Effect of Orchard Management Practices on Peach Tree Growth, Yield, and Soil Ecology

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Soil and Orchard Floor Management

- Historically, standard orchards were planted on sites that were not as productive for row crops
- You must determine soil type and characteristics with soil survey maps

http://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm

USDA United States Department of Agriculture
Natural Resources Conservation Service

Web Soil Survey

Contact Us | Subscribe | Archived Soil Surveys | Soil Survey Status | Glossary | Preferences | Link | Logout | Help

Area of Interest (AOI) | Soil Map | Soil Data Explorer | Download Soils Data | Shopping Cart (Free)

Search

Area of Interest

Import AOI

Quick Navigation

Address

State and County

View

State: North Carolina

County (optional): Johnston

View

Soil Survey Area

Latitude and Longitude

PLSS (Section, Township, Range)

Bureau of Land Management

Department of Defense

Forest Service

National Park Service

Hydrologic Unit

Legend

Area of Interest Interactive Map

View Extent: Contiguous U.S. | Scale: (not to scale)

A Cautionary Note

- Soil Surveys are accurate to approximately 5 acres
- Each map unit contains inclusions
- Always determine associated series to better understand soil/site relations

Note: Soil survey data is useful for initial planning, but field evaluation is necessary for proper site and soil evaluation

Ap—0 to 7 inches; grayish brown (10YR 5/2) sandy loam, very dark grayish brown (10YR 3/2) moist; weak coarse subangular blocky structure; slightly hard, friable, slightly sticky; neutral; abrupt smooth boundary.

B2t—7 to 12 inches; grayish brown (10YR 5/2) sandy clay loam, dark grayish brown (10YR 4/2) moist; weak coarse prismatic structure parting to moderate coarse subangular blocky; slightly hard, friable, sticky; thin continuous clay films; mildly alkaline; clear smooth boundary.

B31—12 to 16 inches; light brownish gray (10YR 6/2) loam, dark grayish brown (10YR 4/2) moist; weak coarse subangular blocky structure; soft, very friable, slightly sticky; neutral; clear smooth boundary.

B32ca—16 to 20 inches; light gray (10YR 7/2) loam, grayish brown (10YR 5/2) moist; weak coarse subangular blocky structure; slightly hard, friable, slightly sticky; visible calcium carbonates occur as concretions and in thin seams and streaks; strongly calcareous; moderately alkaline; clear smooth boundary.

Cca—20 to 60 inches; light gray (10YR 7/2) sandy clay loam, grayish brown (10YR 5/2) moist; massive; slightly hard, friable, sticky; calcareous; moderately alkaline.

The solum is 15 to 40 inches thick. Depth to carbonates is 8 to 30 inches. The mollic epipedon is 7 to 20 inches thick.

The A horizon is sandy loam or fine sandy loam. The C horizon is sandy loam or sandy clay loam that is calcareous or strongly calcareous.

Bankard series

The Bankard series consists of very deep, excessively drained sandy soils on flood plains. These soils formed in sandy alluvium along the Belle Fourche River. The slope range is 0 to 3 percent. The average annual precipitation is about 16 inches. The average annual air temperature is about 46 degrees F.

Bankard soils are similar to Barnum, Haverson, Glenberg, Otero, and Valent soils. They are near Glenberg, Haverson, and Lohmiller soils, and Riverwash. Barnum, Haverson, Glenberg, and Lohmiller soils are finer textured then Bankard soils. Otero and Valent soils do not have an irregular decrease of organic matter. Riverwash is gravelly throughout.

Typical pedon of Bankard loamy fine sand in an area of Bankard loamy fine sand, 0 to 3 percent slopes, 3 miles northwest of Mona, SW1/4NE1/4 sec. 15, T. 56 N., R. 63 W.

A1—0 to 4 inches; pale brown (10YR 6/3) loamy fine sand, dark brown (10YR 4/3) moist; weak granular structure; soft, very friable, nonsticky; mildly alkaline; abrupt wavy boundary.

C1—4 to 26 inches; pale brown (10YR 6/3) loamy fine sand, brown (10YR 4/3) moist; very weak fine subangular blocky structure; slightly hard, very friable, nonsticky; slightly calcareous; moderately alkaline; abrupt wavy boundary.

C2—26 to 34 inches; very pale brown (10YR 7/3) loamy fine sand, grayish brown (10YR 5/2) moist; very weak subangular blocky structure; slightly hard, friable, nonsticky; slightly calcareous; moderately alkaline; abrupt wavy boundary.

C3—34 to 44 inches; very pale brown (10YR 7/3) fine sand, brown (10YR 5/3) moist; single grain; loose, nonsticky; moderately calcareous; moderately alkaline; abrupt wavy boundary.

C4—44 to 48 inches; very pale brown (10YR 7/4) fine sand, yellowish brown (10YR 5/4) moist; massive; slightly hard, very friable, nonsticky; moderately calcareous; moderately alkaline; abrupt wavy boundary.

C5—48 to 60 inches; very pale brown (10YR 7/3) very fine sand, brown (10YR 5/3) moist; single grain; loose, nonsticky; moderately calcareous; moderately alkaline.

The soil may be noncalcareous in the upper few inches. The A horizon is loamy sand or loamy fine sand. The C horizon is moderately to strongly alkaline fine sand to loamy fine sand.

Barnum series

The Barnum series consists of very deep, well drained soils formed in alluvium weathered mainly from red-bed shale and sandstone. These soils are on flood plains and terraces. The slope range is 0 to 3 percent. The average annual precipitation is about 16 inches. The average annual air temperature is about 46 degrees F.

Barnum soils are similar to Bankard, Haverson, Glenberg, and Nevee soils. They are near Haverson, Nevee, Spearfish, Tilford, and Vale soils. Bankard, Haverson, and Glenberg soils have hue no redder than 7.5YR. Nevee soils are not stratified, and organic matter content decreases uniformly with depth. Tilford and Vale soils have a mollic epipedon. Vale soils have an argillic horizon. Spearfish soils have bedrock within a depth of 20 inches.

Typical pedon of Barnum silt loam in an area of Barnum silt loam, 0 to 3 percent slopes, about one-half mile south of Beulah, SE1/4NE1/4 sec. 31, T. 52 N., R. 60 W.

Ap—0 to 8 inches; light reddish brown (5YR 6/4) silt loam, reddish brown (5YR 4/4) moist; very weak fine subangular blocky structure; slightly hard, friable, slightly sticky; calcareous; moderately alkaline; clear smooth boundary.

C—8 to 60 inches; reddish yellow (5YR 6/6) silt loam, yellowish red (5YR 4/6) moist; very weak

Soil Factors to Consider

- Soil depth
- Soil drainage
- Soil permeability and moisture holding capacity
- Soil fertility
  - pH
  - Cation Exchange Capacity (CEC)
- Site slope
- Nematode populations
- Disease history – Oak root rot fungus, *Phytophthora*, etc.

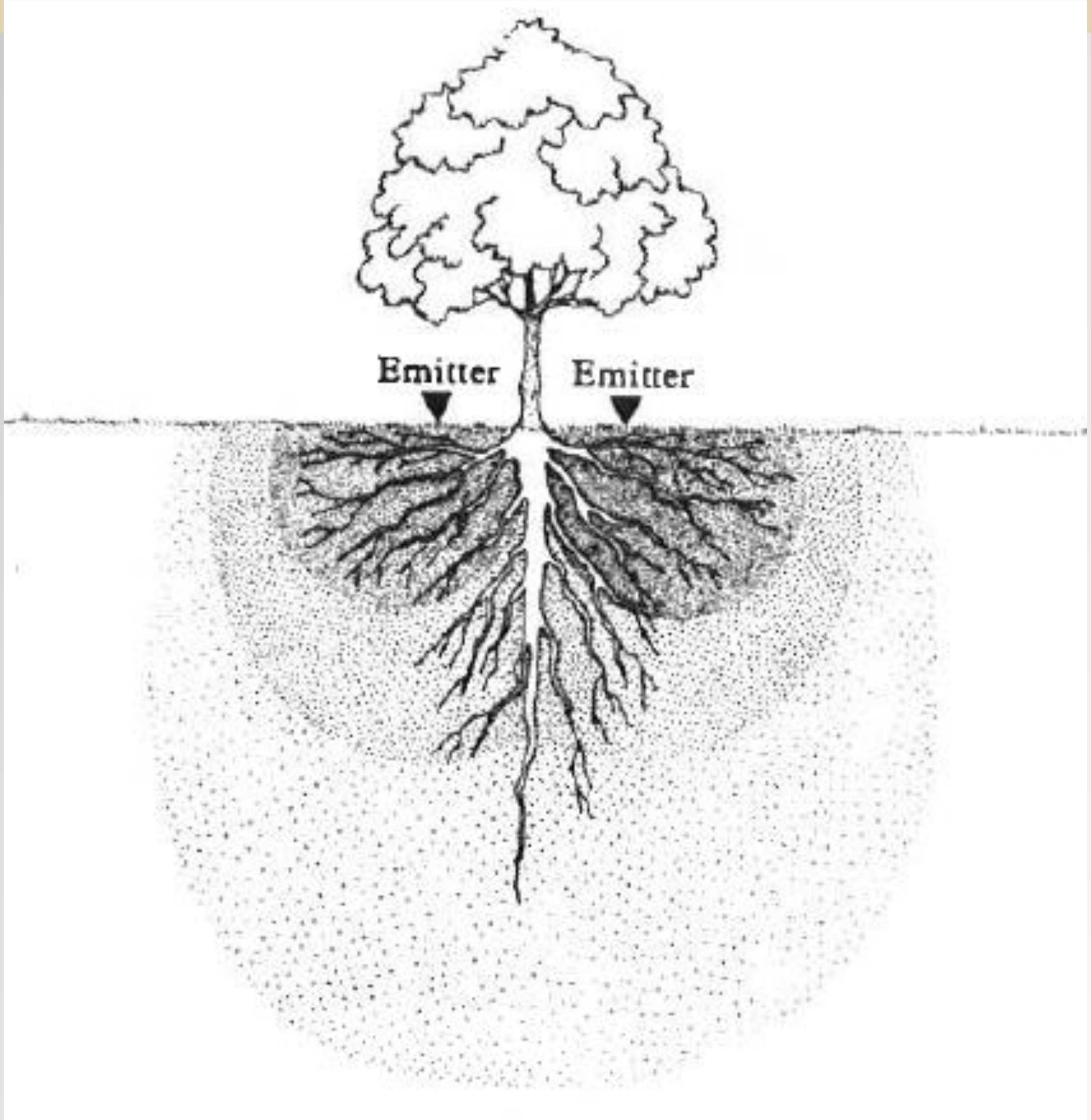
Desired Orchard Soil

- Well-drained sandy loam to loam
- Soil with a depth of at least 3 ft
- No perennial weed problems
- Free from major pest populations

Table 7-2. The relationship of soil type to water holding capacity and moisture availability to plants.

Soil Type	Water Content: At Field Capacity (%)	At Permanent Wilting (%)	Available Water (%)
Sandy loam	12	4	8
Loam	24	12	12
Adobe clay	38	19	19

Pattern of Wetting from Trickle Irrigation



Soil Considerations

- Deep, well drained, sandy loam soils are best
- Tight clay soils = slow growth, reduced productivity
- Low (or no) water table
  - All fruit tree species very sensitive to flooding stress (reduces productivity and may kill trees)
  - Encourages soil-borne fungal and bacterial diseases
- pH 5.5 to 6.5 for most species
  - Slightly acid soils help keep micronutrients (Fe, Cu, Mn, Zn) available
- Adequate calcium is essential for fruit growth and quality (may need to add lime)!

Soil pH Affects Nutrient Availability to Plants

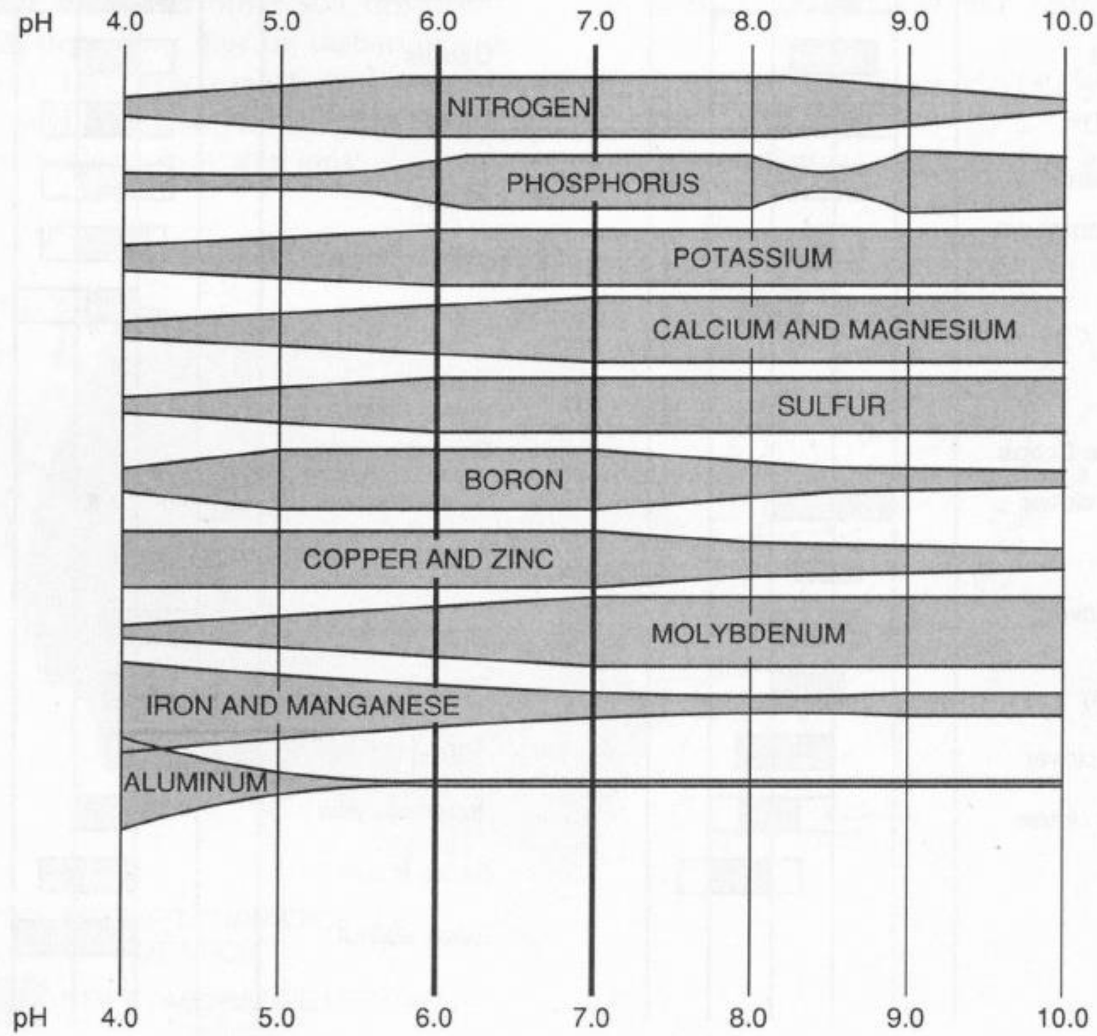


FIGURE 10-8 The soil pH affects the nutrient and aluminum levels in mineral soils of temperate climates. The thicker the bar, the more available the nutrient. The flares at the acid end of the bars for iron and manganese and aluminum show their solubility in acid soil. *(Adapted from Truog, USDA* Yearbook of Agriculture *1943–1947)*

Soil Preparation

- Prepare well ahead of planting (at least 1 yr)
- Soil test for pH, P, K, Ca, Mg levels
- Identify problem areas with poor drainage, poor soil type, frost-prone areas, hard pan depth
- Cover crop such as alfalfa or clover
  - Builds soil tilth, organic matter, N

Soil Preparation: Leveling

- May be necessary for equipment operation, eliminate low spots, poorly drained areas
- Problem-removes top soil from high areas, exposes subsoil; poor growth on former high spots if top soil shallow, result is uneven growth of trees
- Raised beds: Necessary with poor drainage or high water table; increases rooting volume

Soil Preparation: Subsoiling, Chiseling

- May be necessary to break up hard pans/clay layers which restrict rooting
- Subsoil at least 2 feet
- Add lime when mixing soil (if pH low) since calcium movement in soil is very slow; add gypsum if no pH adjustment is necessary
- Alternative = backhoe or auger individual holes for trees


Orchard Floor Management Can Affect Many Aspects of a Peach Orchard
Slide courtesy Mike Parker, NCSU

Orchard Floor Management May Influence:

- Tree Nutrition
- Tree Growth
  - Vegetative
  - Root
- Fruit yield, size
- Winter Hardiness
- Frost Protection
- Soil Moisture
- Soil Ecology
- Insect Populations
  - Beneficial and Pest
- Nematode Populations
- Disease Pressure/Incidence

Three Major Orchard Floor Management Systems

- Clean cultivation
- Permanent vegetation
- Herbicide strip in tree row with vegetative alleys

Slide courtesy Mike Parker, NCSU

Slide courtesy Mike Parker, NCSU

Why Use a Vegetative Cover?

- Erosion control
  - Wind and water
- Support equipment movement under wet conditions
- Moderate spring temperature fluctuations
- Maintain soil structure
- Increase moisture infiltration
- Encourage nutrient recycling

Slide courtesy Mike Parker, NCSU

Qualities of an Acceptable Ground Cover

- Minimizes Erosion
- Minimal competition with tree
- Supports equipment movement
- Does not interfere with labor
- Does not interfere/compete with pollination
- Does not harbor pests
  - Insect, disease, vertebrate

Slide courtesy Mike Parker, NCSU

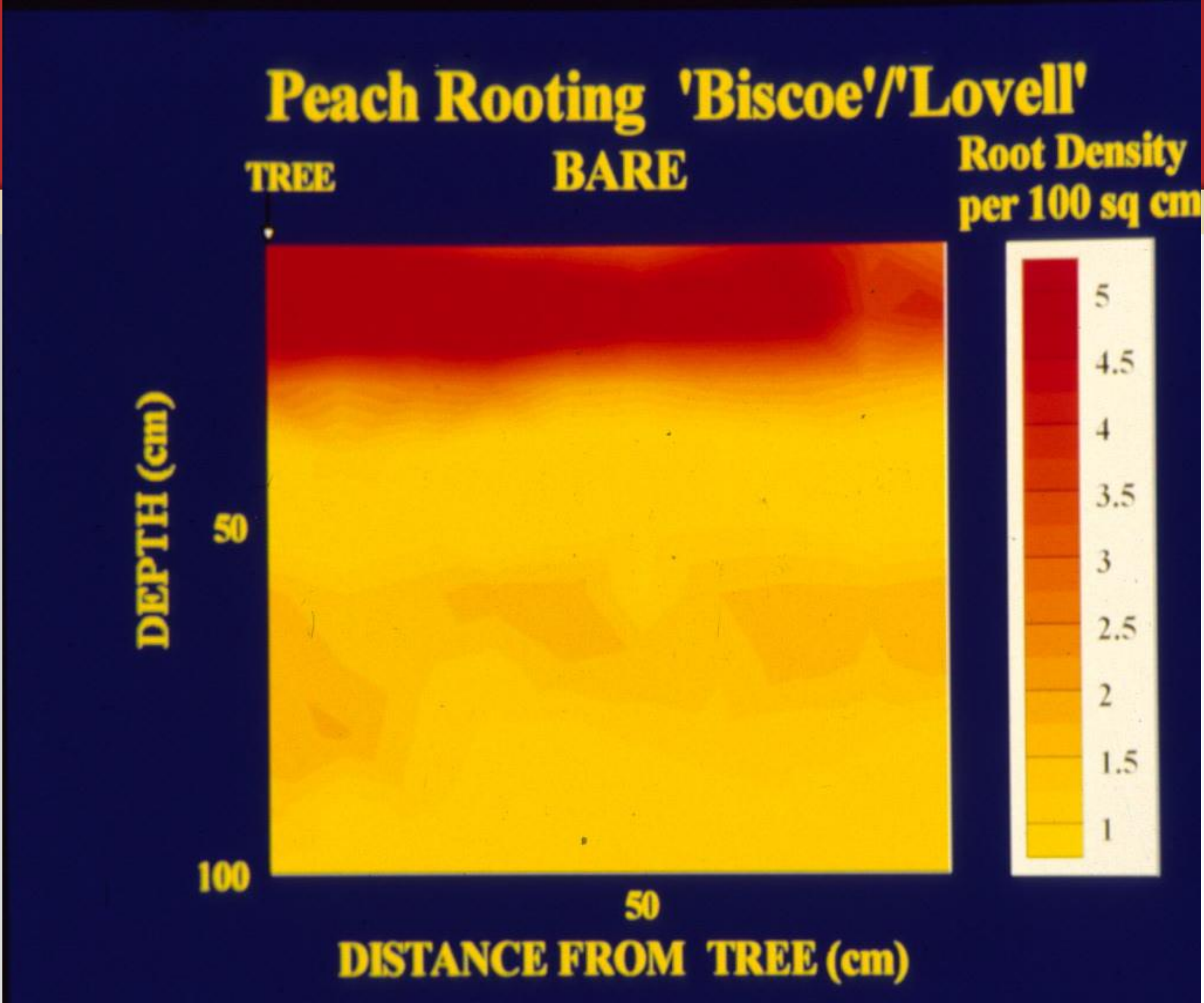
Peach Trunk Cross-Sectional Area
‘Biscoe’/’Lovell’

Ground Cover	TCSA (cm^2)
Bare Soil	73 a
Nimblewill	72 a
Centipede	31 b
Brome	41 b
Bahia Grass	7 c
Weedy Check	32 b

Slide courtesy Mike Parker, NCSU

Bare Soil

Slide courtesy Mike Parker, NCSU

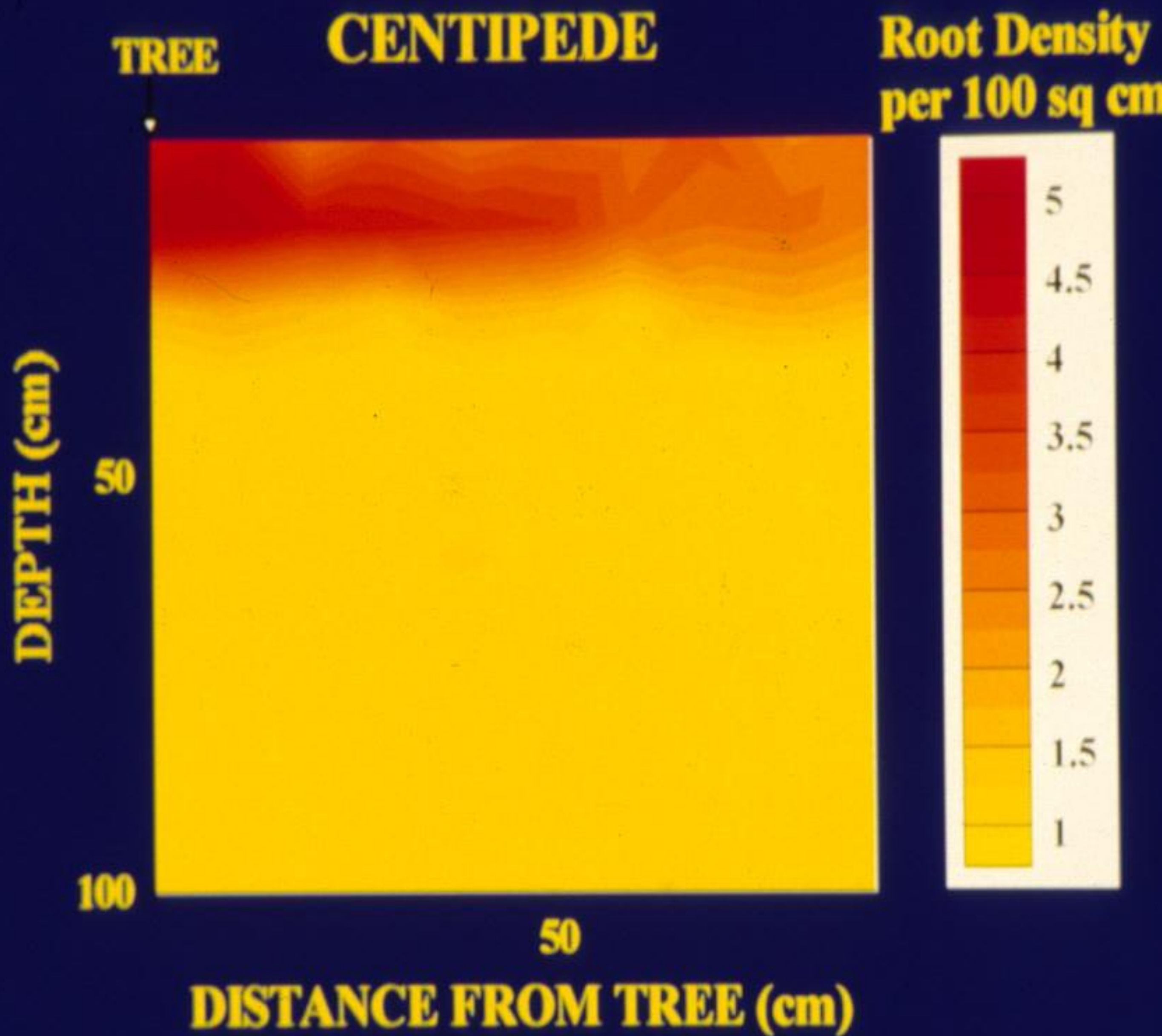


Peach Rooting 'Biscoe'/'Lovell'
TREE
BARE
Root Density per 100 sq cm
5
4.5
4
3.5
3
2.5
2
1.5
1
DEPTH (cm)
50
100
50
DISTANCE FROM TREE (cm)

Centipede

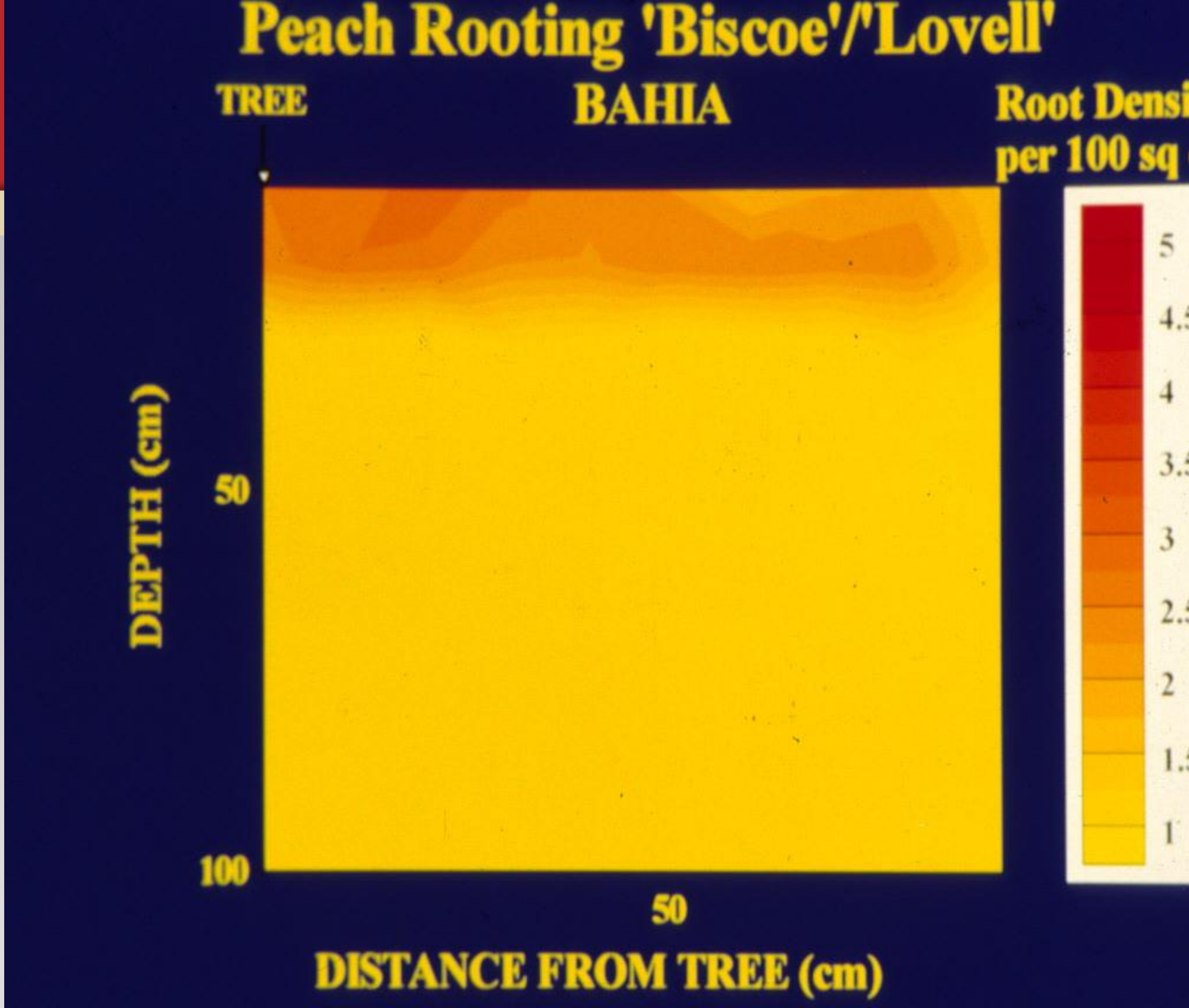
Slide courtesy Mike Parker, NCSU

Peach Rooting 'Biscoe'/'Lovell'



Bahia Grass

Slide courtesy Mike Parker, NCSU


Peach Rooting 'Biscoe'/'Lovell'
TREE
BAHIA
Root
per 100 sq
5
4.5
4
3.5
3
2.5
2
1.5
1
DEPTH (cm)
50
100
50
DISTANCE FROM TREE (cm)


Slide courtesy Mike Parker, NCSU

Vegetation Free - Herbicide

Slide courtesy Mike Parker, NCSU

Clean Cultivation - Mechanical

Slide courtesy Mike Parker, NCSU

Wintergreen Fine Fescue

Slide courtesy Mike Parker, NCSU

K-31 Tall Fescue

Slide courtesy Mike Parker, NCSU

Peach Relative Moisture Levels

Under Sod (June)

	Depth (in)		
Ground Cover	6	12	18
Clean-Herbicide	73	77	84
Clean Cultivation	74	88	89
‘Park’ Ken. Blue	24	41	37
Wintergreen F.F.	31	45	58
Peak Alfalfa	23	26	26
White Dutch Clover	17	16	11

Slide courtesy Mike Parker, NCSU

Vegetation Control

- Chemical Control
- Mechanical Cultivation
- Mulching
- Other??

Slide courtesy Mike Parker, NCSU

Types of Herbicides Used in Orchards

- Contact herbicides - Kills green tissue on contact (i.e. Glyphosate, Gramoxone, etc.)
- Pre-emergent herbicides – Prevents the germination/emergence of vegetation (i.e. Princep, Chateau, etc.)
- Broadleaf herbicides – Kills only broadleaf vegetation (i.e. 2,4-D, etc.)
- Graminicides – Kills grasses (i.e. Poast, Fusilade, etc.)

Slide courtesy Mike Parker, NCSU

Slide courtesy Mike Parker, NCSU

Slide courtesy Mike Parker, NCSU

Research on the Effects of Peach Orchard Floor Management…

- Treatments:
  - Vegetation-free strips: 0, 0.6, 1.2, 2.4, 3.0, 3.6 m
  - With or without irrigation
- Measurements:
  - Growth – TCSA when dormant
  - Catfacing insect damage at thinning
  - Yield, individual fruit weight and diameter at harvest (3-4 harvest dates each year)
  - Soil ecology – spring and fall

Sandhills Research Station
Jackson Springs, NC

Peach trees: Contender on Guardian rootstock
Planted Feb 2006

Treatments

Vegetation-free strips

0 m

0.6 m

1.2 m

2.4 m

3.0 m

3.6 m

With or without irrigation

Herbicide Application

Micro-Sprinkler Irrigation

- No irrigation was applied when precipitation during the week was ≥ 2.5 cm
- Delivered 2.5 cm of water in a 6.0-m diameter around the tree

Table 1. Monthly weather data for the Sandhills Research Station, Jackson Springs, NC.[z]

	2009	2010	2011	2012	2013
March					
Temperature min (°C)	4.9	5.2	5.4	10.1	2.1
Temperature max (°C)	15.6	16.9	16.7	22.0	13.7
Precipitation (cm)	10.2	12.1	11.3	15.9	8.3
Irrigation (cm)	—	0	0	0	0
April					
Temperature min (°C)	9.6	10.9	11.0	10.4	10.6
Temperature max (°C)	22.6	24.7	23.5	22.0	22.0
Precipitation (cm)	4.3	2.8	10.2	11.3	17.6
Irrigation (cm)	—	5.1	0	0	0
May					
Temperature min (°C)	15.4	16.6	15.3	16.5	14.0
Temperature max (°C)	26.0	27.4	26.7	27.3	24.7
Precipitation (cm)	9.9	17.6	11.1	19.0	12.4
Irrigation (cm)	—	2.5	0	0	0
June					
Temperature min (°C)	19.5	21.1	19.9	17.4	19.3
Temperature max (°C)	30.1	32.4	32.6	29.4	28.9
Precipitation (cm)	6.1	8.9	10.0	10.3	36.0
Irrigation (cm)	—	7.6	10.2	0	0
July					
Temperature min (°C)	19.6	21.4	21.9	21.8	21.4
Temperature max (°C)	30.2	32.4	33.5	32.7	29.7
Precipitation (cm)	14.0	27.9	14.2	42.4	46.3
Irrigation (cm)	—	5.1	5.1	2.5	0

[z]Temperature and precipitation data were obtained from the State Climate Office of North Carolina CRONOS Database (http://www.nc-climate.ncsu.edu/cronos/) for the weather station located at the Sandhills Research Station, Jackson Springs, NC.

— = Missing irrigation data from 2009.

April 2010


One week before harvest 2010

Previous Work in This Orchard

- Dr. Wang, visiting scientist (year 3)*:
  - Irrigation and weed control facilitate peach growth and mycorrhizal infection of peach roots while reducing available nutrients in soil
  - Weed control reduced microbial biomass
  - Faster plant growth, high mycorrhizal infection and low soil nutrient availability along with early tree defoliation in the fall, may potentially increase susceptibility to infection with nematodes and bacterial canker or PTSL

** unpublished data*

Known

- Vegetation competes with trees for water and nutrients
- Reducing vegetation in the tree row results in larger trees and greater fruit yield
- Vegetation management affects soil ecology and pest behavior

Project Objective

- To examine the impacts of vegetation-free strip width and irrigation on peach tree growth, yield, size, catfacing incidence, and soil ecology in a peach orchard on sandy soil in years 4-8, the age when such an orchard is prone to losses attributed to the peach tree short life complex

No trees were lost to PTSL during this study so the results focus on measures of microbial activity and soil health in the tree's rhizosphere

What is Peach Tree Short Life?

- Refers to the sudden spring collapse and death of young peach trees, 3 to 7 years old
- Not caused by a single specific factor, but rather by a complex of cold damage and bacterial canker
- Many other factors, including time of pruning, rootstocks, orchard floor management, fertilization practices, and rapid fluctuation in late winter/early spring temperatures
- Primary biotic factor responsible for predisposing peach trees to bacterial canker or cold injury or both is the ring nematode

Beckman & Nyczepir, 2004

What is Peach Tree Short Life?

Figure 1. Initially, internal browning due to peach tree short life extends only to soil line (knife blade).

Figure 2. Water-soaked bark and trunk leakage often accompany internal damage to peach tree short life.

Figure 3. Bacterial canker damage associated with peach tree short life.

Beckman & Nyczepir, 2004

HortScience 50(5):699–704. 2015.

Vegetation-free Width and Irrigation Impact Peach Tree Growth, Fruit Yield, Fruit Size, and Incidence of Hemipteran Insect Damage

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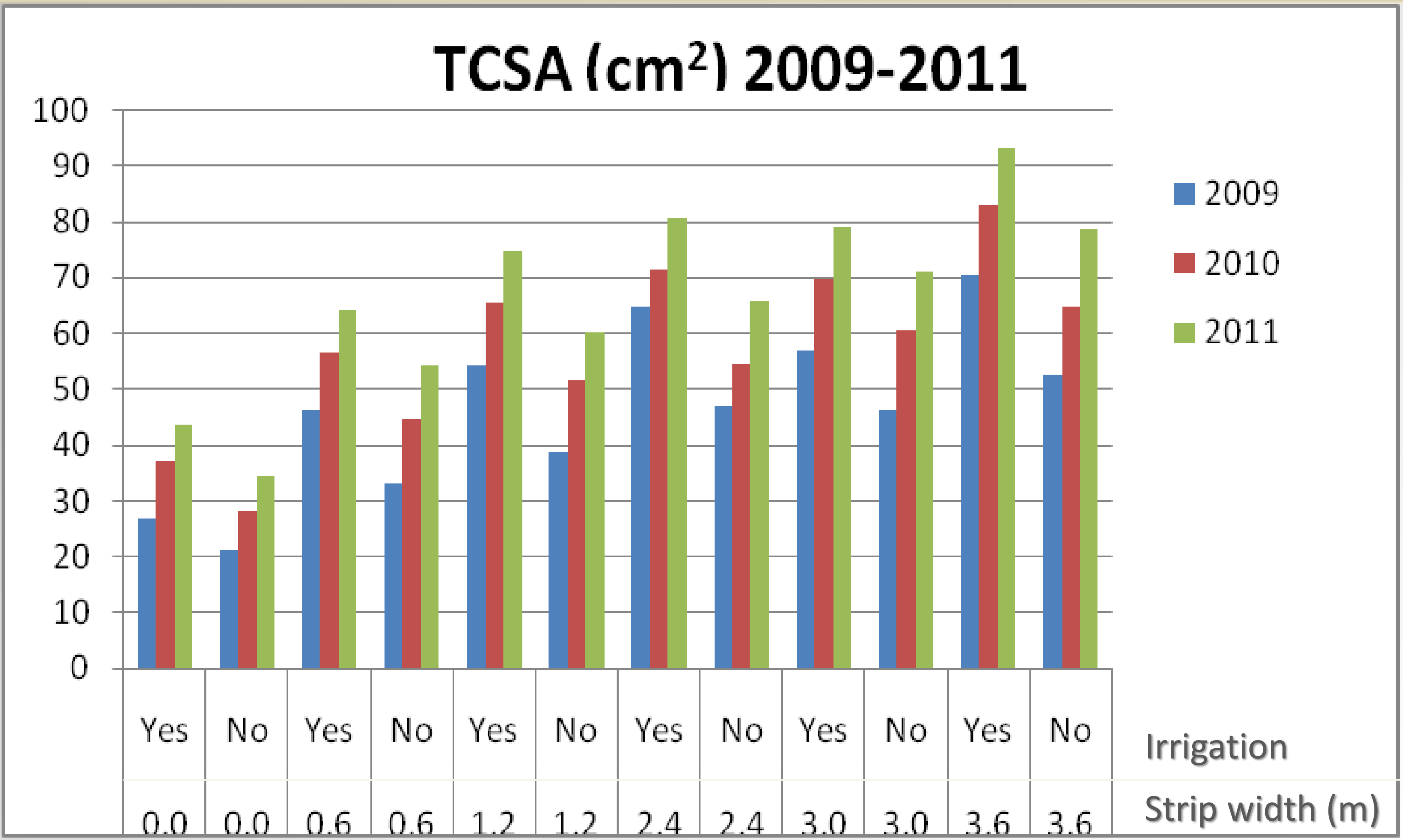
Additional index words. *Prunus persica*, orchard floor management, catfacing

Abstract. **Orchard floor vegetation competes with peach trees for water and nutrients and may harbor pathogens and insects. Tree growth, fruit yield, and fruit size can be optimized through management of vegetation in the tree row and irrigation. Under-tree vegetation-free strip widths (0, 0.6, 1.2, 2.4, 3.0, and 3.6 m) and irrigation were studied in years four through eight of a young peach orchard to determine their effects on peach tree growth and fruit yield, harvest maturity, and fruit size. Immature fruit samples were collected during thinning in years four through six to determine the effect of the treatments on the incidence of hemipteran (catfacing) insect damage. Trunk cross-sectional area (TCSA), as a measure of tree growth, increased with increasing vegetation-free strip width; trees grown in the 3.6-m vegetation-free strip had TCSAs 2.2 times greater, on average, than trees grown in the 0-m vegetation-free strip. TCSA also increased with irrigation; trees grown with irrigation had TCSAs 1.2 times greater, on average, than trees grown without irrigation. Yield increased with increasing vegetation-free strip width, from 9.6 kg per tree in the 0-m plot to 26.5 kg per tree in the 3.6-m plot in year four, to 24.3 kg per tree in the 0-m plot and 39.6 kg per tree in the 3.6-m plot in year eight, for a total yield over years 4–8 per tree of 100 kg in the 0-m plot compared with 210 kg per tree in the 3.6-m plot. Yield, average fruit weight, and average fruit diameter increased with irrigation in three of 5 years; the other 2 years had higher than average rainfall reducing the need for supplemental irrigation. In 3 out of 5 years fruit in irrigated plots matured earlier than fruit in nonirrigated plots. In all years, fruit grown in the 0-m strip matured earliest and had the smallest diameter. Establishing a vegetation-free strip of as narrow as 0.6 m reduced the incidence of catfacing damage compared with the 0-m treatment, even though the orchard was on a commercial pesticide spray schedule. The least damage was seen with the industry standard vegetation-free strip widths greater than 3.0 m with or without irrigation.**

Peach Tree Growth



TCSA Results

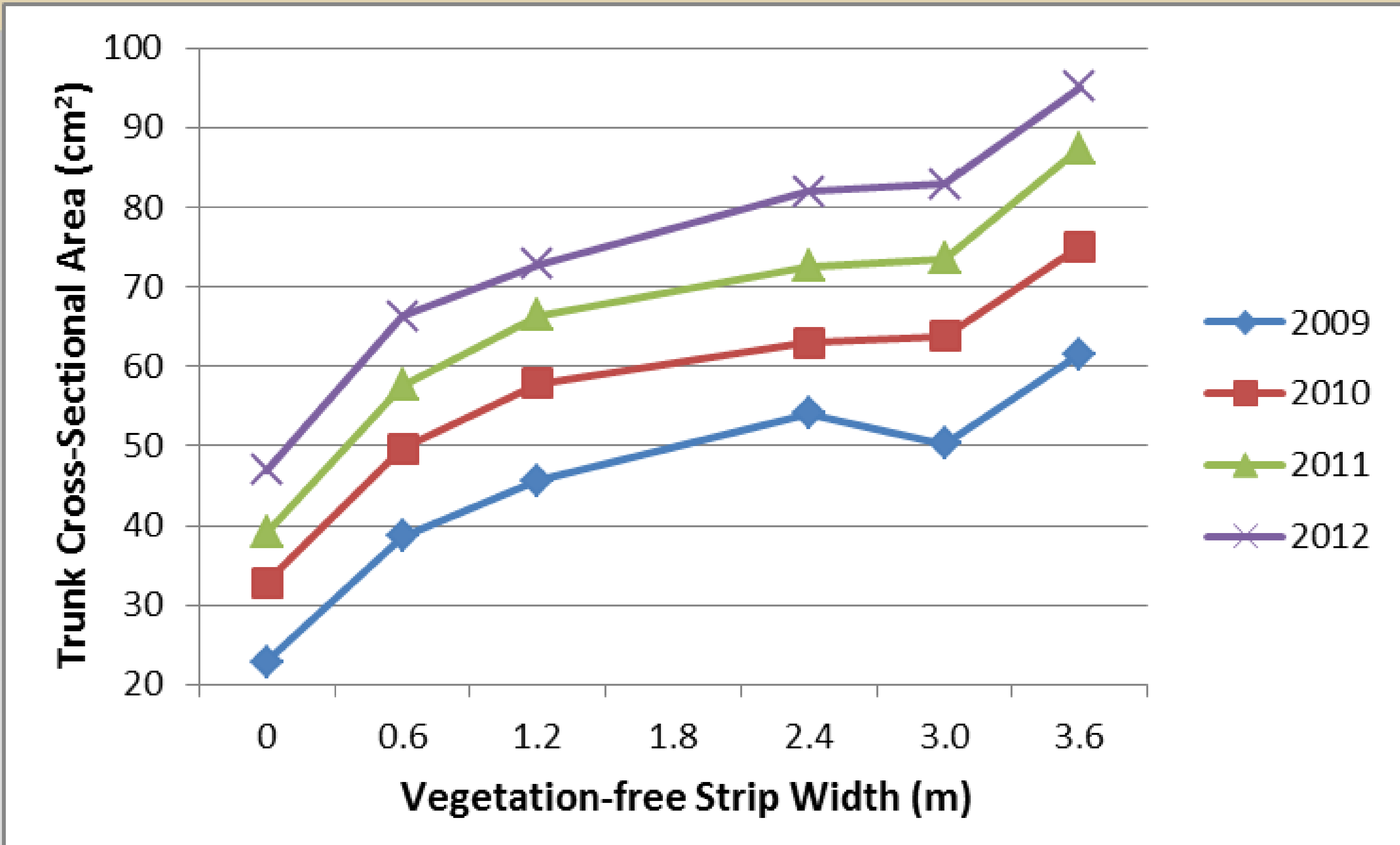
Table 2. Effect of vegetation-free strip width and irrigation on trunk cross-sectional area (cm^2), years 4–8.[z]

	Yr				
	2009	2010	2011	2012	2013
	Trunk cross-sectional area (cm^2)				
Strip width (m)					
0	22.8 d[y]	32.8 d	39.2 d	47.0 d	64.9 c
0.6	38.7 c	49.6 c	57.6 c	66.3 c	85.8 b
1.2	45.7 bc	57.8 bc	66.4 bc	72.8 bc	91.7 b
2.4	54.1 ab	62.9 b	72.6 b	81.9 ab	102.7 ab
3.0	50.0 b	63.8 b	73.5 ab	82.4 ab	99.5 ab
3.6	62.6 a	75.7 a	88.0 a	96.3 a	115.5 a
P value	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Irrigation					
Irrigated	51.9 a	63.1 a	70.8 a	80.3 a	97.6 a
Nonirrigated	39.4 b	51.1 b	61.6 b	68.5 b	89.1 b
P value	<0.0001	<0.0001	0.0021	0.0002	0.0373
P value for strip × irrigation interaction	0.5065	0.8062	0.8661	0.9184	0.6707

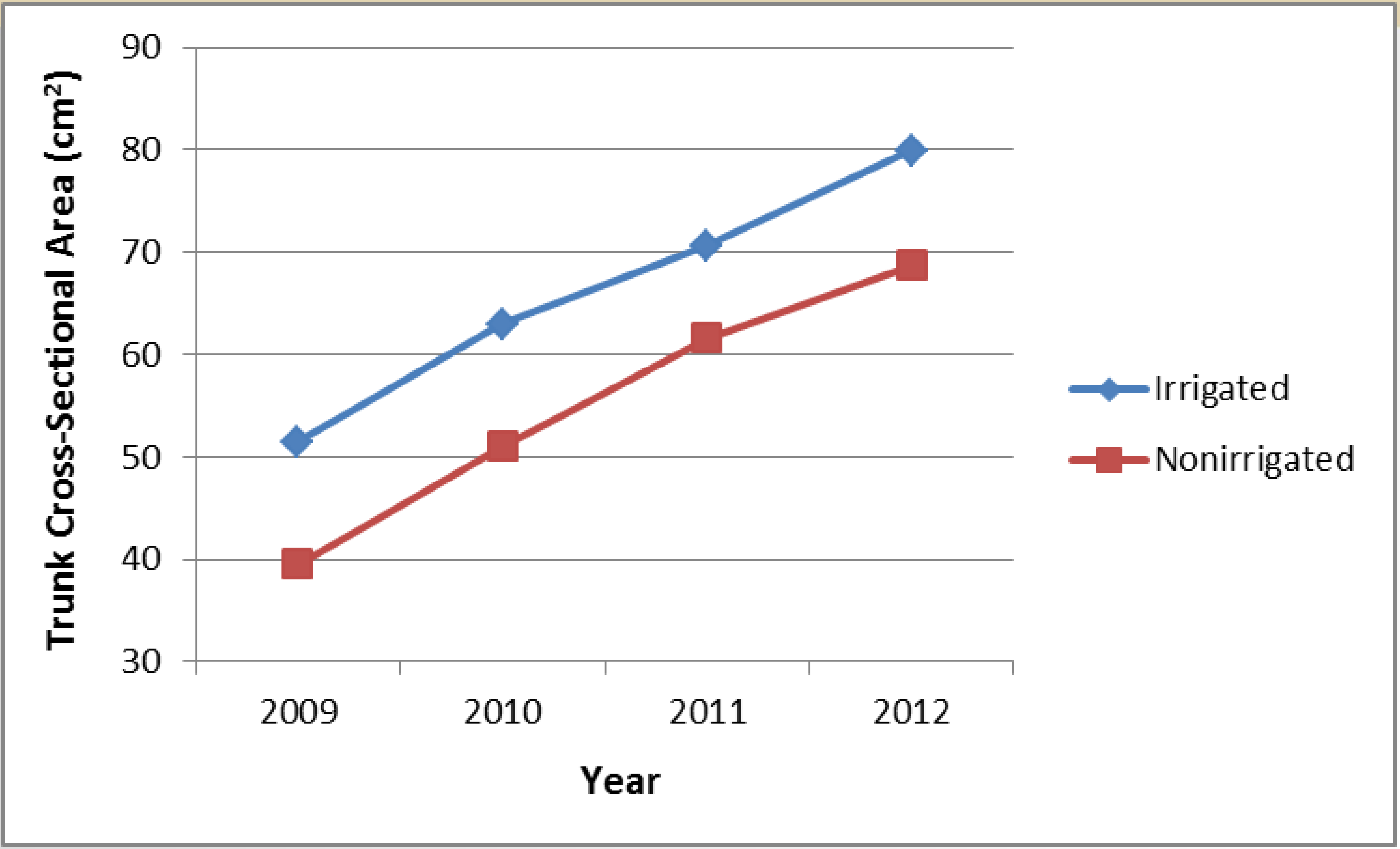
[z]Main effect means are pooled across other main effects and 6 reps.

[y]Treatments were separated by the Tukey-Kramer method for each harvest date at the $P \leq 0.05$ level and means within each column within main effects followed by the same letter do not significantly differ.

Effect of Vegetation-free Strip Width on TCSA, years 4-7



Effect of irrigation on TCSA, years 4-7



Rating Catfacing Damage

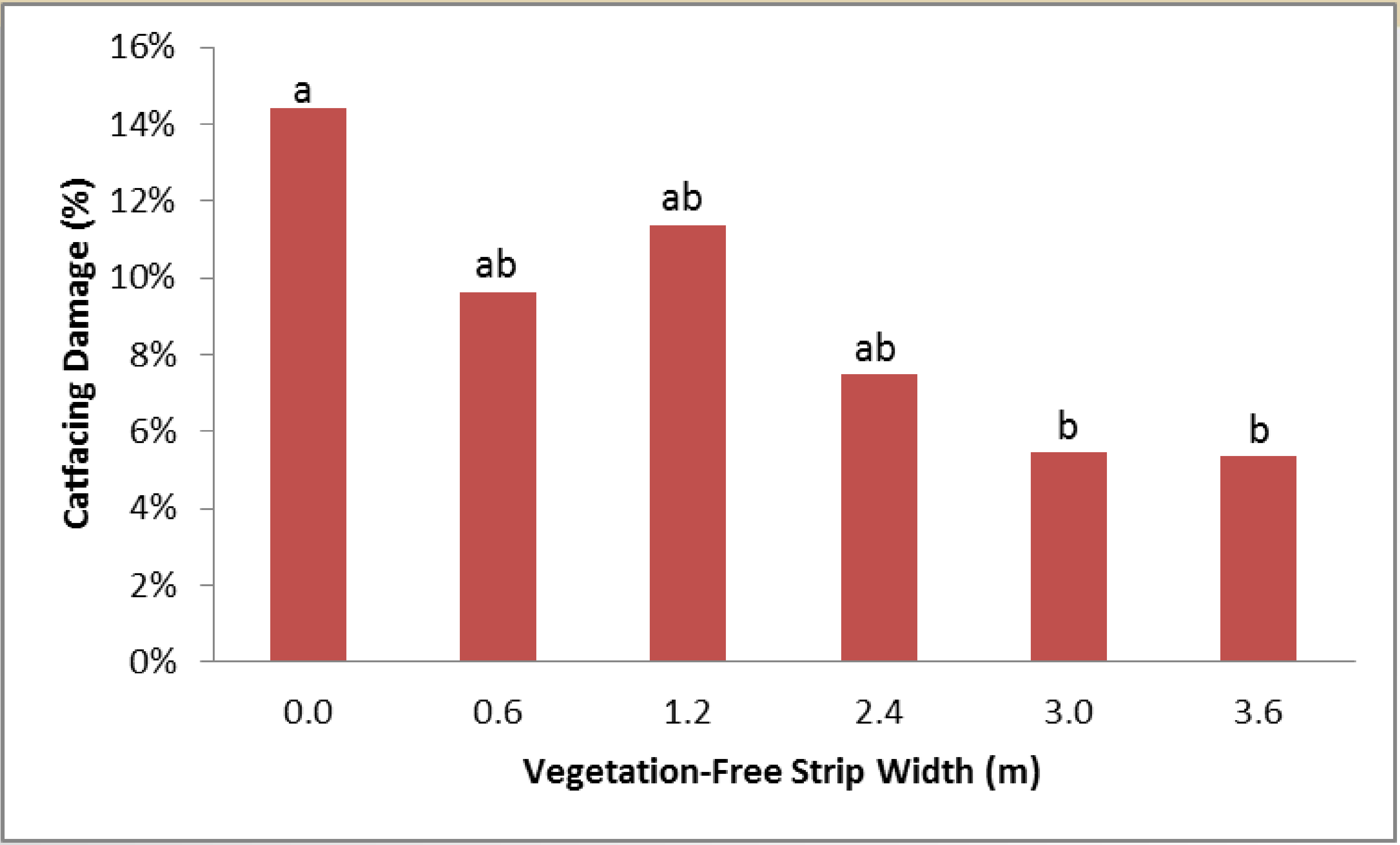
Catfacing Results

Table 7. Effect of vegetation-free strip width and irrigation on percent catfacing damage in 'Contender' peach, years 4–6.[z]

	Yr		
	2009	2010	2011
	Catfacing (%)		
Strip width (m)			
0	14.5 a[y]	6.9	5.3 a
0.6	9.8 ab	6.4	2.7 b
1.2	11.5 ab	4.9	2.9 b
2.4	7.5 bc	4.8	3.2 b
3.0	5.5 c	6.4	2.2 b
3.6	5.4 c	5.2	1.7 b
P value	0.0018	0.1412	0.0059
Irrigation			
Irrigated	8.6	5.9	3.7 a
Nonirrigated	9.4	5.6	2.3 b
P value	0.5539	0.5699	0.0145
P value for strip × irrigation interaction	0.0500	0.3881	0.5700

[z]Main effect means are pooled across other main effects and 4 reps.
[y]Treatments were separated by Duncan's new multiple range test for each harvest date at the $P \leq 0.05$ level and means within each column within main effects followed by the same letter do not significantly differ.

Catfacing Results, 2009

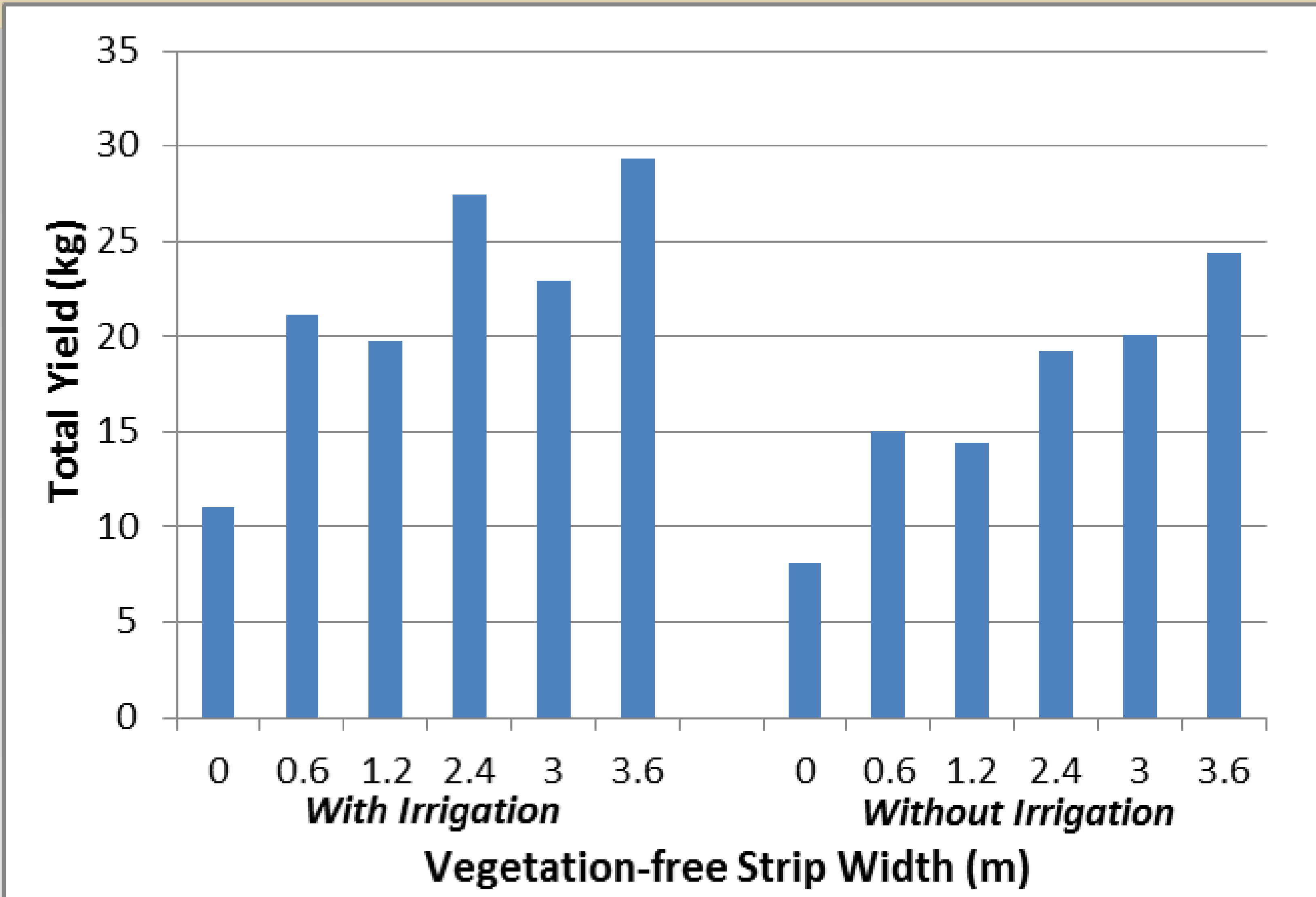


Harvest

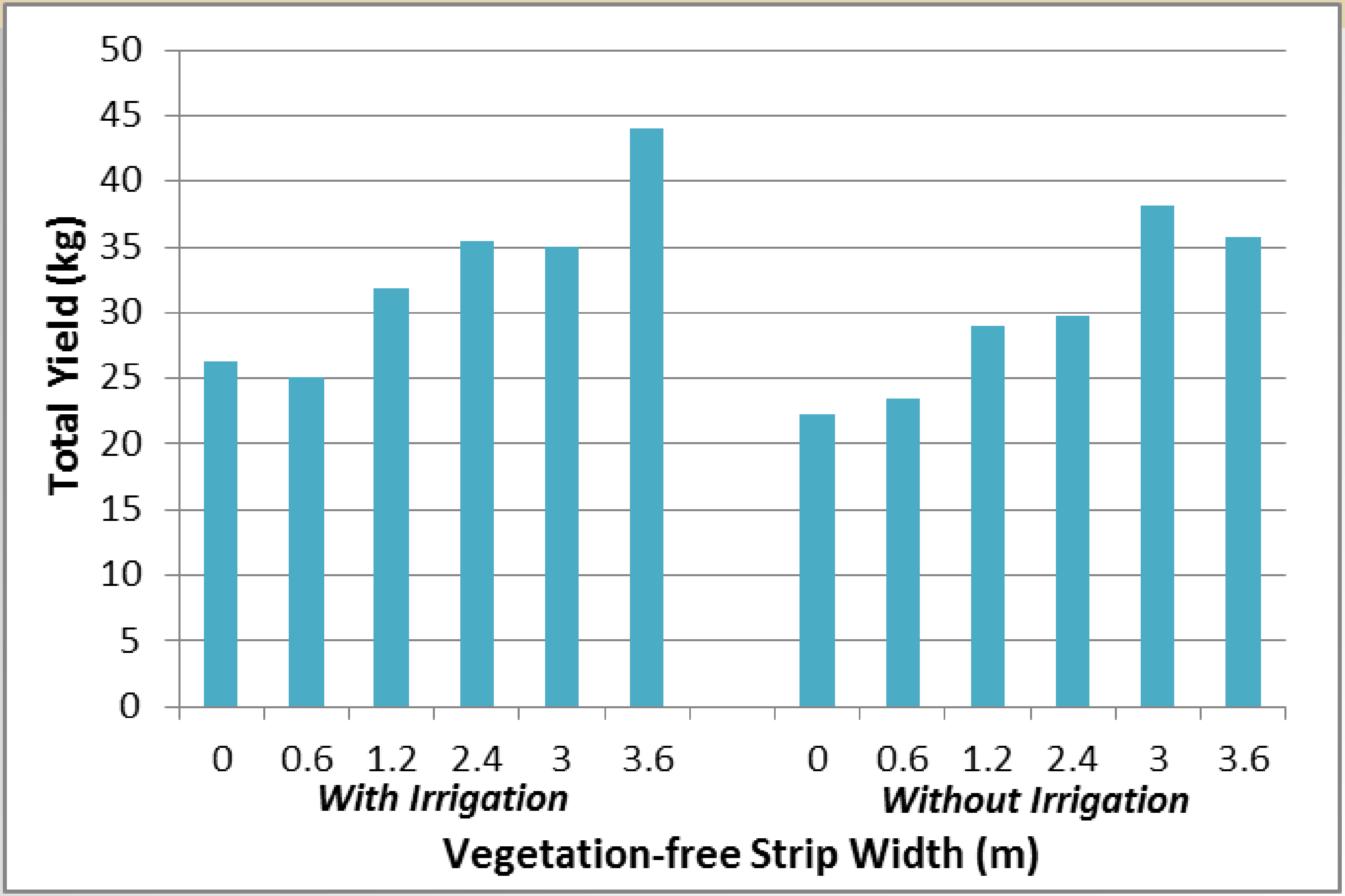
Yield and Fruit Size Measurements

Yield and Fruit Size Measurements

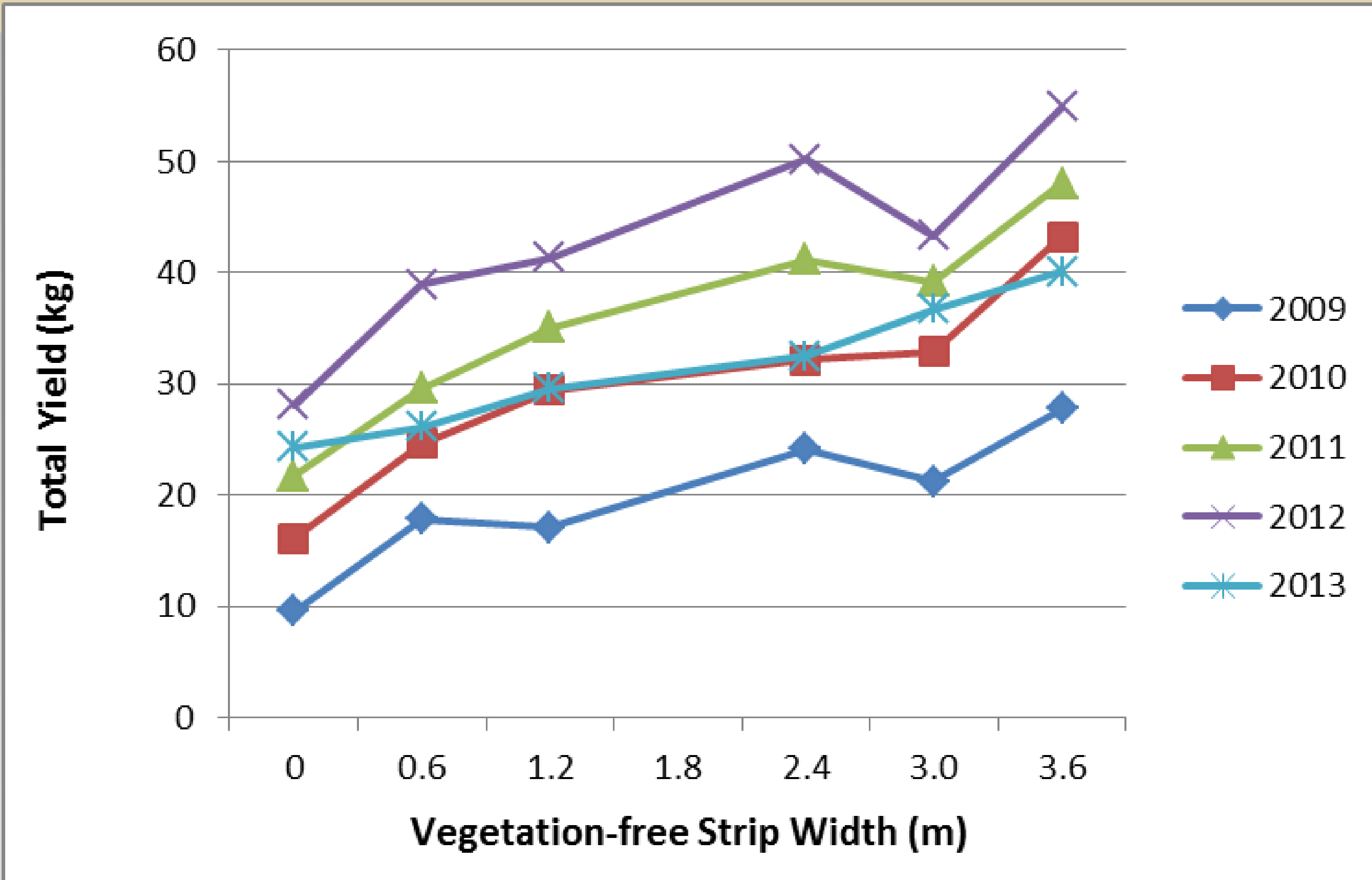
2009 Fruit Yield



2013 Fruit Yield



Effect of Vegetation-free Strip Width on Yield, Years 4-8



Yield Results

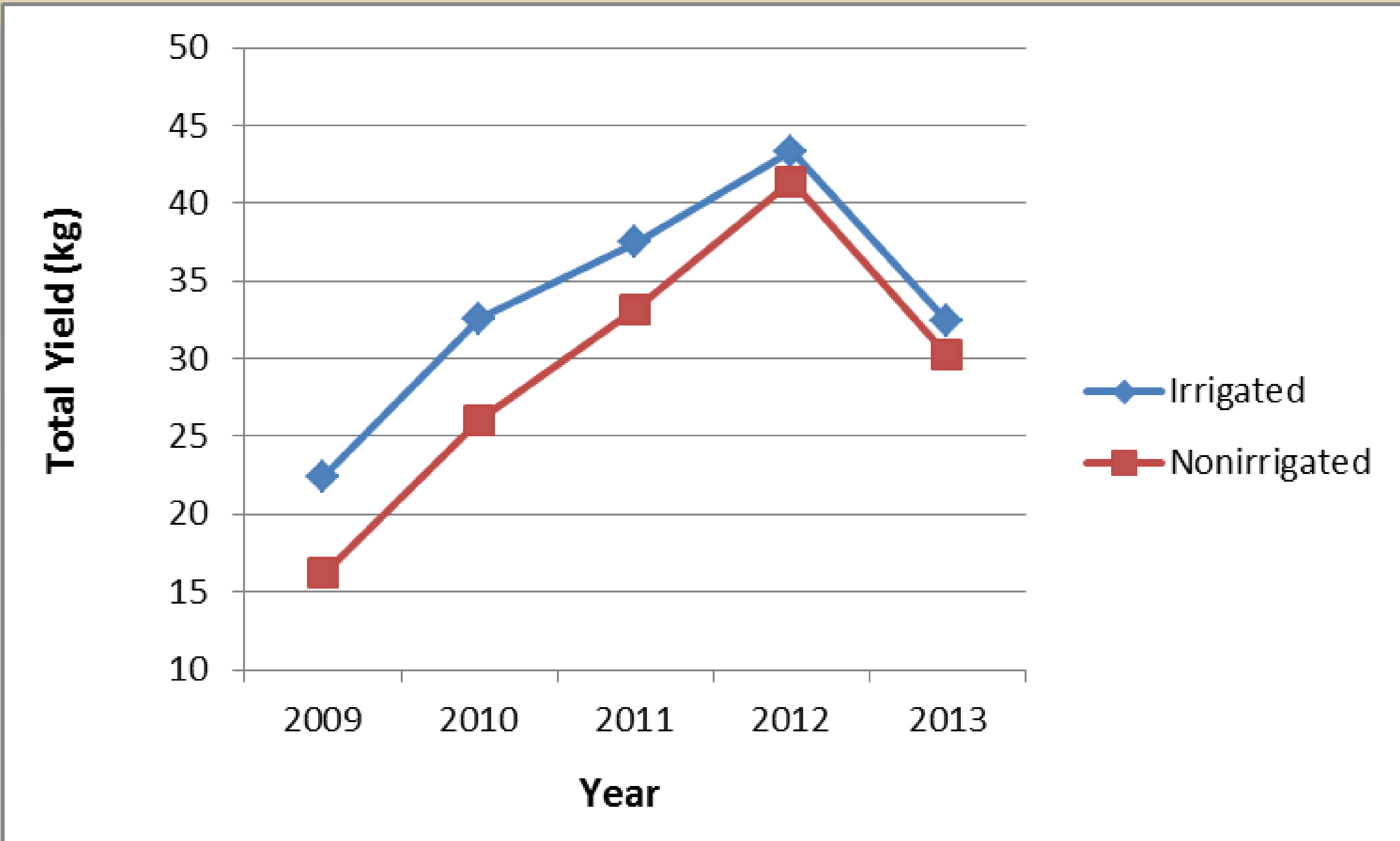
Table 3. Effect of vegetation-free strip width and irrigation on peach yield (kg), years 4–8.[z]

	Yr					
	2009	2010	2011	2012	2013	Cumulative yield
	Peach yield (kg)					
Strip width (m)						
0	9.6 e[y]	16.1 d	21.7 d	28.1 d	24.3 d	99.8 d
0.6	18.5 cd	22.8 c	29.6 c	38.3 c	25.8 cd	134.9 c
1.2	17.1 d	29.5 b	34.6 bc	40.5 c	29.8 bc	151.4 c
2.4	23.3 ab	31.8 b	39.8 b	49.1 ab	31.6 b	175.7 b
3.0	21.6 bc	33.1 b	39.9 b	44.3 bc	37.0 a	175.9 b
3.6	26.5 a	43.2 a	46.7 a	54.2 a	39.6 a	210.2 a
P value	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Irrigation						
Irrigated	22.7 a	32.7 a	37.8 a	43.5	32.7	169.4 a
Nonirrigated	16.2 b	26.1 b	33.0 b	41.3	30.0	146.6 b
P value	<0.0001	<0.0001	0.0020	0.2890	0.0571	<0.0001
P value for strip × irrigation interaction	0.0759	0.5165	0.4302	0.4898	0.0798	0.2393

[z]Main effect means are pooled across other main effects and 6 reps.

[y]Treatments were separated by Duncan's new multiple range test for each harvest date at the $P \leq 0.05$ level and means within each column within main effects followed by the same letter do not significantly differ.

Effect of Irrigation on Yield, Years 4-8



Individual Fruit Weight Results

Table 5. Effect of vegetation-free strip width and irrigation on average peach weight (g), years 4–8.[z]

	Yr				
	2009	2010	2011	2012	2013
	Avg peach wt (g)				
Strip width (m)					
0	169.9 b[y]	133.6 d	185.3	185.6	196.1
0.6	166.8 b	147.5 c	182.6	205.4	201.6
1.2	176.7 ab	151.8 bc	183.0	185.4	204.1
2.4	178.8 ab	156.2 bc	193.7	189.8	222.2
3.0	193.1 a	163.4 ab	193.0	197.2	210.3
3.6	191.5 a	172.0 a	186.7	190.7	220.9
P value	0.0041	<0.0001	0.1531	0.0795	[x]
Irrigation					
Irrigated	202.8 a	165.0 a	199.7 a	185.1 b	203.8
Nonirrigated	155.8 b	143.1 b	175.0 b	199.6 a	214.6
P value	<0.0001	<0.0001	<0.0001	0.0014	[x]
P value for strip × irrigation interaction	0.7042	0.7782	0.3129	0.2088	0.0496

[z]Main effect means are pooled across other main effects and 6 reps.

[y]Treatments were separated by Duncan's new multiple range test for each harvest date at the $P \leq 0.05$ level and means within each column within main effects followed by the same letter do not significantly differ.

[x]Values not reported due to significant interaction.

Fruit Diameter Results

Table 6. Effect of vegetation-free strip width and irrigation on average peach diameter (cm), years 4–8.[z]

	Yr				
	2009	2010	2011	2012	2013
	Avg peach diam (cm)				
Strip width (m)					
0	6.6 c[y]	6.3 d	6.9	6.8	7.2 c
0.6	6.7 bc	6.4 cd	6.9	7.0	7.3 bc
1.2	6.9 b	6.5 bc	7.0	6.9	7.3 bc
2.4	6.9 b	6.6 bc	7.1	7.0	7.5 a
3.0	7.1 a	6.7 ab	7.1	7.0	7.4 ab
3.6	7.1 a	6.8 a	7.0	7.0	7.5 a
P value	<0.0001	<0.0001	0.0688	0.2340	<0.0001
Irrigation					
Irrigated	7.2 a	6.7 a	7.1 a	6.9 b	7.3 b
Nonirrigated	6.5 b	6.4 b	6.8 b	7.0 a	7.4 a
P value	<0.0001	<0.0001	<0.0001	0.0138	0.0013
P value for strip × irrigation interaction	0.3431	0.9620	0.1002	0.3149	0.1261

[z]Main effect means are pooled across other main effects and 6 reps.

[y]Treatments were separated by Duncan's new multiple range test for each harvest date at the $P \leq 0.05$ level and means within each column within main effects followed by the same letter do not significantly differ.

Conclusions

- Increasing vegetation-free strip widths results in greater tree growth and greater yield as has been reported by others
- Yield increased, on average, by:
  - 23.4 kg between the irrigated 0 m and 3.6 m plots
  - 20.8 kg between the non-irrigated 0 m and 3.6 m plots
  - An additional bushel of peaches per tree
- If we assume an expected price of $24 per bushel and an average of 121 trees per acre at our 5.5 x 6.0 m spacing, that’s an increase of $2904 gross income per acre

Conclusions, continued

- Trend for greater individual fruit weight and diameter with increasing vegetation-free strip width
- The 3.0 and 3.6 m plots produced fruit ≥7.0 cm in diameter in 4/5 years
- In 2013 fruit from all strip widths, w & w/o irrigation, were >7.0 cm
- Supplemental irrigation increases tree growth and yield per tree, as reported by others
- Greater average weight and diameter in irrigated versus non-irrigated plots in 3/5 years (2009-2011)

Catfacing Conclusions

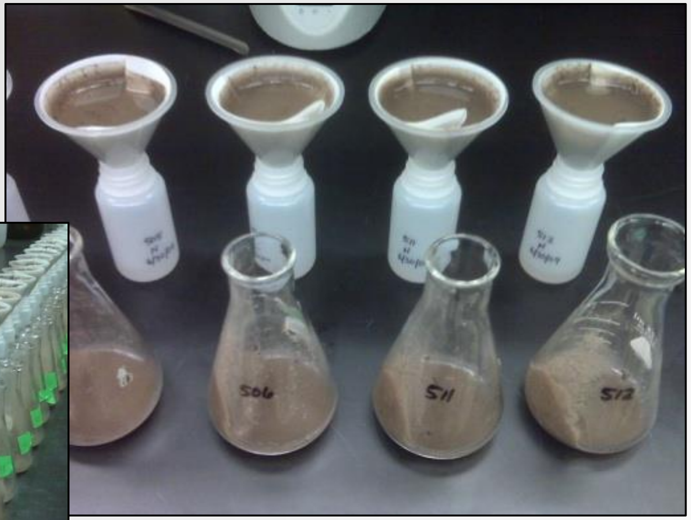
- Although the orchard used in the present study was on a commercial pest management schedule, there was still a reduction in catfacing damage by increasing strip widths
- Using 2009 data, if we assume an average yield of 20,000 $kg \cdot h^{-1}$ and an expected price of US$24 per 23 kg, an average 9% increase in saleable yield would produce an additional 1800 kg of fruit worth US$1878 per hectare annually
- This increase in saleable yield would more than offset the cost of herbicides necessary to maintain the vegetation-free strip

Soil Sampling, April & October

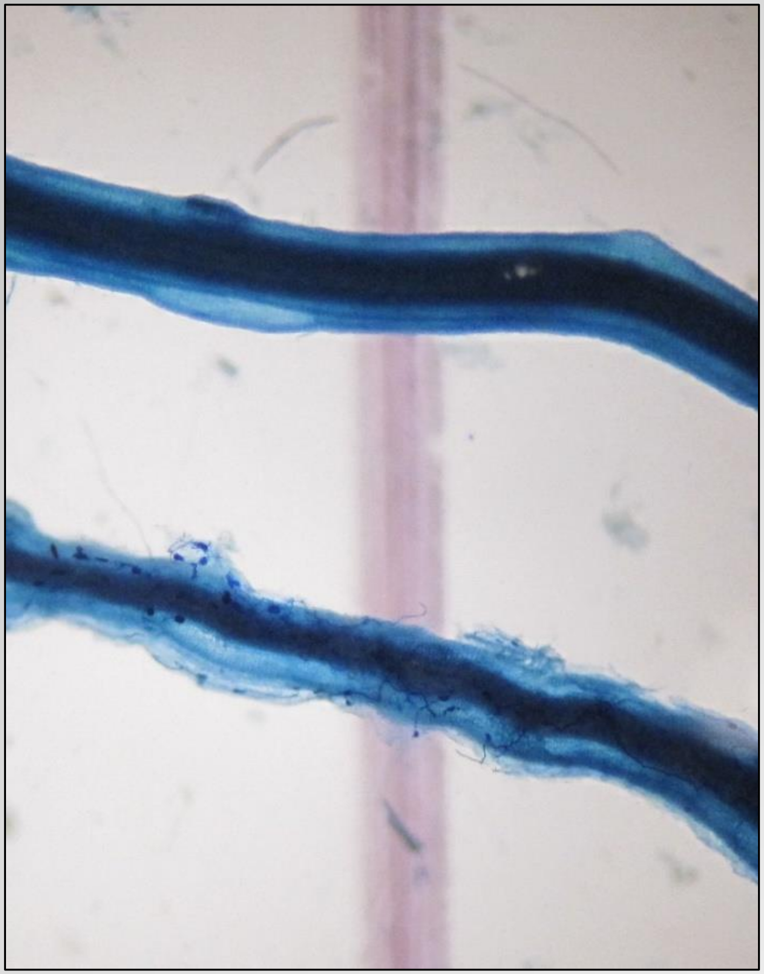
Soil Sampling, cont.

Laboratory Analyses

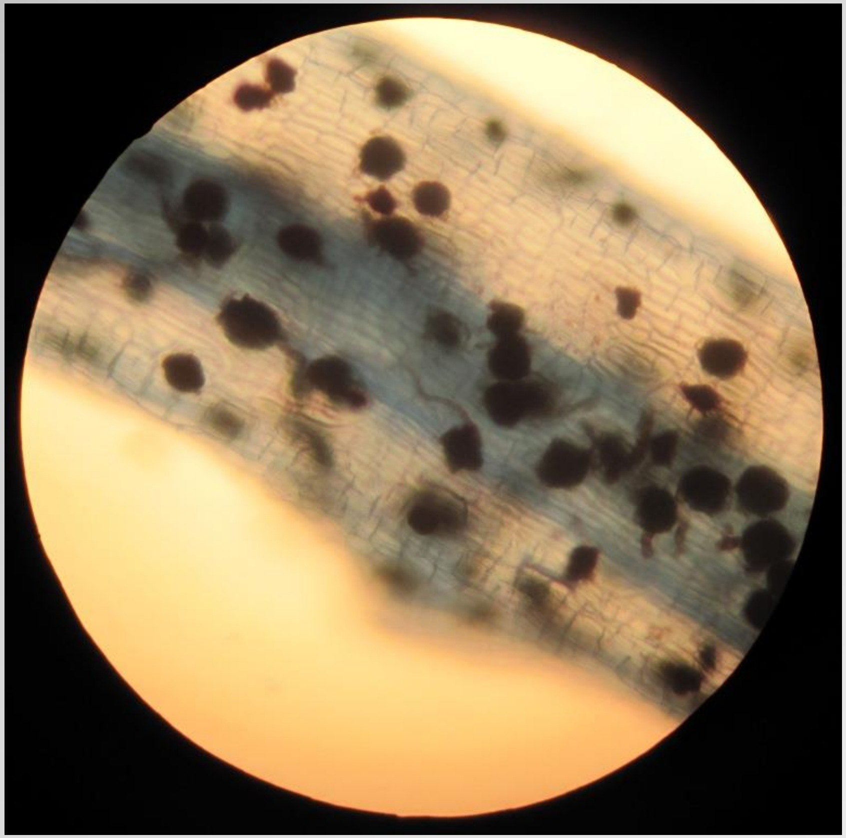
- Soil moisture, pH, and EC
- Soil microbial biomass carbon and nitrogen
- Soil microbial respiration
- Net nitrogen mineralization
- Mycorrhizal root colonization

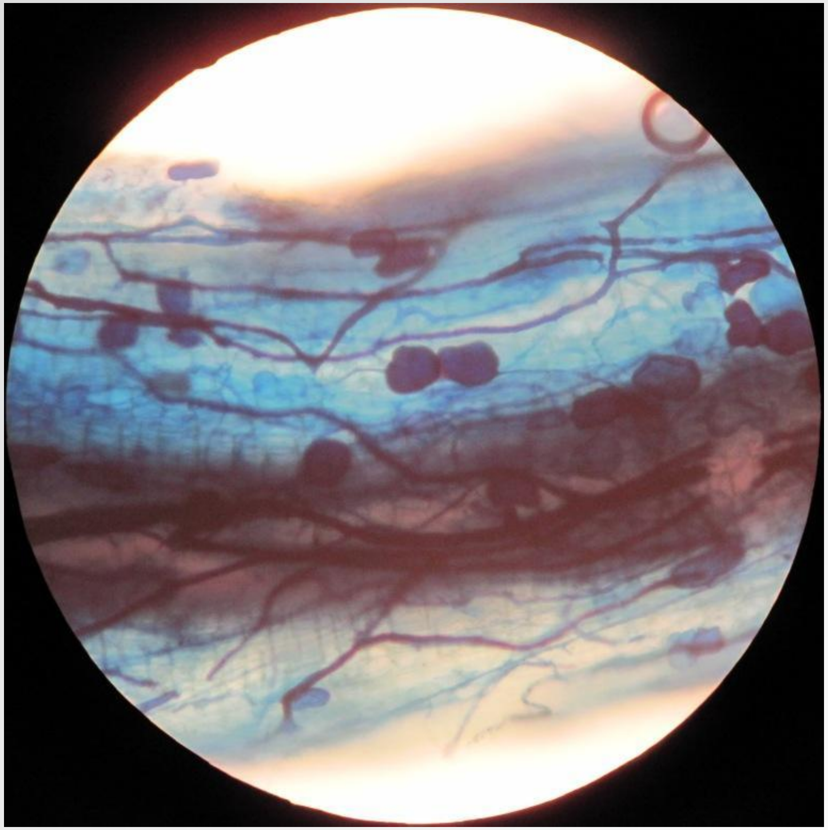



Rating Mycorrhizal Colonization



Vesicles and Hyphae





Soil Moisture, pH, and EC Results

- Soil moisture increased with greater strip width in spring 2010 (P=0.0491), but had no significant impact on other sampling dates
- Irrigation increased soil moisture in the fall of 2009 and spring of 2010 (P<0.0001); no significant difference was measured in the fall of 2010
- No significant differences for pH or EC

MBC, MBN, SMR, & NNM Results

Table 1. Effects of vegetation-free strip width and irrigation on rhizosphere soil microbial biomass carbon (MBC) and nitrogen (MBN), soil microbial respiration (SMR), and net nitrogen mineralization (NNM) for peach on sandy soil in the North Carolina, USA Sandhills

	Fall 2009				Spring 2010				Fall 2010			
Strip width	**MBC** mg/kg	**MBN**[1] mg/kg	**SMR** $mgCO_2/kg/d$	**NNM** mg/kg/d	**MBC** mg/kg	**MBN** mg/kg	**SMR** $mgCO_2/kg/d$	**NNM** mg/kg/d	**MBC** mg/kg	**MBN** mg/kg	**SMR** $mgCO_2/kg/d$	**NNM** mg/kg/d
0 m	21.74	8.00ab	21.48a	6.83a	32.69	5.69	14.99	6.29a	36.62	8.30	13.11	3.15a
1.2 m	18.48	10.95a	17.17ab	6.27a	29.95	5.43	13.52	4.79ab	32.53	6.18	12.43	2.31ab
2.4 m	‡	‡	‡	‡	25.04	5.23	12.05	3.44b	30.31	7.14	11.08	1.35bc
3.6 m	15.29	5.69b	10.08b	4.63b	26.87	5.10	11.81	3.66b	31.31	4.72	11.33	0.88c
p value	*0.1796*	*0.0168*	*0.0199*	*0.0024*	*0.0763*	*0.9263*	*0.8062*	*0.0053*	*0.1192*	*0.2241*	*0.6821*	*0.0010*
Irrigation												
Irrigated	17.06	9.03	15.44	6.07	27.05	7.24a	10.16b	4.92	31.23	7.31	12.09	2.24
Not Irrigated	19.96	7.40	17.04	5.76	30.22	3.48b	16.02a	4.17	34.16	5.94	11.88	1.61
p value	*0.2968*	*0.2068*	*0.5929*	*0.4919*	*0.1417*	*0.0001*	*0.0333*	*0.1820*	*0.1311*	*0.2213*	*0.8734*	*0.0688*
p value for strip*irrigation interaction	*0.3662*	*0.7337*	*0.4256*	*0.9019*	*0.5644*	*0.9223*	*0.2886*	*0.9099*	*0.9305*	*0.8617*	*0.6652*	*0.4848*

[1] Means within each column within main effects followed by the same letter do not differ (α=0.05)

‡ No samples were collected from 2.4 m plots in 2009

Mycorrhizae Results

Table 2. Effects of vegetation-free strip width and irrigation on endomycorrhizal root colonization of peach on sandy soil in the North Carolina, USA Sandhills

	Mycorrhizal Colonization (%)		
Strip width (m)	Fall 2009	Spring 2010	Fall 2010
0	64.50	57.05	68.19
1.2	58.95	47.79	62.88
2.4	‡	46.53	66.89
3.6	62.80	53.30	73.91
p value	*0.0551*	*0.2744*	*0.1327*
Irrigation			
Irrigated	61.79	52.50	65.64
Non-irrigated	62.38	49.84	70.29
p value	*0.7429*	*0.5147*	*0.1564*
*p value for strip*irrigation interaction*	*0.0086*	*0.1601*	*0.9477*

‡ No samples were collected from 2.4 m plots in 2009

Nematode Results, Year 5

- Root knot, ring, and other nematode populations were not affected by differences in vegetation-free strip width
- Root knot and ring nematode populations tended to increase with irrigation though not significantly (P=0.1776 and P=0.0807, respectively)

Conclusions

- Results support earlier work in this orchard (Wang, unpublished data) by showing that increasing the width of the vegetation-free strip reduces microbial biomass and associated activities in the soil through year four, but also demonstrate that differences become insignificant by year five
- All treatments exhibited a similar percentage of endomycorrhizal root colonization

Conclusions, continued

- The 0 m strip width and the 3.6 m strip width consistently had the highest percent of endomycorrhizal root colonization and is possibly due to the plant species in the vegetative cover encouraging mycorrhizal association with the trees
- These findings show that under standard commercial management of a bearing peach orchard there is little impairment of soil ecological function, allowing for maximum peach yield and quality while supporting the optimal health of trees and soil

Questions?

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