials in Blackville, SC 2023-2024.

- Higher yellow nutsedge shoot count per plot were recorded in CHK treatment.
- CMM significantly increased suppression of yellow nutsedge.
- On an average, 11.1 and 18.0 yellow nutsedge shoot count were recorded in CHK treatment during 2023 and 2024, respectively.

Yellow nutsedge shoot count at 42 d and 70 d post ASD termination



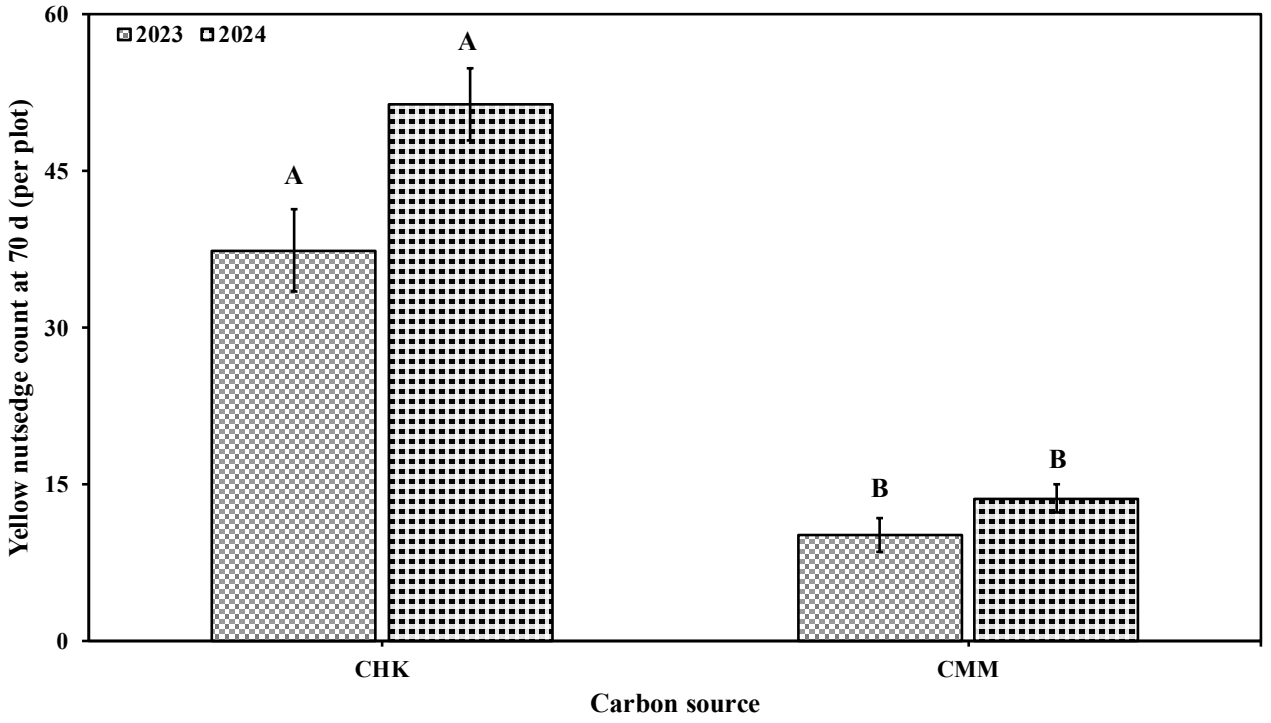
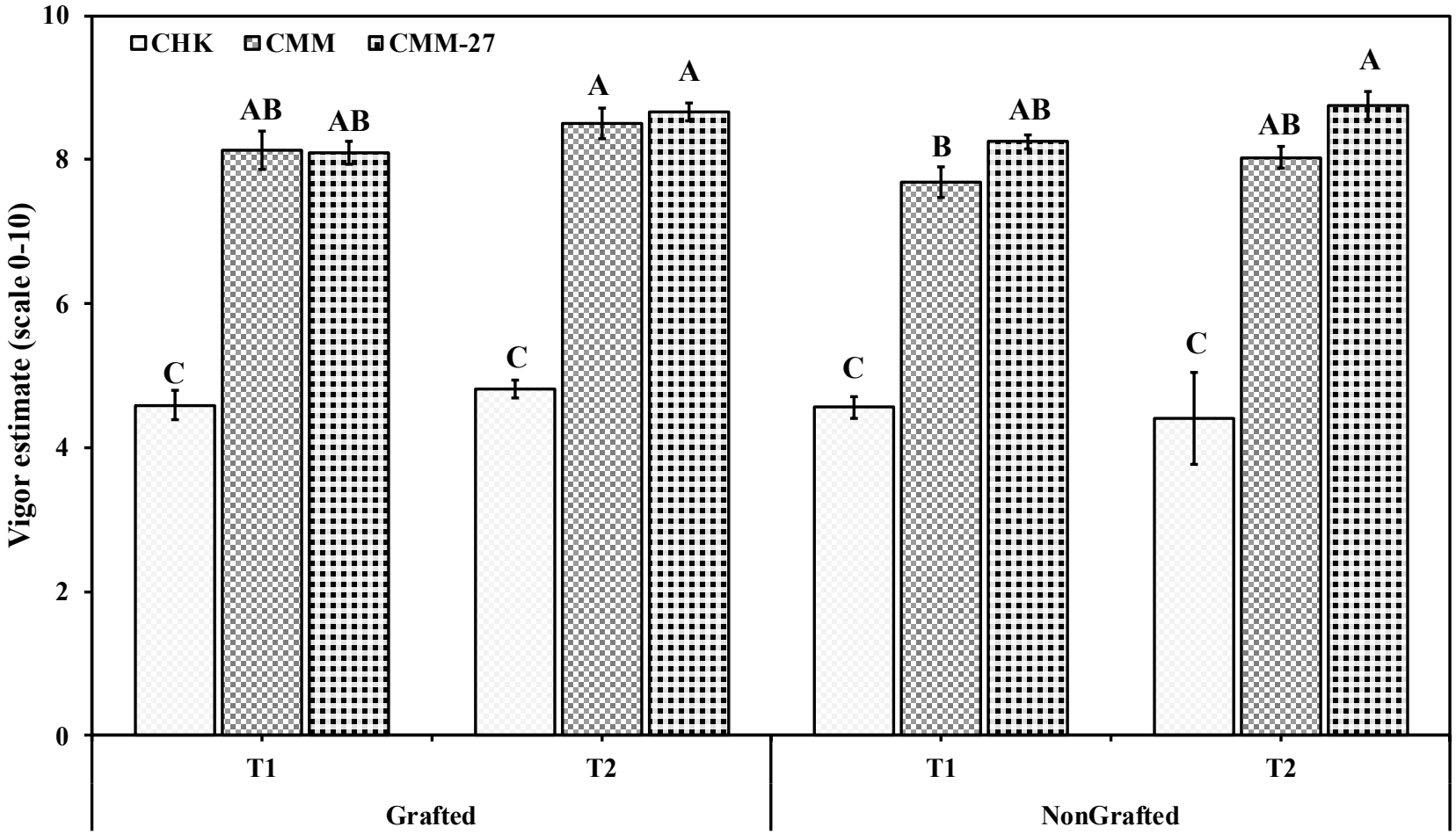


Figure: Effect of anaerobic soil disinfestation (ASD) carbon source: nonamended check (CHK), and chicken manure, molasses (CMM) on yellow nutsedge shoot count per plot at (a) 42 days (d) and (b) 70 (d) post ASD termination in field trials in Blackville, SC 2023-2024.

- At 70 d, low 10.1 and 13.6 yellow nutsedge shoot count were recorded in CMM treatment relative to CHK 37.3, and 51.3 during 2023 and 2024 growing season.

Watermelon plant vigor estimate (scale 0-10) at 28 days after transplant



- Soil treated with CMM significantly increased plant vigor.
- Comparatively more vigorous plants were recorded in CMM-27 and transplant timing 2 (T2).

Figure: Effect of anaerobic soil disinfestation (ASD) carbon source: nonamended check (CHK), chicken manure, molasses (CMM), and chicken manure, molasses-SC27 (CMM-27), on watermelon vigor estimate (scale 0-10) at 28 days after transplant in field trials in Blackville, SC 2023-2024.

2023

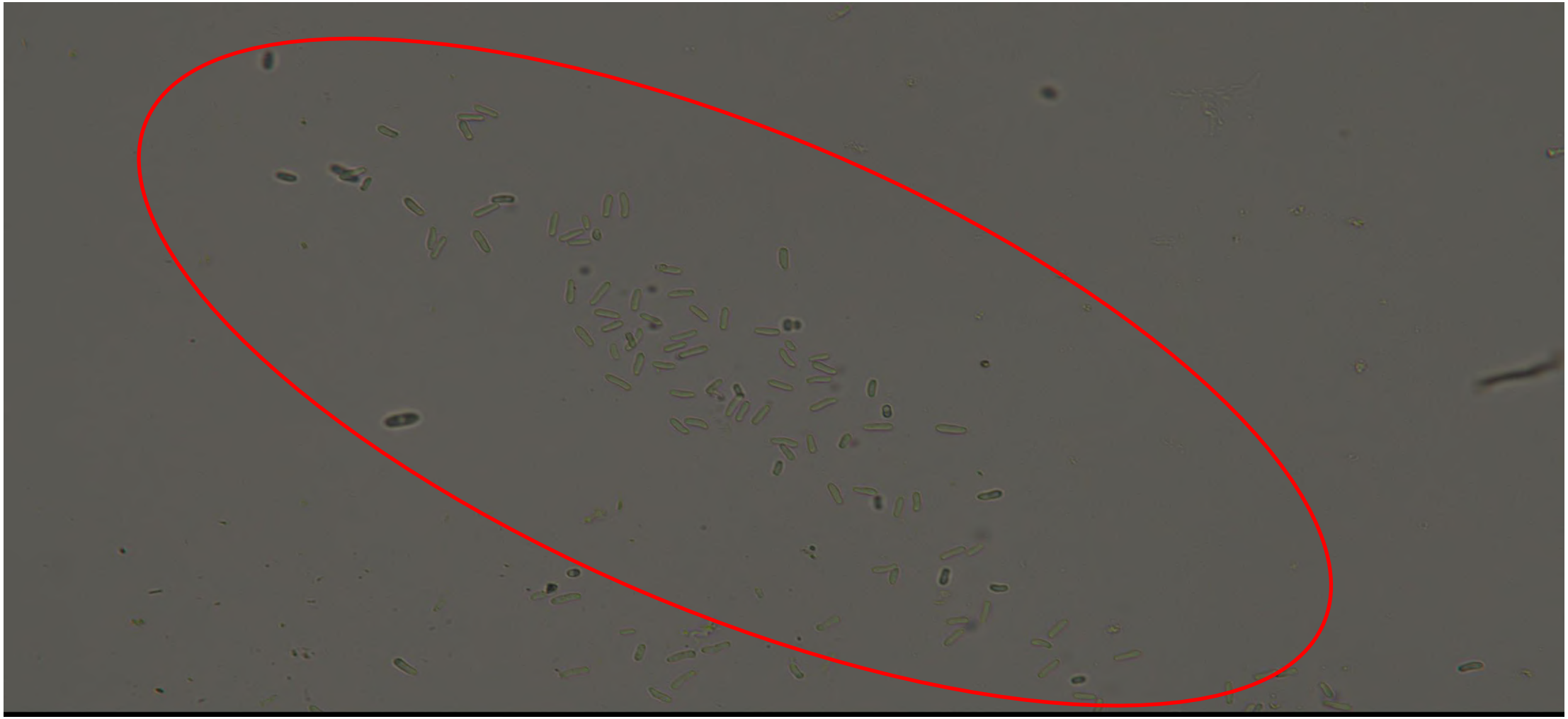


Photo credit: Jordan Withycombe (Dept. of Plant Industry)

Watermelon fruit count per plot

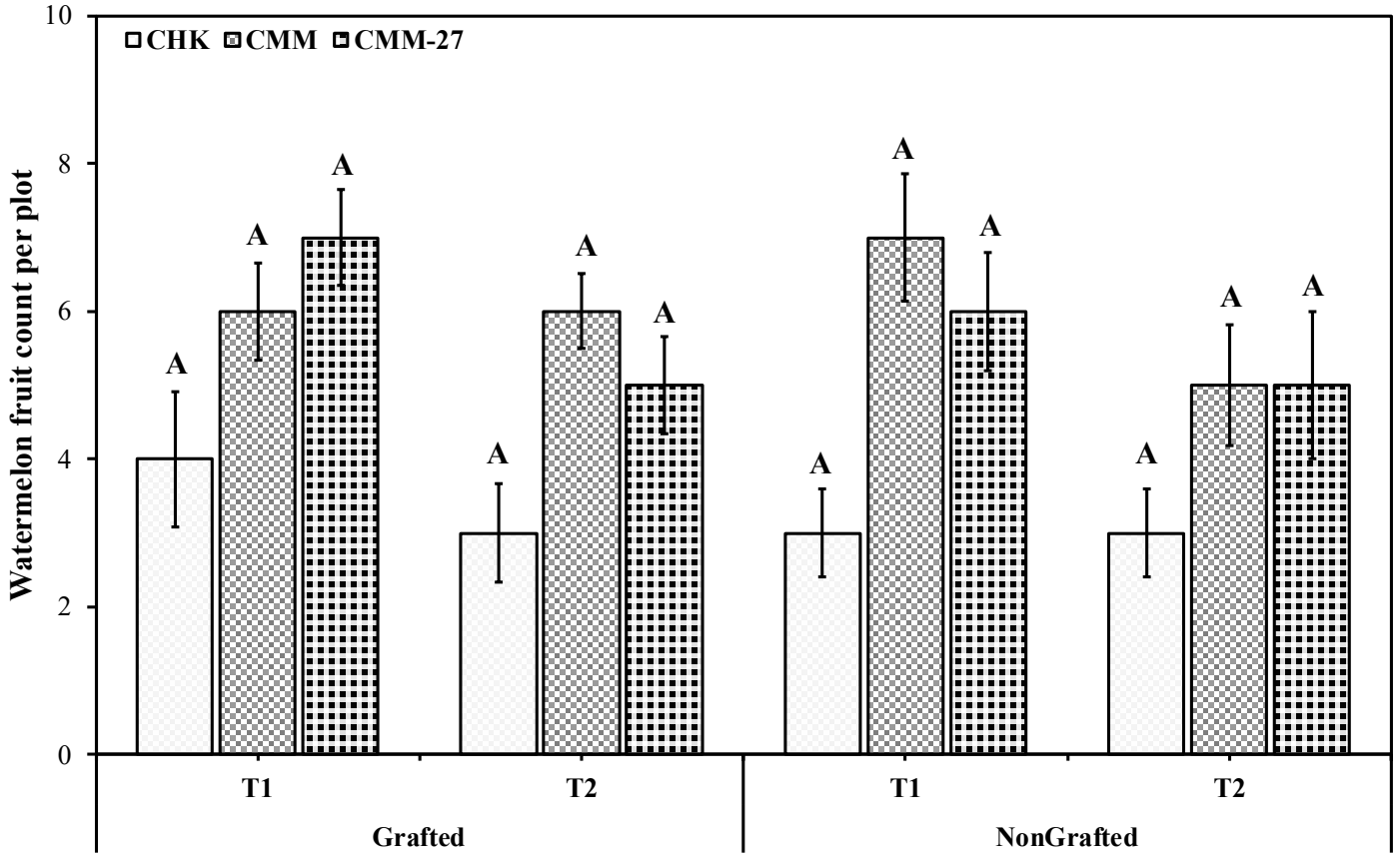


Figure: Effect of anaerobic soil disinfestation (ASD) carbon source: nonamended check (CHK), chicken manure, molasses (CMM), and chicken manure, molasses-SC27 (CMM-27), on watermelon fruit count per plot in field trials in Blackville, SC 2023-2024.

Summary

Hypothesis: ASD will increase weed control and suppress emergence of yellow nutsedge, barnyard grass, and Palmer amaranth.

- ASD treatments improved weed control and enhanced suppression of yellow nutsedge, barnyard grass and Palmer amaranth. (Hypothesis accepted)

Hypothesis: To determine the impact of rhizobacteria SC-27 and transplanting time on watermelon plant vigor, and yield.

- Rhizobacteria SC-27 improved watermelon plant vigor. (Hypothesis accepted).

Conclusions

- ASD treatment CMM significantly improved suppression of yellow nutsedge, barnyard grass, and Palmer amaranth.
- Application of rhizobacteria SC-27 comparatively improved plant vigor.
- No significant different were observed between transplant times.

Chapter IV

Evaluating the impact of anaerobic soil disinfestation on weed management in grafted and nongrafted watermelon

Objective 1: To evaluate whether ASD suppress emergence of yellow nutsedge, purple nutsedge, and grass weed species.

Hypothesis: ASD will suppress emergence of yellow nutsedge, purple nutsedge, and grass weed species.

Objective 2: To determine the efficacy of locally available carbon source on weed control, plant health, yield, and quality.

Hypothesis: locally available carbon source will improve weed control, plant health, yield, and quality.

Material and methods

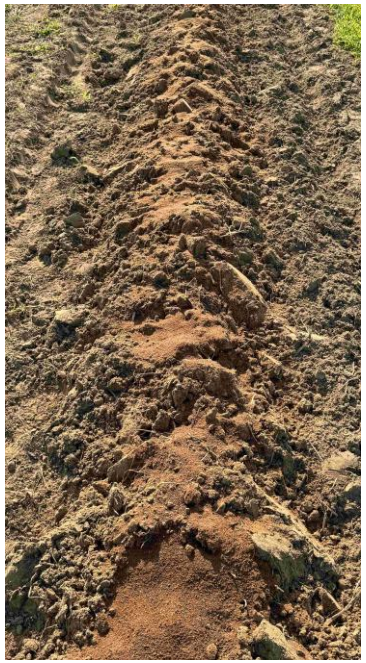
- Location: CREC, Charleston, SC
- Date: 06/19/2023 & 06/17/2024 (Summer/Fall watermelon crop)
- Experimental design: RCBD with four replications
- Carbon source: nontreated control (CT), chicken manure + molasses (CMM), cottonseed meal (CSM)
- Cultivars: Powerhouse (non-grafted), Carolina Strongback (grafted) (5 plants/plot)
- Pollinizer: SP-7 (2 plants/plot)
- ASD run for 4 weeks

Data collection: individual weed count at different time intervals, IRIS tube paint removal (%), watermelon plant vigor, watermelon yield, soluble solid contents (%)

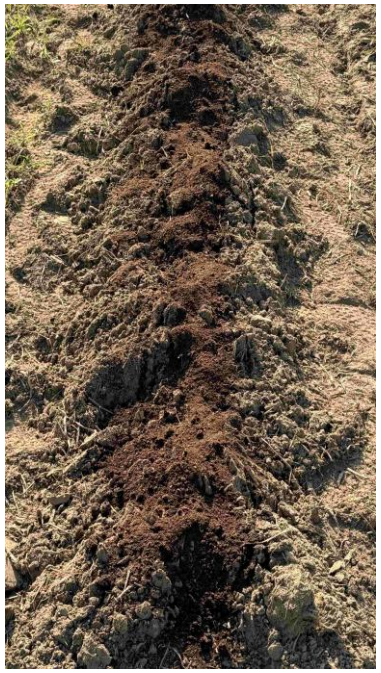
Data analysis: using JMP PRO 18

Experimental layout

Control



Cottonseed meal



Chicken manure + molasses

Preplant fertilizer

Incorporation

Polyethylene mulch and Installation of IRIS Tubes

- Soil type: Charleston loamy fine sand with pH 6.4, and 1.15% organic matter.
- Preplant fertilizer: 10-2-8 (150 units of N/Ac)

Results and discussion

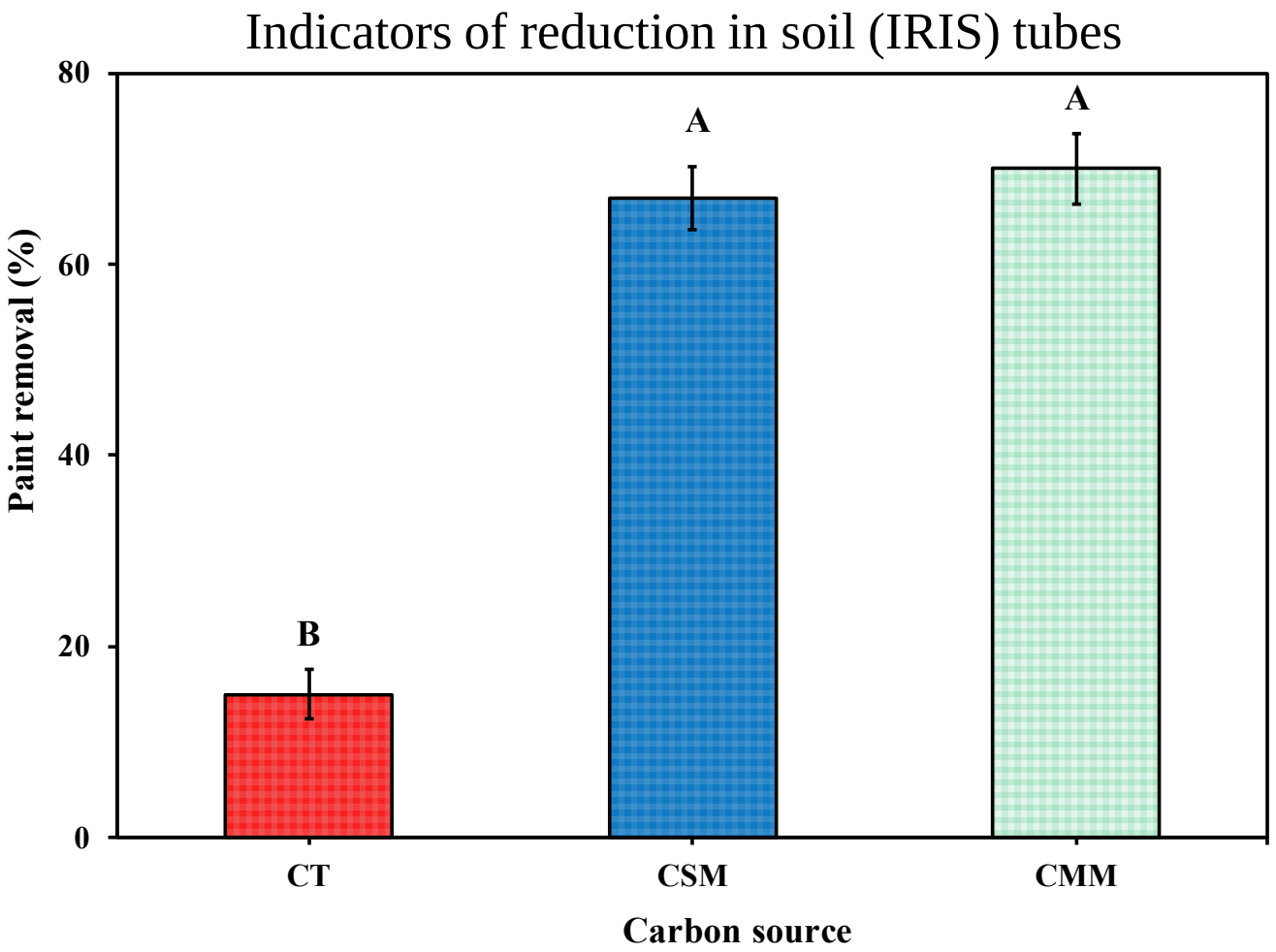


Figure: Effect of anaerobic soil disinfestation (ASD) carbon sources: nontreated control (CT), cottonseed meal (CSM), and chicken manure, molasses (CMM), on Indicators of Reduction in Soils (IRIS) tube paint removal (%) in field trials in Charleston, SC 2023-2024.

- CSM and CMM significantly removed iron oxide paint from IRIS tubes.
- Greater percent paint removal were recorded in CSM (66%) and CMM (70%) compared to CT (15%).
- Higher percent paint removal % indicates higher anaerobic conditions in the soil.
- Soil treated with CSM and CMM created higher anaerobic conditions in the soil relative to CT treatment.

Yellow nutsedge shoot count at ASD termination, 0 days (d)

CT

CSM

CMM

Weed population at 42 d and 70 d post ASD termination

Table: Effect of anaerobic soil disinfestation (ASD) carbon sources: nontreated control (CT), cottonseed meal (CSM), and chicken manure, molasses (CMM), on weed control at 42 d and 70 d post ASD termination in field trials in Charleston, SC 2023-2024.

Treatment		Yellow nutsedge		Purple nutsedge		Grass	
		42 d	70 d	42 d	70 d	42 d	70 d
Carbon source	Cultivar	----------Plants m^{-2}----------					
CT	Non-Grafted	15.8 a	30.4 a	10.7 a	19.4 a	3.0 a	5.4 a
	Grafted	16.0 a	32.3 a	10.8 a	18.0 a	2.5 a	6.0 a
CSM	Non-Grafted	6.0 bc	18.6 b	3.0 b	7.5 bc	0.4 b	3.1 bc
	Grafted	6.7 b	19.3 b	2.6 b	7.1 bc	0.5 b	2.7 c
CMM	Non-Grafted	6.0 bc	20.8 b	2.1 b	6.5 c	0.2 b	2.9 bc
	Grafted	4.8 c	18.7 b	2.9 b	8.0 b	0.5 b	3.3 b
p-value	Treatment	<0.0001*	<0.0001*	<0.0001*	<0.0001*	<0.0001*	<0.0001*
	Cultivar	0.5787	0.7745	0.2365	0.8105	0.2346	0.0646
	Treatment × Cultivar	0.0104*	0.0095*	0.0365*	0.0004*	0.0354*	0.0041*

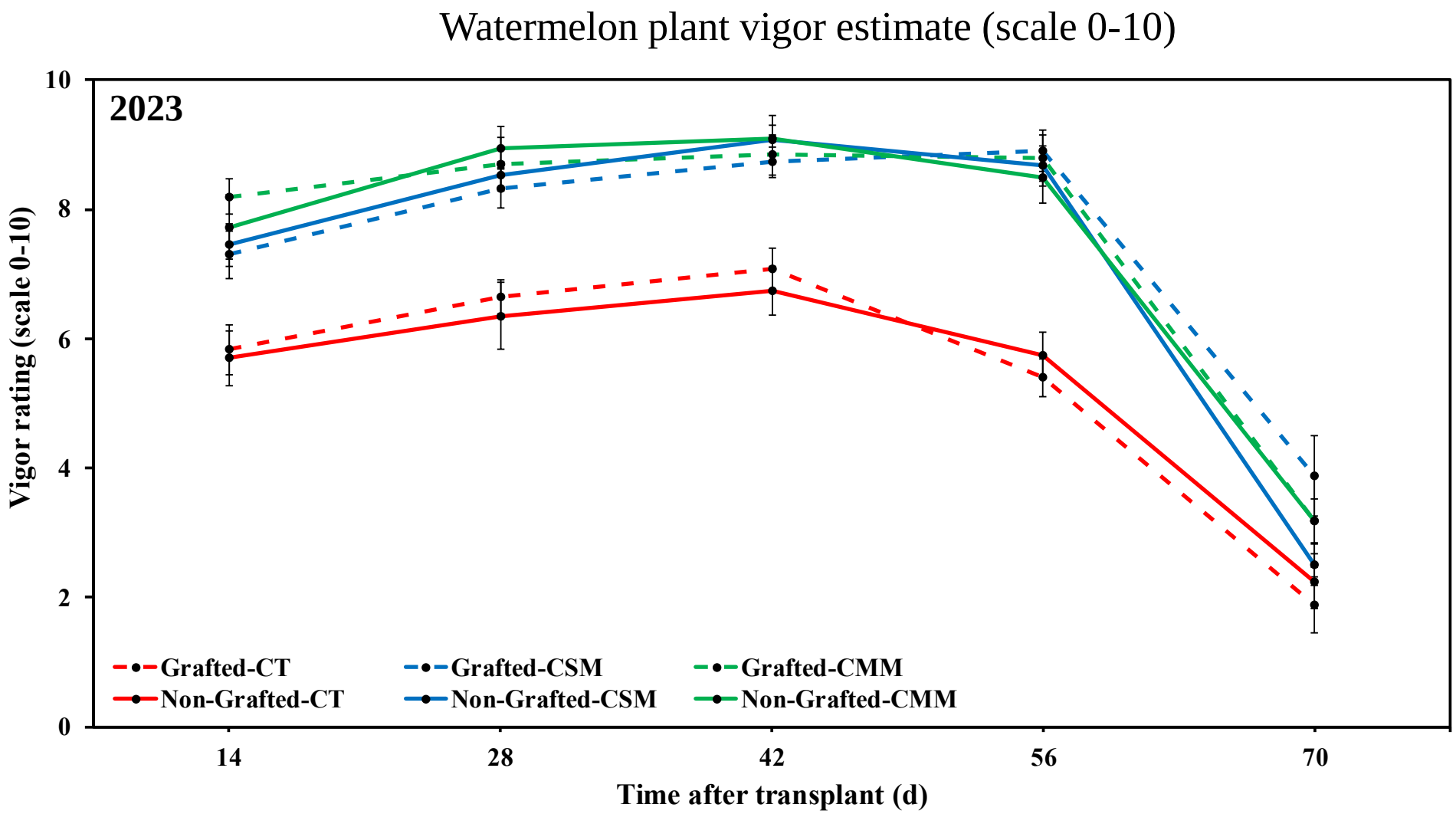


Figure: Effect of anaerobic soil disinfestation (ASD) on watermelon crop vigor rating by an index ranging from 0 (all plants are dead) to 10 (all plants are vigorous and no disease) and averaged for each season in field trial in Charleston, SC 2023. All watermelon plants per plot were evaluated visually. Abbreviations: CT, nontreated CT; CSM, cottonseed meal; CMM, chicken manure, molasses.

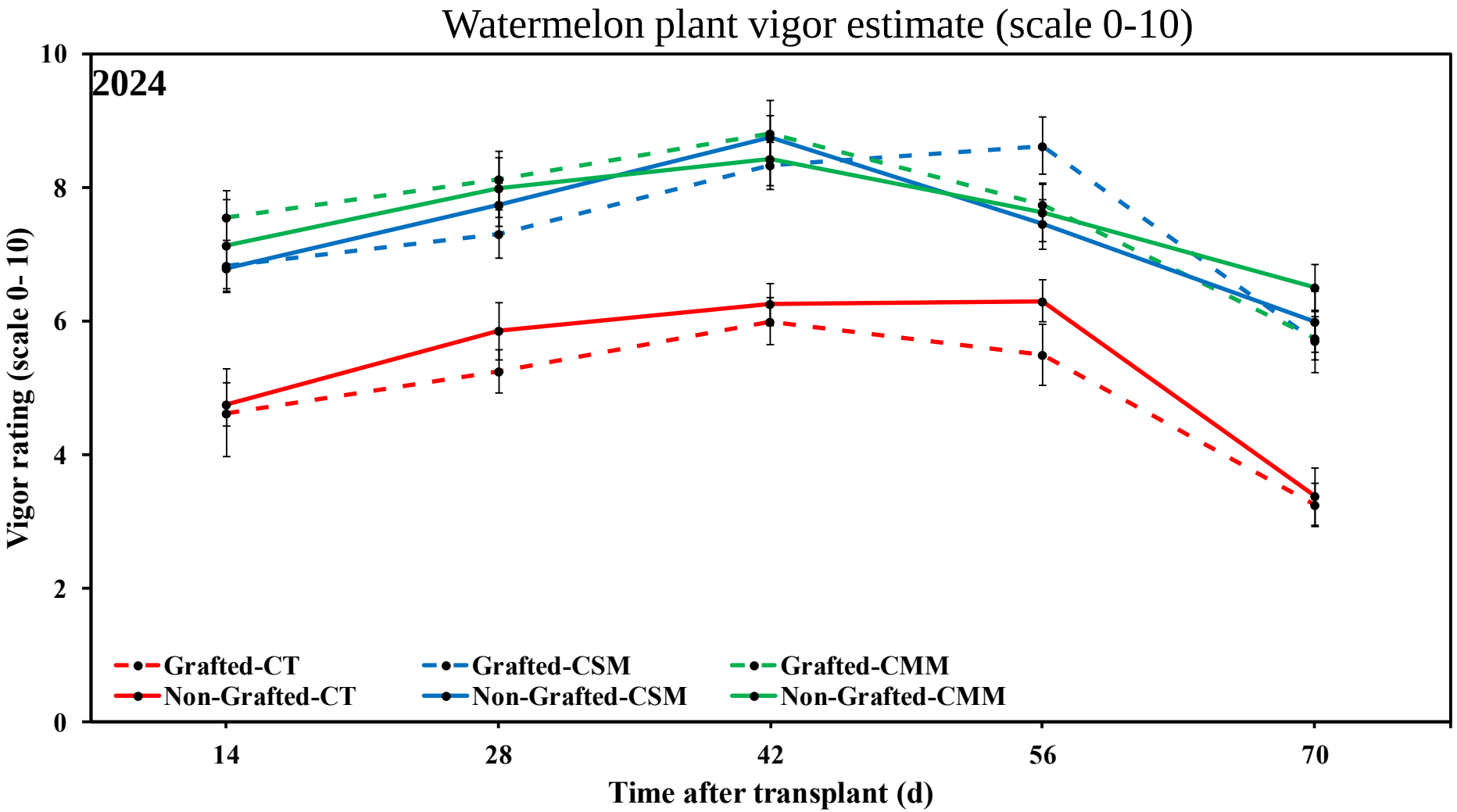


Figure: Effect of anaerobic soil disinfestation (ASD) on watermelon crop vigor rating by an index ranging from 0 (all plants are dead) to 10 (all plants are vigorous and no disease) and averaged for each season in field trial in Charleston, SC 2024. All watermelon plants per plot were evaluated visually. Abbreviations: CT, nontreated CT; CSM, cottonseed meal; CMM, chicken manure, molasses.

Watermelon marketable yield

Table: Effect of anaerobic soil disinfestation (ASD) carbon sources: nontreated control (CT), cottonseed meal (CSM), and chicken manure, molasses (CMM), on watermelon marketable yield in field trials in Charleston, SC 2023 and 2024.

Treatment		Yield 2023		
Carbon source	Cultivar	Marketable	Total	Cull
CT	Non-Grafted	23500 a	37058 a	13558 a
	Grafted	19361 a	30938 a	11577 a
CSM	Non-Grafted	35359 a	46997 a	11638 a
	Grafted	25575 a	35790 a	10215 a
CMM	Non-Grafted	43576 a	56012 a	12436 a
	Grafted	26460 a	37693 a	11233 a
p-value	Treatment	0.1809	0.3169	0.8619 a
	Cultivar	0.0928	0.0958	0.5403 a
	Treatment × Cultivar	0.6615	0.7597	0.9911

Treatment		Yield 2024			
		Harvest 1	Harvest 2		
Carbon source	Cultivar	Marketable	Marketable	Total	Cull
CT	Non-Grafted	7467 c	3506 c	5459 c	1953
	Grafted	12567 c	4089 c	6904 c	2815
CSM	Non-Grafted	58744 ab	12817 b	14076 b	1259
	Grafted	55247 b	14343 ab	15312 ab	969
CMM	Non-Grafted	74829 a	17196 a	18318 a	1122
	Grafted	60850 ab	12710 b	13778 b	1068
p-value	Treatment	<0.0001*	<0.001*	<0.0001*	<0.0001*
	Cultivar	0.1623	0.2138	0.3545	0.3940
	Treatment × Cultivar	0.0482*	0.0023*	0.0026*	0.0707

- In 2023, relatively higher marketable yield was recorded in Powerhouse (Non-Grafted) in CMM and CSM compared to when Powerhouse grafted onto rootstock Carolina Strongback (Grafted).
- In 2024, higher marketable yield was recorded in Powerhouse (Non-Grafted) in CMM treatment.
- However, CMM and CSM were statistically similar.


NO ENTRE

CMM

CSM

CT

Linear regression between yellow nutsedge shoot count and watermelon marketable yield

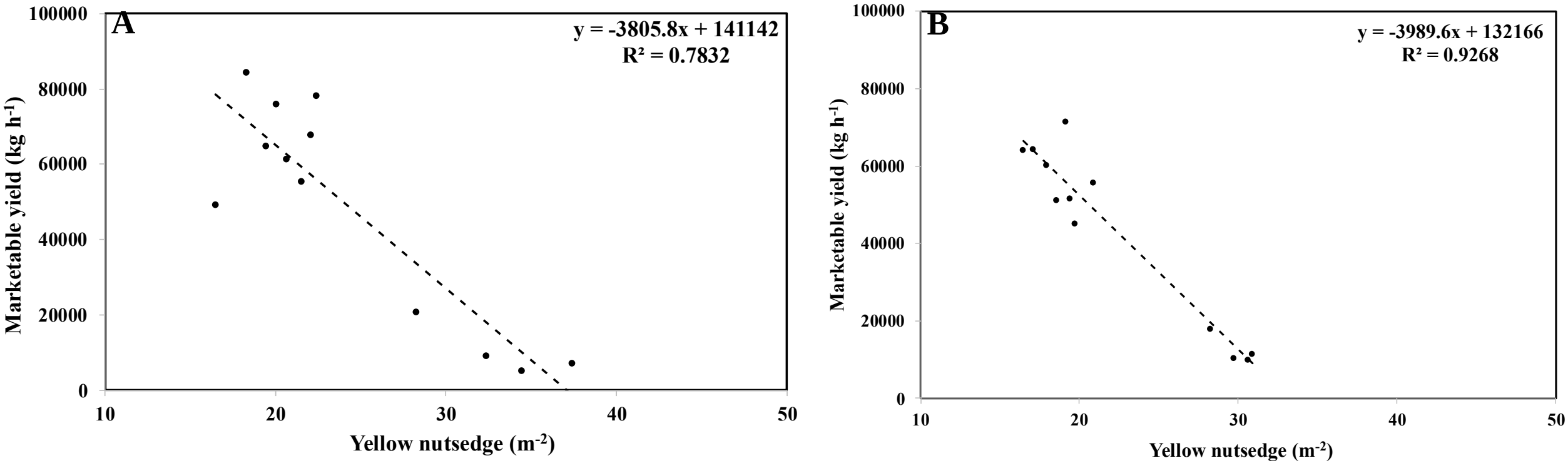
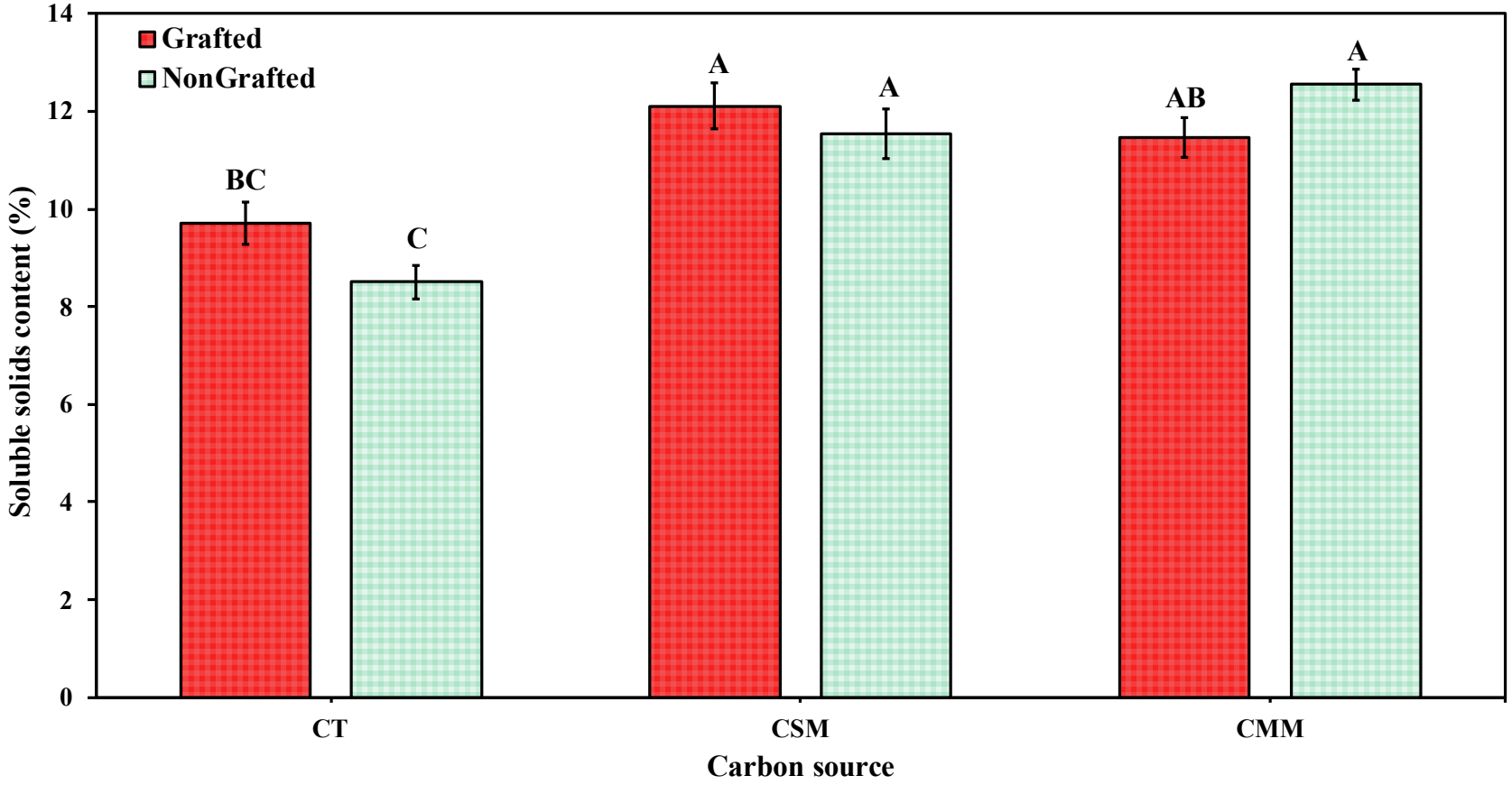


Figure: Linear regression between total yellow nutsedge count at 70 d post ASD termination, (A) Non-Grafted and (B) Grafted watermelon marketable yield in 2024.

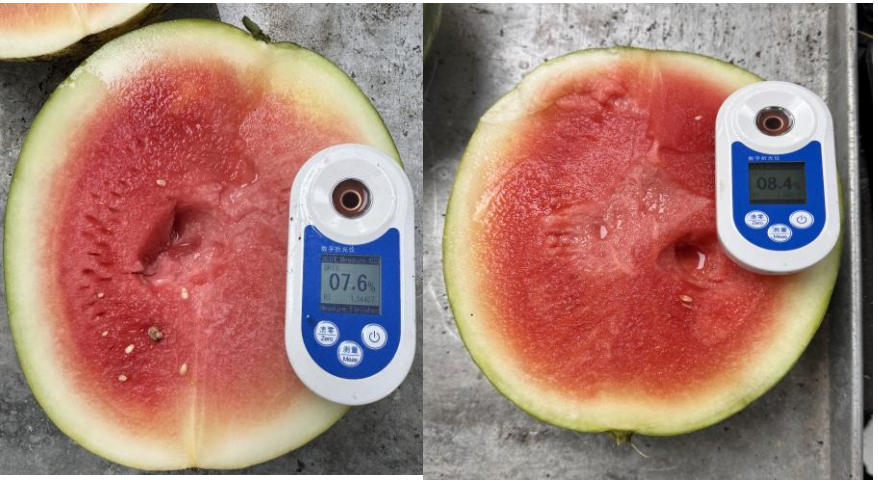
Watermelon fruit soluble solid contents (SSC) (%)



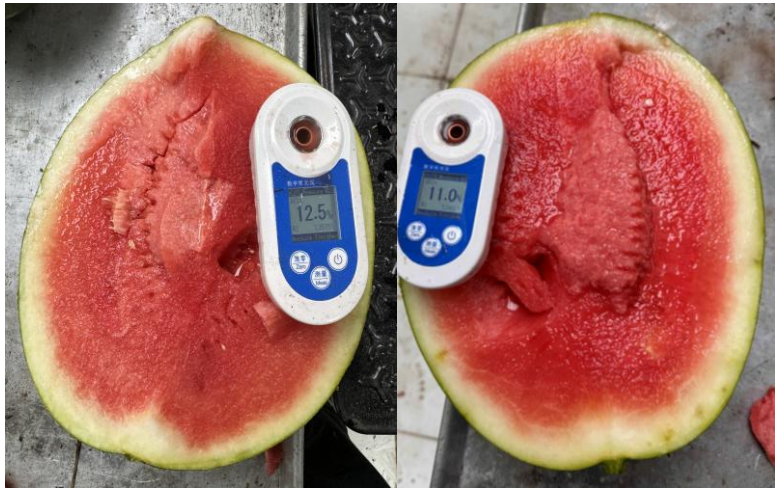
- CSM and CMM significantly improved SSC % relative to CT treatment.
- There was no significantly difference in SSC % between Non-Grafted and Grafted.
- >10% SSC is considered good quality fruit.

Figure: Effect of anaerobic soil disinfestation (ASD) carbon sources: nontreated control (CT), cottonseed meal (CSM), and chicken manure, molasses (CMM), on soluble solids content (SSC) (%) in field trials in Charleston, SC 2023-2024.

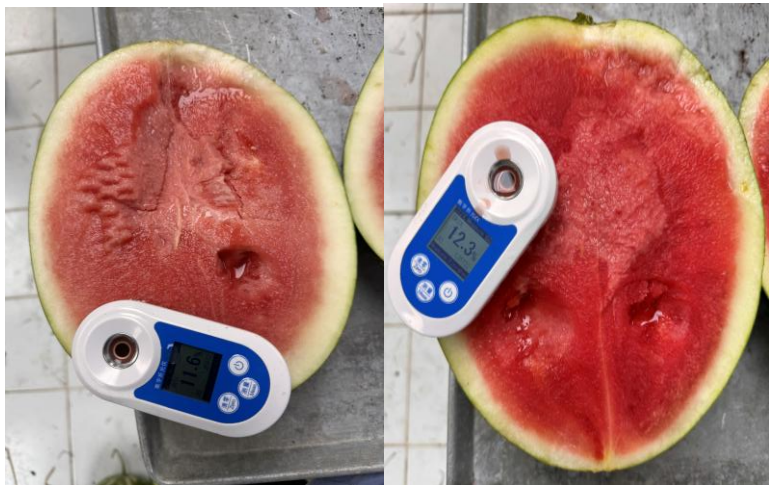
CT



CSM



CMM



Summary

Hypothesis: ASD will suppress emergence of yellow nutsedge, purple nutsedge, and grass weed species.

- ASD treatments improved suppression of yellow nutsedge, purple nutsedge, and grass weed species. (Hypothesis accepted)

Hypothesis: To determine the efficacy of locally available carbon source on weed control, plant health, yield, and quality.

- Locally available carbon source CSM significantly improved weed control, plant vigor, yield and fruit quality. (Hypothesis accepted)

Conclusions

- Locally available carbon source CSM significantly improved weed control.
- CSM can be replaced with CMM as locally available carbon source for watermelon production.
- Implementation of ASD with CSM may provide equal weed control in grafted and nongrafted watermelon.

Research questions

Q1: Could we provide a guide for genotype selection in organic watermelon production in South Carolina?

- Yes.

Q2: Could we select the best plastic mulch which improves efficacy of ASD for weed management?

- Yes.

Q3: Could we use rhizobacteria and optimize planting time for watermelon production in ASD?

- Yes.

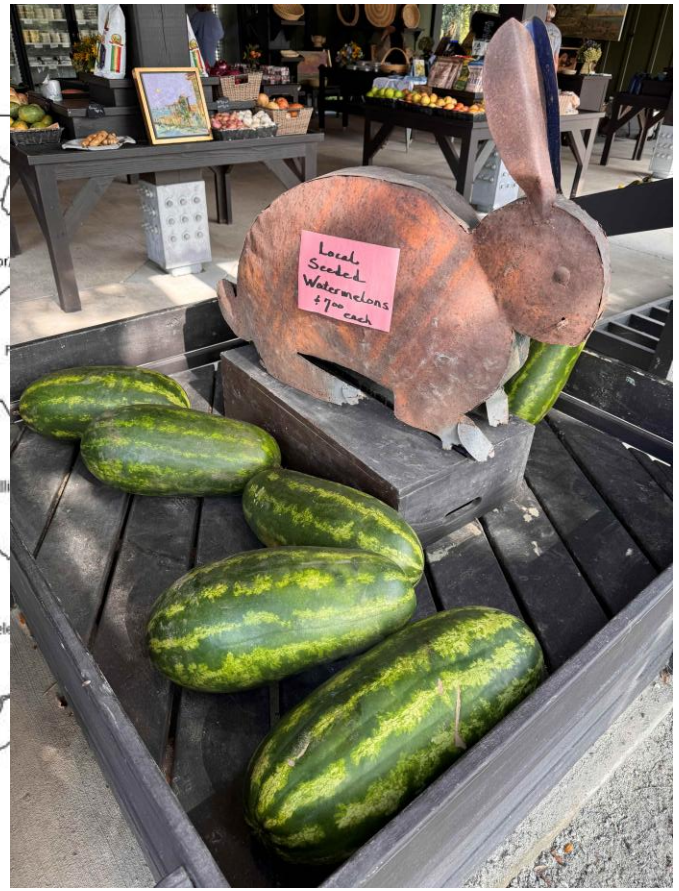
Q4: Could we utilize locally available carbon sources, such as locally available cottonseed meal, broccoli waste, to replace with Florida standard carbon source chicken manure, molasses for ASD?

- Yes.

Future research

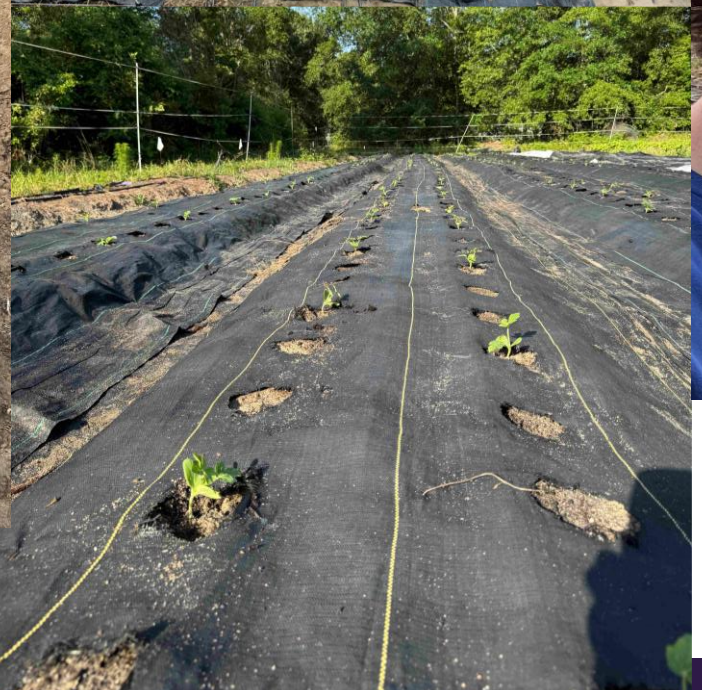
- Need to evaluate more locally sourced carbon.
- Need to evaluate more organic weed management techniques.
- Need extension agent training for ASD.
- Need to explore cover crops for ASD.
- Need to evaluate long term impact of ASD on weed seed bank.

On-farm trials




Dillon
Marion
Georgetown
Allendale
Hampton
Jasper


CT
BB+RB
RB




Marlboro

Sumter

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Co-chair: Dr. Brian Ward
Committee members:
Drs. Michael Marshall, Bhupinder Farmaha, William Bridges

SOUTHERN SARE
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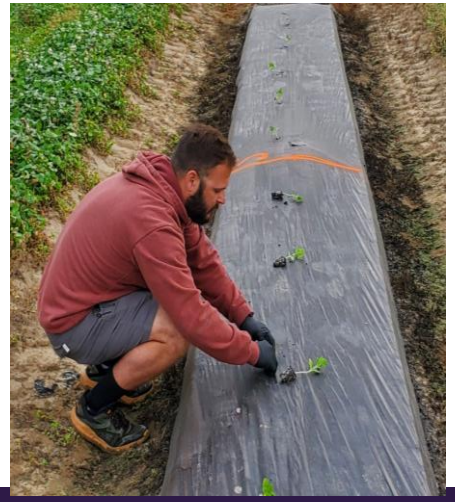


Any Questions??
NO
TRESPASSING