Cover Cropping in Conservation Tillage and Sustainable Vegetable Production

Sustainable Vegetable Production

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University of California Cooperative Extension
September 18, 2018

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Agriculture and Natural Resources

Zheng Wang

- UCCE Vegetable and Irrigation Farm Advisor since March 2018
- University of Kentucky: PhD (2011-2015)
- The Ohio State University: Postdoc (2015-2017)
- Optimizing regional and statewide vegetable production

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September 13, 2018

Provides fundamental knowledge about 1) major differences between conventional and conservation tillage, and 2) how conservation tillage is implemented in vegetable production.

Quick Review...

Conservation tillage is an alternative to the conventional tillage, and offers benefits from many aspects.

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Quick Review...

Many factors have to be considered prior to making a decision, such as cover crop selection, management and termination, cash crop selection, and on-farm equipment availability.

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Quick Review...

Conservation tillage is a holistic program, not simply a reduction of the number of tractor passes.

Today's Class Focuses on…

1) The cover crop usage (some commonly used species) in conservation tillage systems, and
2) The impact of conservation tillage on vegetable growth, soil properties, and fruit yield through a case study.

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From Reading Assignments

Five questions to think about:

- Why did they use cover crops?
- From your understanding, what are the most important factors for cover cropping?
- Why did they choose multiple species over single species?
- When should you consider using multiple species of cover crops?

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From Reading Assignments

Five questions to think about: Q5 is an open question.

- If you were a commercial vegetable grower in the central valley who have farmed conventionally for many years, but now decides to transition to the reduced tillage and use of cover crops, what factors do you have to consider prior to growing a cover crop and what factors do you think that are unique to other states?

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What is a Cover Crop?

A cover crop is a plant that is used primarily to slow erosion, improve soil health, enhance water availability, smother weeds, help control pests and diseases, increase biodiversity, and bring a host of other benefits to your farm.

SARE
Sustainable Agriculture Research & Education

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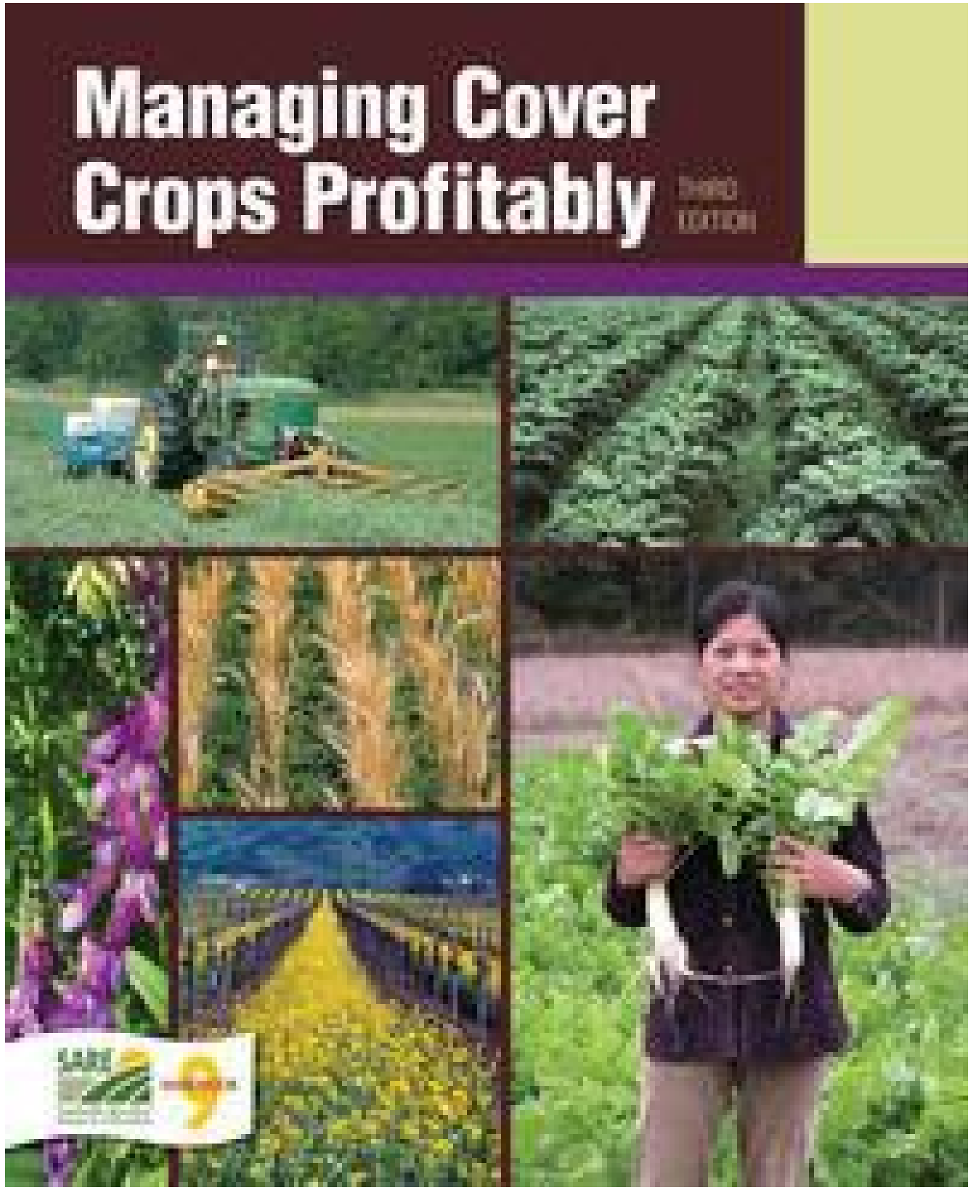
Types of Cover Crops



https://www.sare.org/Learning-Center/Books/Managing-Cover-Crops-Profitably-3rd-Edition

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Types of Cover Crops

Grasses:

- annual cereal grains,
- annual/perennial forage grass, and
- warm-season grass

Winter Rye

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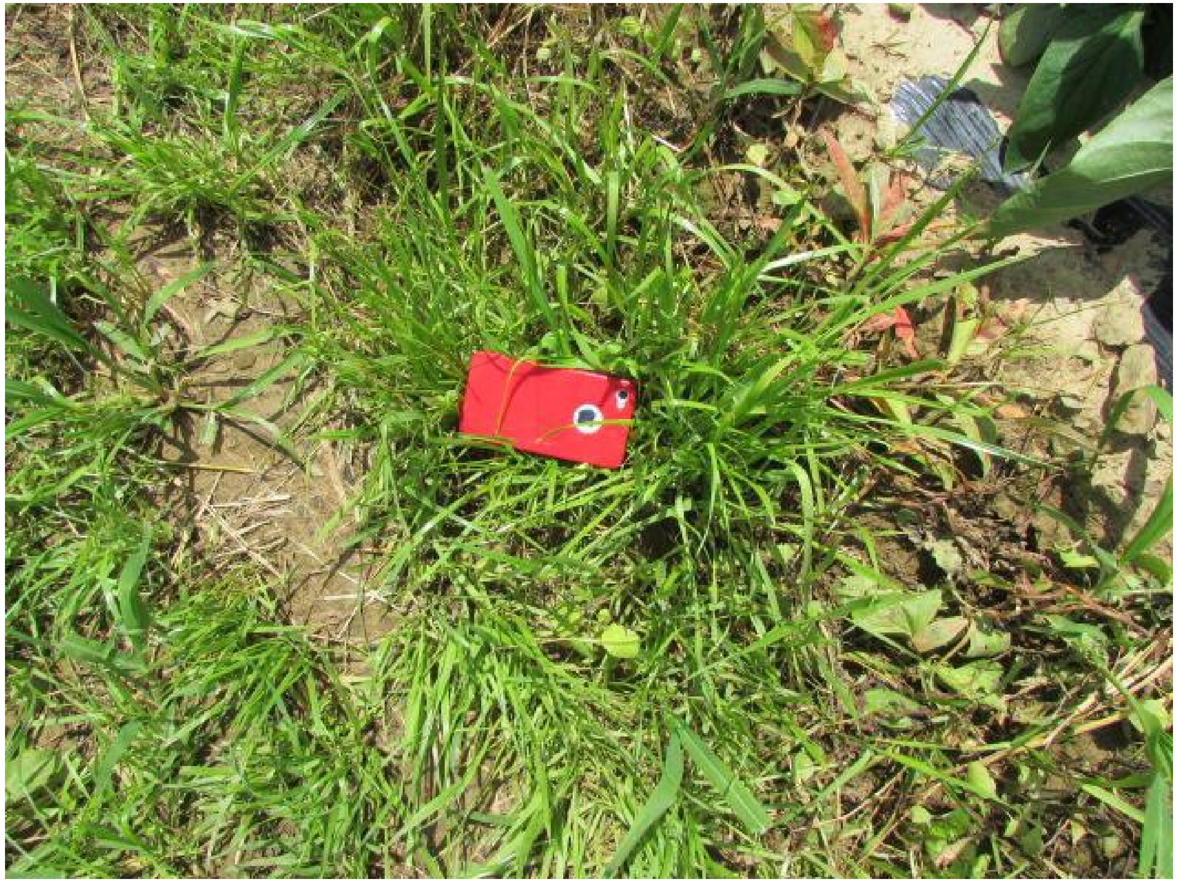
Types of Cover Crops

Grasses:

- annual cereal grains,
- <u>annual/perennial forage grass</u>, and
- warm-season grass



Annual Ryegrass

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Types of Cover Crops

Grasses:

- annual cereal grains,
- annual/perennial forage grass, and
- <u>warm-season grass</u>

Sorghum Sudangrass

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Types of Cover Crops

Legumes:

- <u>summer annual legumes</u>,
- winter annual legumes, and
- biennial and perennial legumes

Cowpea

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Types of Cover Crops

Legumes:

- summer annual legumes,
- <u>winter annual legumes</u>, and
- biennial and perennial legumes

Hairy Vetch

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Types of Cover Crops

Legumes:

- summer annual legumes,
- winter annual legumes, and
- <u>biennial and perennial legumes</u>

White Clover

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Types of Cover Crops

Brassicas:

- leafy species,
- oil-producing species, and
- root species

Mustard

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Types of Cover Crops

Brassicas:

- leafy species,
- oil-producing species, and
- root species

Rapeseed

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Types of Cover Crops

Brassicas:

- leafy species,
- oil-producing species, and
- root species

Tillage Radish

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Multiple R’s: right time? right rate? right management? right purpose? ……

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Abundance is not a problem; not knowing how to match their functions with your goals before conservation tillage is a problem.

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By purpose, cover crops can…

1) suppress weeds
2) replenish soil nutrients
3) increase soil organic matter
4) scavenge excess nutrients
5) enhance soil properties

Your goals matter!

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Examples

A tomato grower from Michigan plans to protect his field by shifting from intensive tillage to strip tillage and growing cover crops. Historically, his soil is lacking nitrogen, but his weed control is good by using herbicide. How can you help him with cover cropping using your knowledge?

Keywords extracted: Tomato, Michigan, lack of N, low weed pressure.

Further analysis: Tomato, Michigan, lack of N, low weed pressure.

Tomato = high nutrient demanding.

Michigan = cold and long winter and short summer season.

Lack of N = replenishment is necessary.

Low weed pressure = good habit, keep it.

Solutions:

Hairy vetch is the possible choice because it is

1) winter-hardy enough down to Zone 3 (snow cover).
2) efficient in nitrogen fixation (> 100 lb N/Acre).
3) killed easily and decomposed quickly (less likely to become a new weed).

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Examples

A tomato grower from Michigan plans to protect his field by shifting from intensive tillage to strip tillage and growing cover crops. Historically, his soil is lack of nitrogen, and <u>he wants to reduce the cost of using herbicide</u>. How can you help him with cover cropping using your knowledge?

Keywords extracted: Tomato, Michigan, lack of N, weed pressure, high cost of weed control.

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Further analysis: Tomato, Michigan, lack of N, weed pressure, high cost of weed control.

Tomato = high nutrient demanding

Michigan = cold and long winter and short summer season

Lack of N = replenishment is necessary

Weed pressure = good mulch coverage

High cost of weed control = effects last longer

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Solutions:

"Hairy vetch + winter rye" is the possible choice because it is

1) winter-hardy enough down to Zone 3 (snow cover).
2) efficient in nitrogen fixation (> 100 lb N/Acre).
3) killed easily and decomposed quickly (less likely to become a new weed).
4) producing large biomass to suppress weed emergence.
5) decompose slowly that control effects last longer.
6) growing rapidly even in the winter.

Our solutions have to cope with the changes of circumstance.

They are Different…

A (tomato vs. broccoli) grower from (Michigan vs. California) plans to protect his field by shifting from intensive tillage to strip tillage and growing cover crops. Historically, his soil is (lack vs. excess) in nitrogen, and he wants to (reduce the cost of using herbicide vs. turn to organic). How can you help him with cover cropping using your knowledge?

Recap: Three Questions to Ask

Before implementing conservation tillage,

1) are you ready for seeding cover crops (e.g., equipment, rate, irrigation)?
2) what is your goal (very important)?
3) can they overwinter and when to terminate?

Today’s Class Focuses on…

1) The cover crop usage (<u>some commonly used species</u>) in conservation tillage systems, and
2) The impact of conservation tillage on vegetable growth, soil properties, and fruit yield through <u>a case study</u>.

Strip Tillage, Plant-Soil Water Properties, and Crop Productivity: A Case Study in Kentucky

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Impact of Tillage and Irrigation Management on Bell Pepper (*Capsicum annuum* L.) Grown in Organic and Conventional Production Systems

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Evaluation of Conservation Tillage and Plasticulture Production Systems for Organically and Conventionally Grown Bell Peppers in Well-Watered and Drought Conditions

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Working Objectives

Determine if tillage and irrigation management will impact soil moisture content, soil compaction, pepper plant-water status, and plant productivity in organic and conventional systems.

UK’s Horticulture Research Farm (Lexington, KY)

2011 and 2012

Certified organic and conventional systems

Strip tillage vs. plastic mulch

Well-watered vs. water-restricted

Bell Pepper ‘Aristotle’

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Field Preparation

<u>Organic/conventional strip-till</u>: rye-vetch (organic) and winter wheat (conventional) cover crops were rolled/crimped and herbicide killed followed by strip tilling.

<u>Organic/conventional plastic mulch</u>: cover crops were mowed using a flail mower, and the field was tilled by a rotary spader or a roto-tiller prior to laying plastic.

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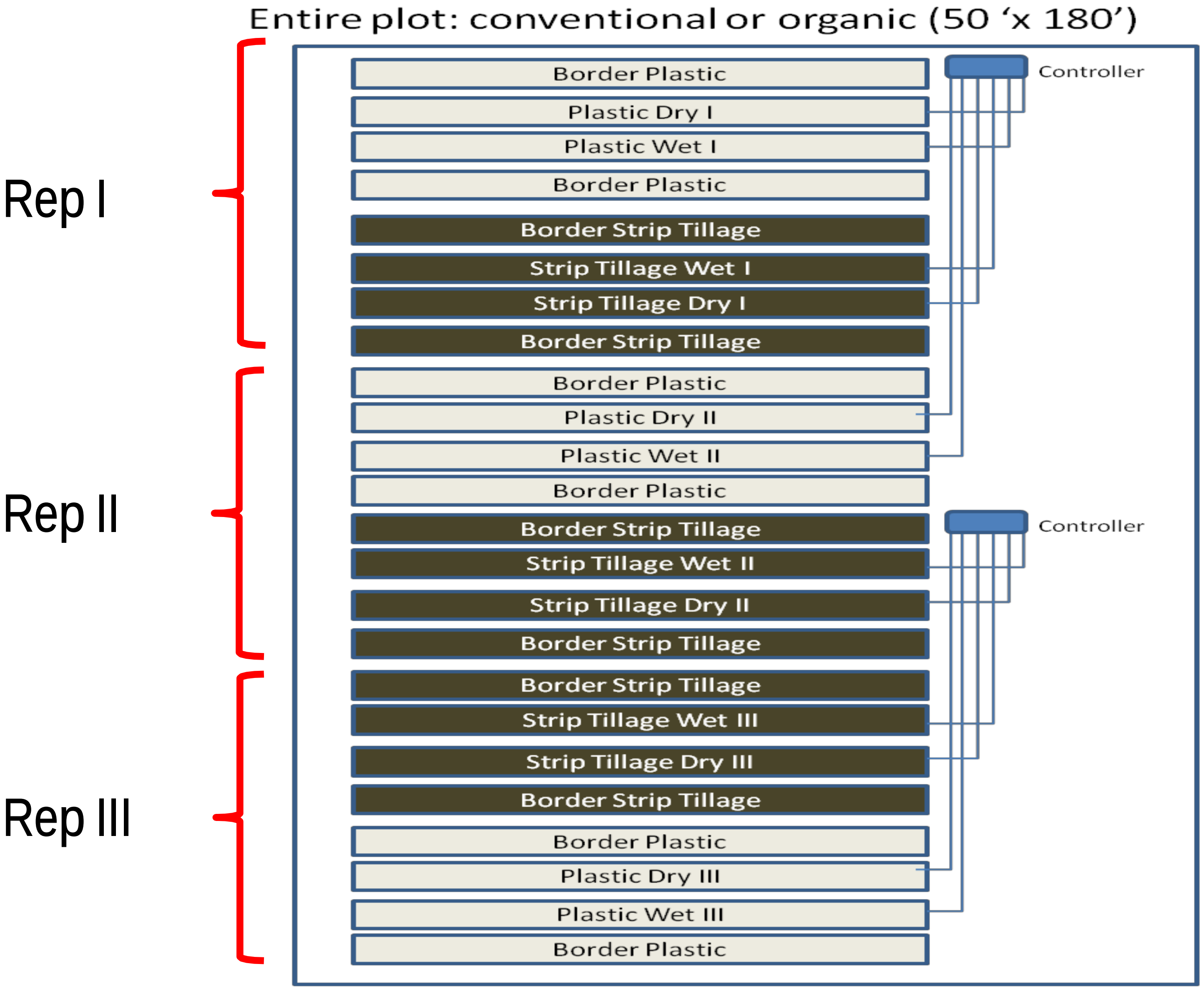

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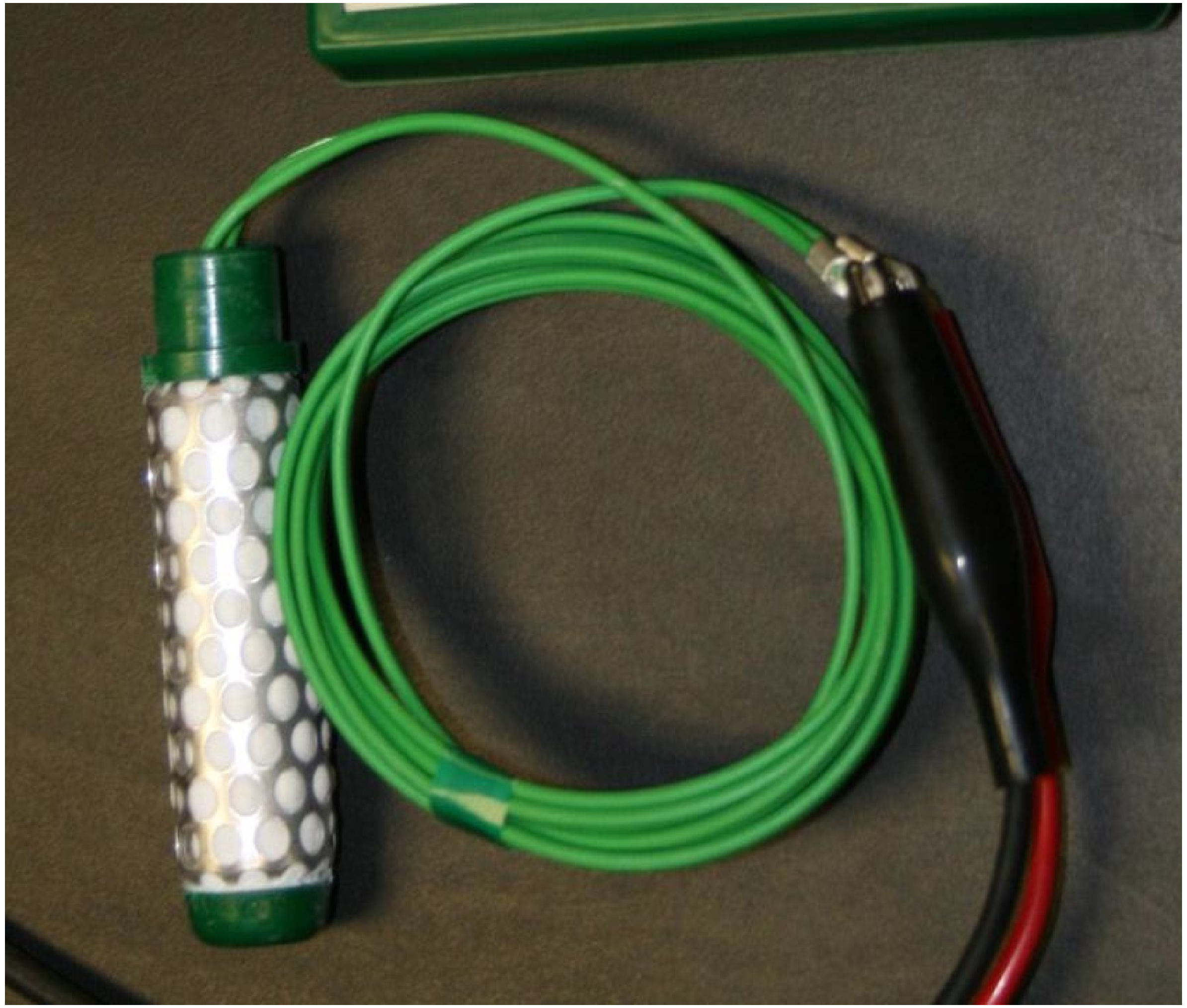
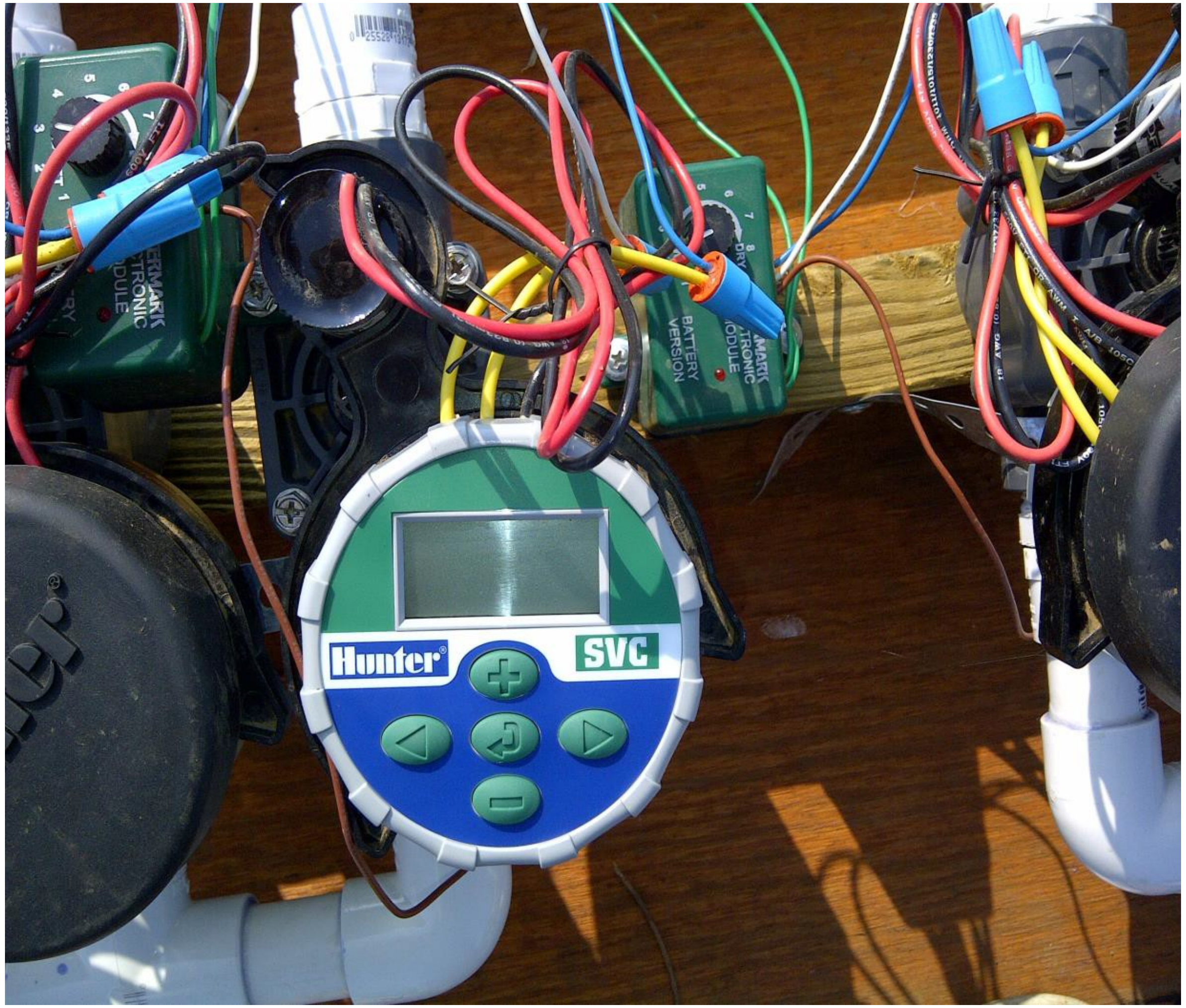
Irrigation Installation





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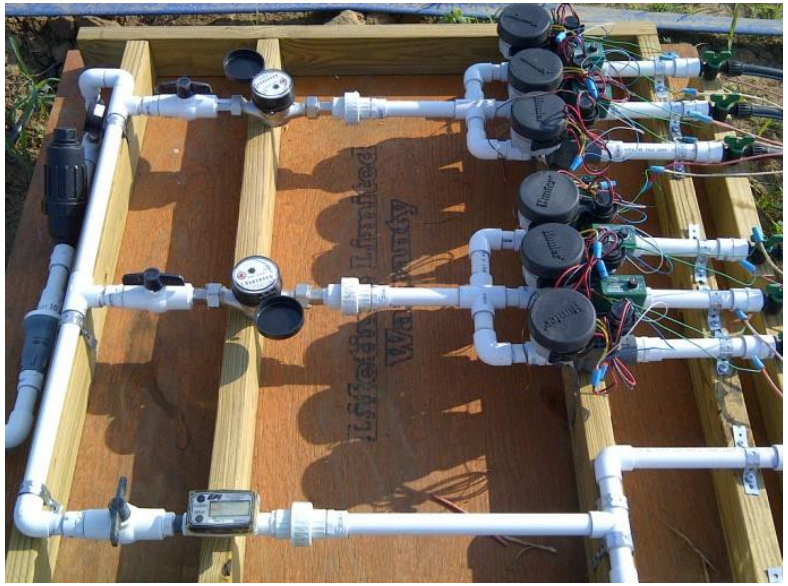

Well-water: 23% VWC (-61 kPa)
Water-restriction: 19% VWC (-101 kPa)

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Data Collection

Volumetric soil moisture and temperature: hourly readings from 5-TM moisture/temperature probes installed at depth of 6-inch were stored in EM-50 datalogger.

Leaf water potential: measured 1) by a pressure pump chamber, and 2) at pre-dawn and mid-day.

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Soil penetration resistance:

Measured 8 wks after transplanting (within and between row).

Defined as work (energy) plant roots need to push through and grow downward into the soil.

Measured every 2 inches from 2 to 12 inches

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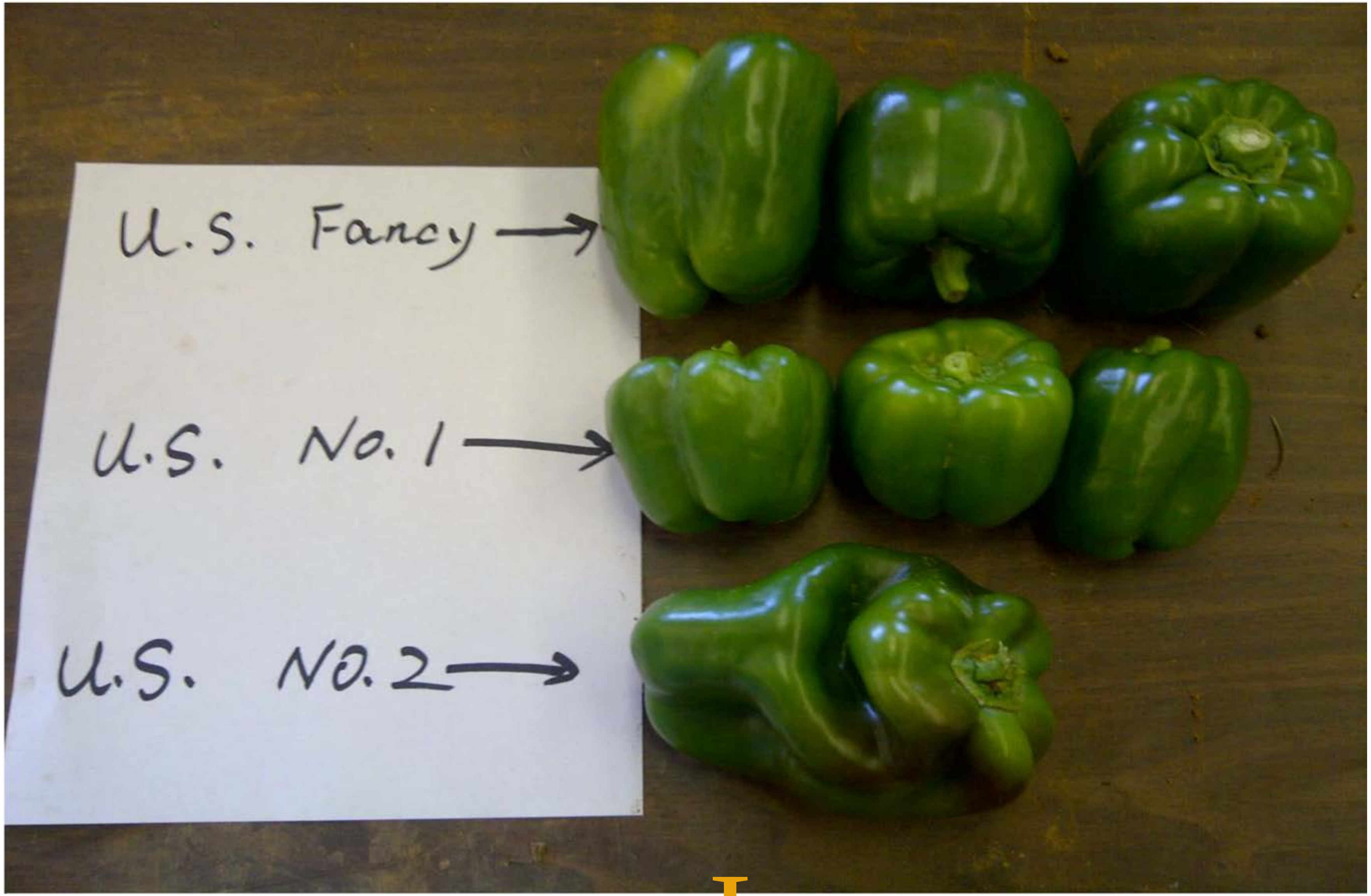
Yield Performance

- 3 and 5 harvests in 2011 and 2012.
- Fruit was counted, weighed, graded by USDA standard of sweet pepper, and data were converted to 1000-plant basis.



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Results

Soil Moisture Level

Soil volumetric water content (VWC) ($cm^3 \cdot cm^{-3}$) at 6-inch depth

Tillage	Irrigation	2011				2012			
		OR[z]		CO		OR		CO	
		VWC ($cm^3 \cdot cm^{-3}$)							
ST[y]	WW[x]	25.6	A	25.3	A	22.8	AB	24.1	A
ST	WR	22.3	B	23.1	B	22.1	B	22.8	B
PM	WW	19.7	C	26.0	A	23.8	A	20.9	C
PM	WR	18.8	C	22.6	B	22.5	B	20.5	C

[z]OR and CO = organic and convention; [y]ST and PM = strip tillage and plastic mulch

[x]WW and WR = well-watered and water-restricted

Wang et al. (2015) HortScience

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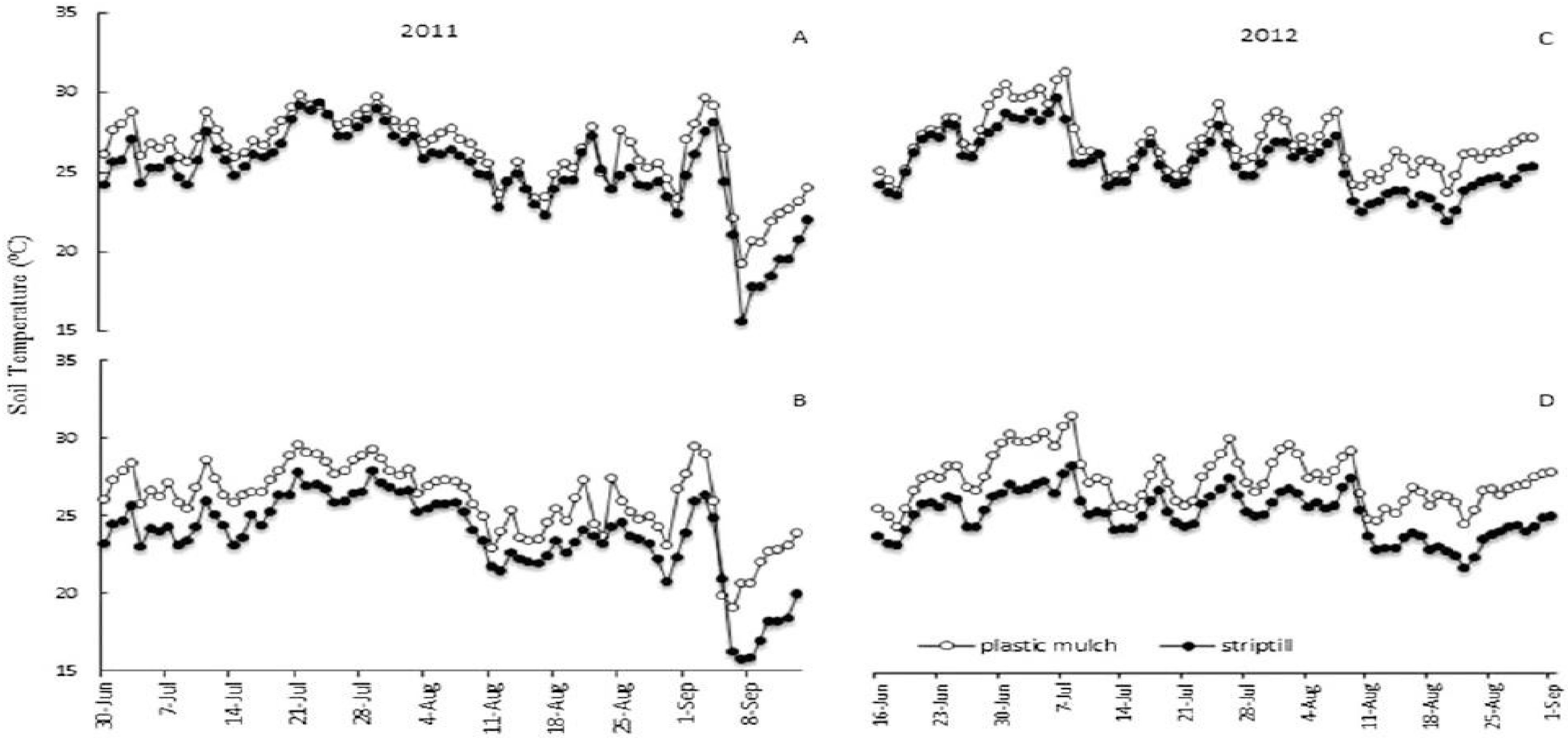
Soil Temperature at 6-inch



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A and C: Conventional; B and D: Organic

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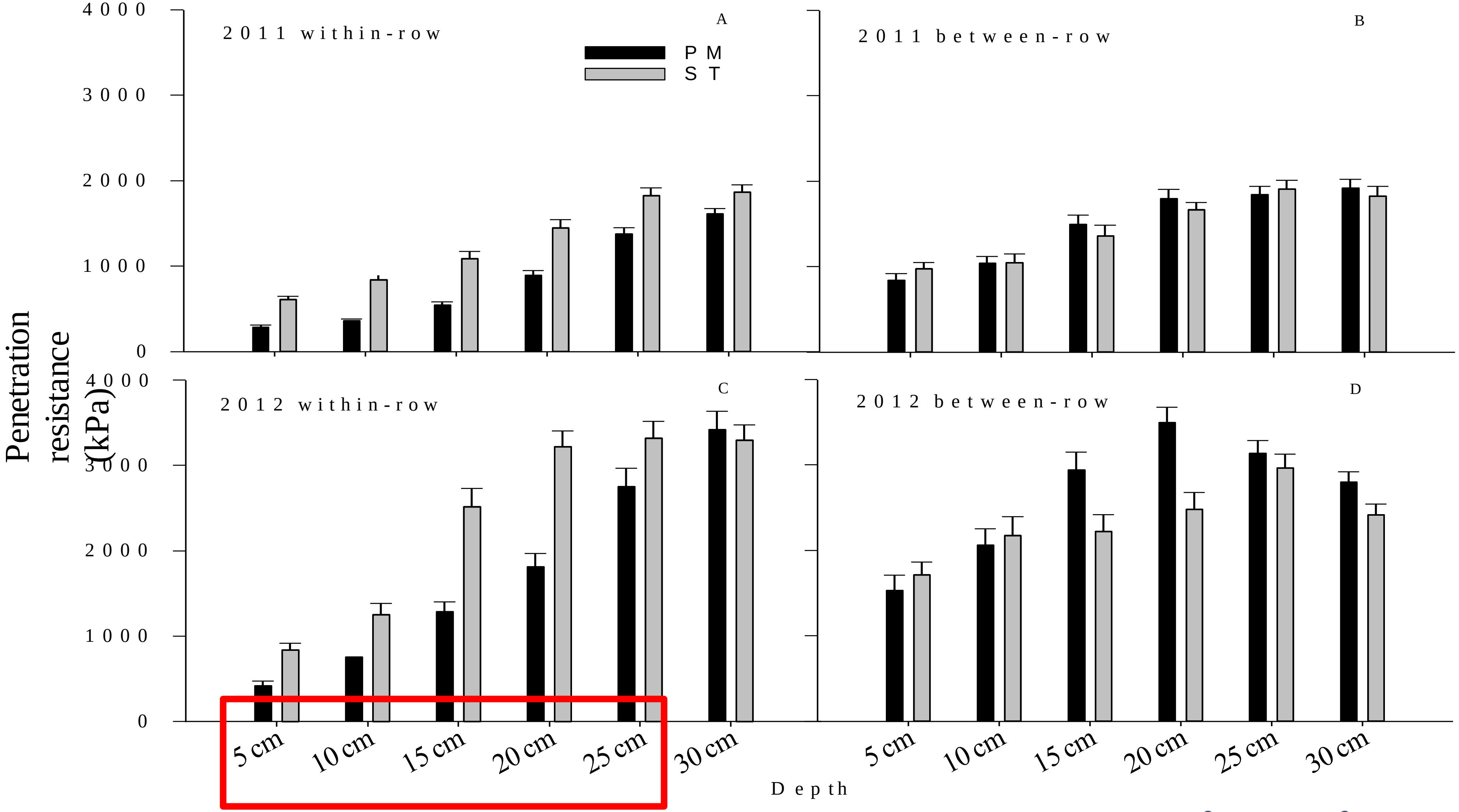
Soil Penetration Resistance



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Tillage	Irrigation	Conventional			Organic		
		Mkt. yield (lb/1000 plants)	Mkt. no. (no/1000 plants)	Avg. fruit wt. (oz)	Mkt. yield (lb/1000 plants)	Mkt. no. (no/1000 plants)	Avg. fruit wt. (oz)
				2011			
Plastic	WW*	2915 A	7030 A	6.6 A	1830 A	4820 B	6.1 A
Plastic	WR	1800 B	4985 B	5.8 B	2130 A	5300 B	6.4 A
Strip	WW	1780 B	4930 B	5.8 B	2245 A	7070 A	5.1 B
Strip	WR	1600 B	4635 B	5.5 B	1900 A	6000 AB	5.1 B
				2012			
Plastic	WW	4895 A	14355 A	5.5 A	4650 A	13460 B	5.5 A
Plastic	WR	4760 A	13640 B	5.6 A	3575 A	11000 B	5.2 A
Strip	WW	3520 B	10705 C	5.3 AB	4555 A	14210 A	5.1 A
Strip	WR	3410 B	11085 C	4.9 B	4160 A	13160 B	5.1 A

*WW and WR = Well-watered and Water-restricted.

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Tillage Effects on Maturity Delay

Tillage	Conventional	Organic
	Yield_Mid (days)*	
	2011	
Plastic	63 B	65 B
Strip	69 A	75 A
	2012	
Plastic	92 A	94 A
Strip	93 A	97 A

*Yield_Mid: No. of days after transplanting at which 50% of marketable fruit were harvested.

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Conclusions from the Study

1. Strip tillage field maintained higher soil water content and penetration resistance, and lower temperature than the standard tillage treatment (plastic mulch).

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Conclusions from the Study

2. Yield performance and fruit maturity were affected differently by tillage applications in organic and conventional systems.

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From Reading Assignments

Five questions to think about:

- Why did they use cover crops?
- From your understanding, what are the most important factors for cover cropping?
- Why did they choose multiple species over single species?
- When should you consider using multiple species of cover crops?

From Reading Assignments

Five questions to think about: Q5 is an open question.

- If you were a commercial vegetable grower in the central valley who have farmed conventionally for many years, but now decides to transition to the reduced tillage and use of cover crops, what factors do you have to consider prior to growing a cover crop and what factors do you think that are unique to other states?

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Lecture Slides

Download PDF copies of the two lectures: http://cestanislaus.ucanr.edu/Agriculture/Vegetable_Crops/.

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Post-class Survey

Please complete the post-class surveys Feel free to contact Dr. Zavalloni or me (209.525.6822; zzwwang@ucdavis.edu) with questions.

GOOD LUCK!

THANK YOU

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