# Recent Research Results with High Tunnel Vegetable Crops

## November 29, 2018

Amy Ivy, CCE Eastern NY Commercial Horticulture Program

Judson Reid, Cornell Vegetable Program

Mike Davis, Manager and Director of the Cornell Willsboro Research Farm, Willsboro, NY

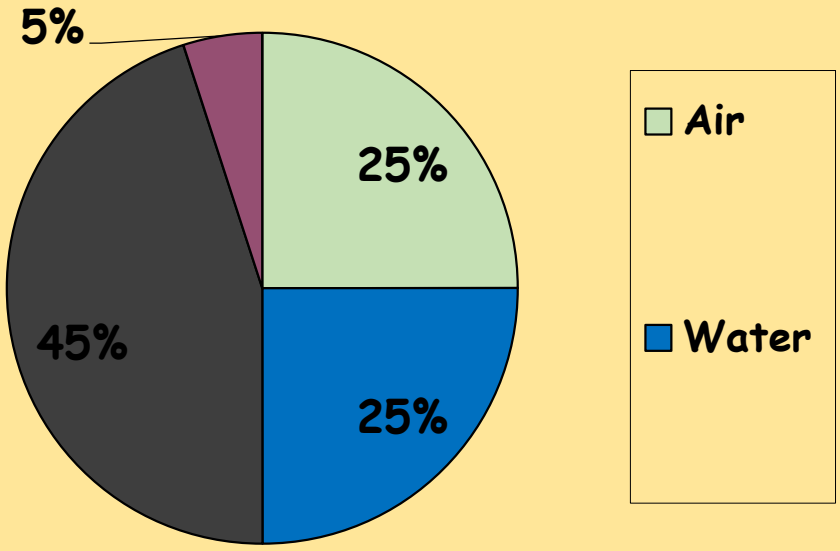
Cornell Cooperative Extension

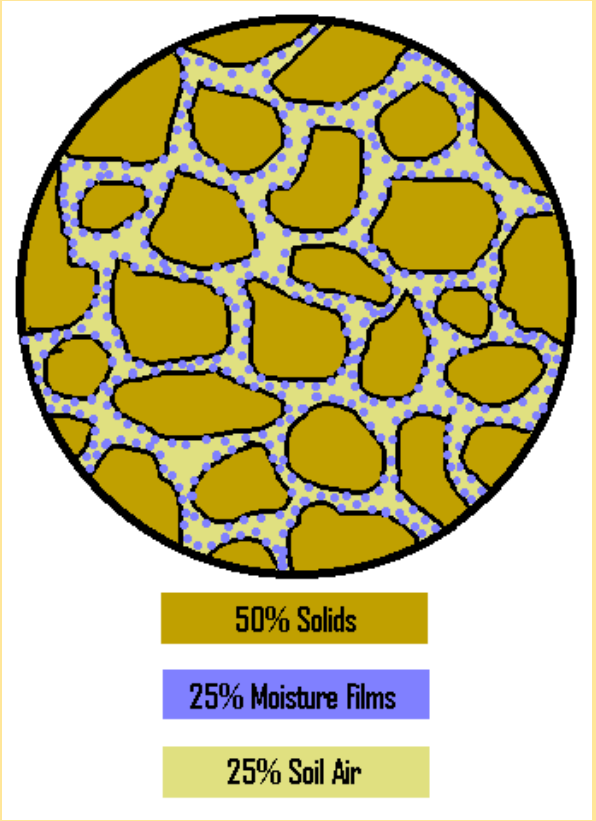
Eastern NY Commercial Horticulture Program

NORTHERN NEW YORK AGRICULTURAL DEVELOPMENT PROGRAM

# Cornell Willsboro Research Farm

# What is soil?



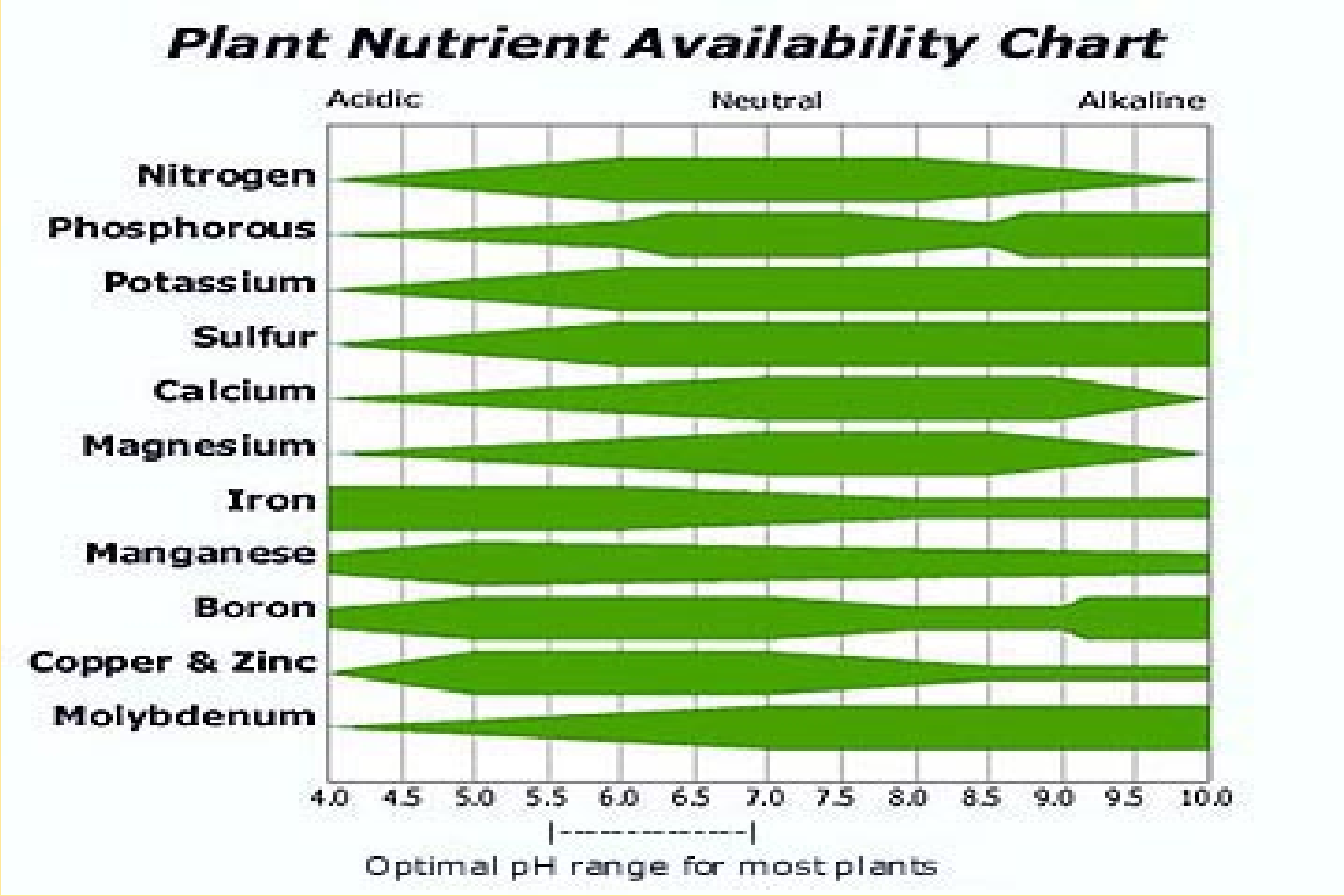




Source: NRCS Soils Resources

# Soil Chemistry

- All soils contain some levels of basic nutrients
  - Macro-nutrients: Nitrogen, Phosphorus, Potassium
  - Secondary nutrients: Calcium, Magnesium, Sulfur,
  - Micronutrients: Boron, Copper, Iron, Chloride, Manganese, Molybdenum, and Zinc

# Nutrient availability varies with pH



http://casoilresource.lawr.ucdavis.edu/gmap/

| Element | lbs/acre* | Very Low | Low | Optimum | High | Very High |
|---|---|---|---|---|---|---|
| Phosphorus (P) | 669 | | | | | |
| Potassium (K) | 2,616 | | | | | |
| Calcium (Ca) | 16,142 | | | | | |
| Magnesium (Mg) | 1,971 | | | | | |

| .nent | Value | Element | Value | Element | Value |
|---|---|---|---|---|---|
| Soil pH | 7.8 | Manganese (Mn), lbs/acre | 56 | Aluminum (Al), lbs/acre | 4 |
| Iron (Fe), lbs/acre | 6 | Zinc (Zn), lbs/acre | 6 | % OM | 11.9 |

# High Tunnel Fertility Challenges

- Nutrient deficiencies are too often over corrected.
  - Excess P
  - Excess Ca
- Most fertilizers elevate soil EC
- Many fertilizers, composts and in particular irrigation water raise pH.
- High pH, salts and nutrient imbalances decrease yield and quality.

https://cvp.cce.cornell.edu/submission.php?id=407&crumb=greenhouse_and_tunnels|greenhouse_tunnels

# Tomatoes thrive in high tunnels

# It is easy for things to get out of hand

# We have learned a lot about training and pruning slicing tomatoes

# Cherry Tomatoes are challenging to train

# Cherry tomatoes are the first to ripen for earliest sales.

# 3 Treatments 8/4/17

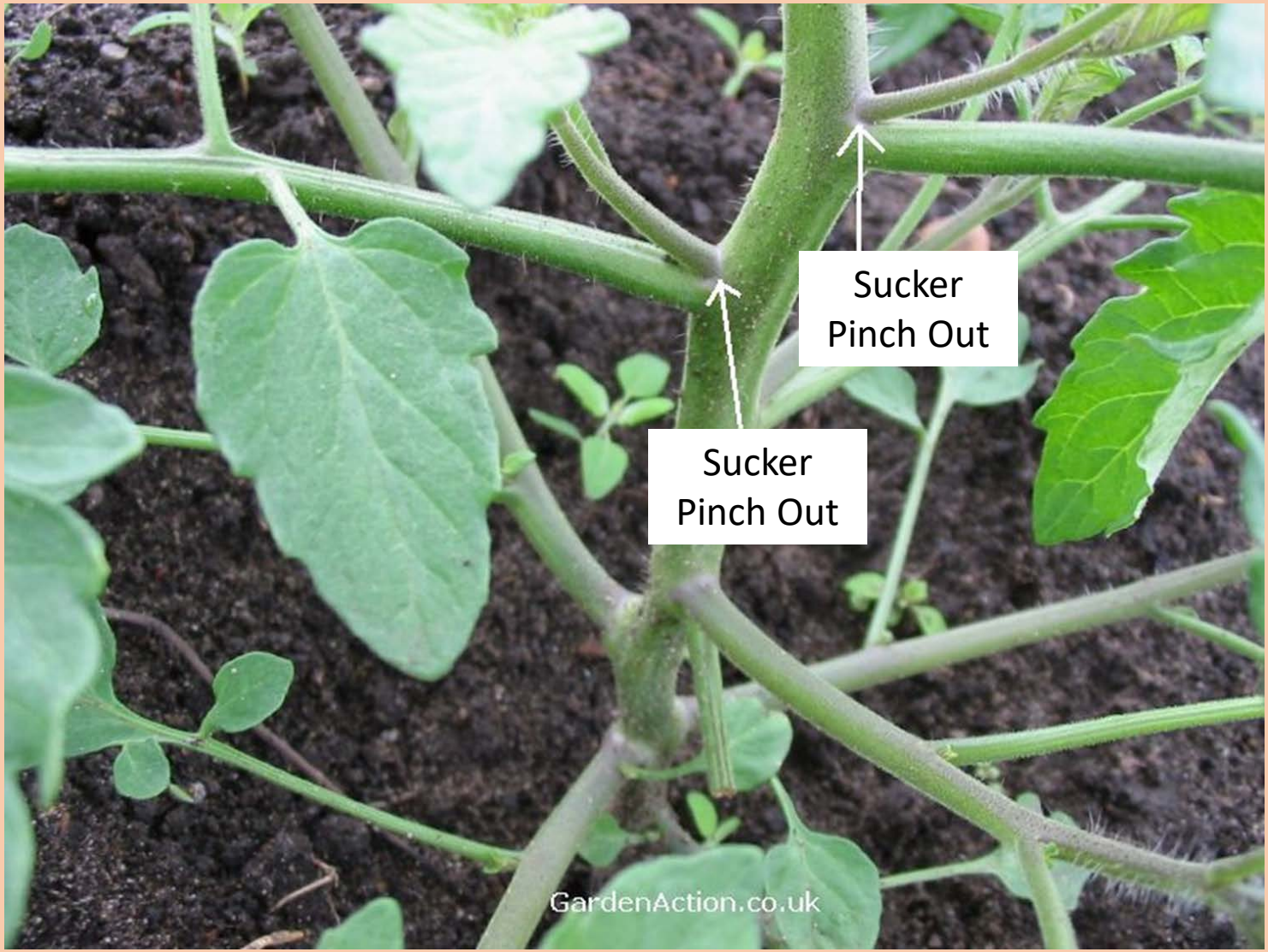
Single Leader

Double Leader

Multi Leader

# How to train: Single Leader remove every sucker

# Keep ALL suckers pruned off



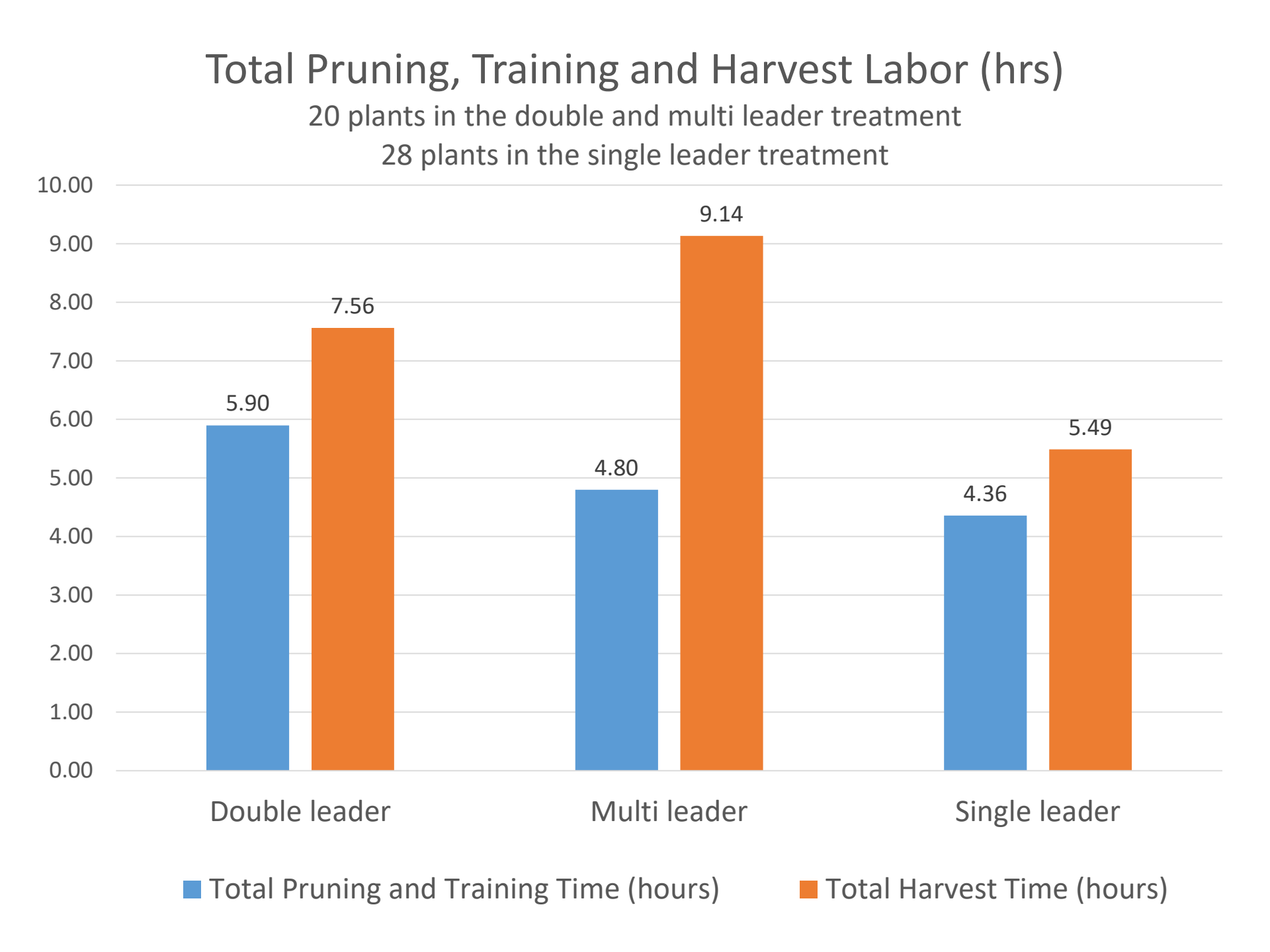
# **Double Leader**: start with ‘strong Y’ then remove all suckers

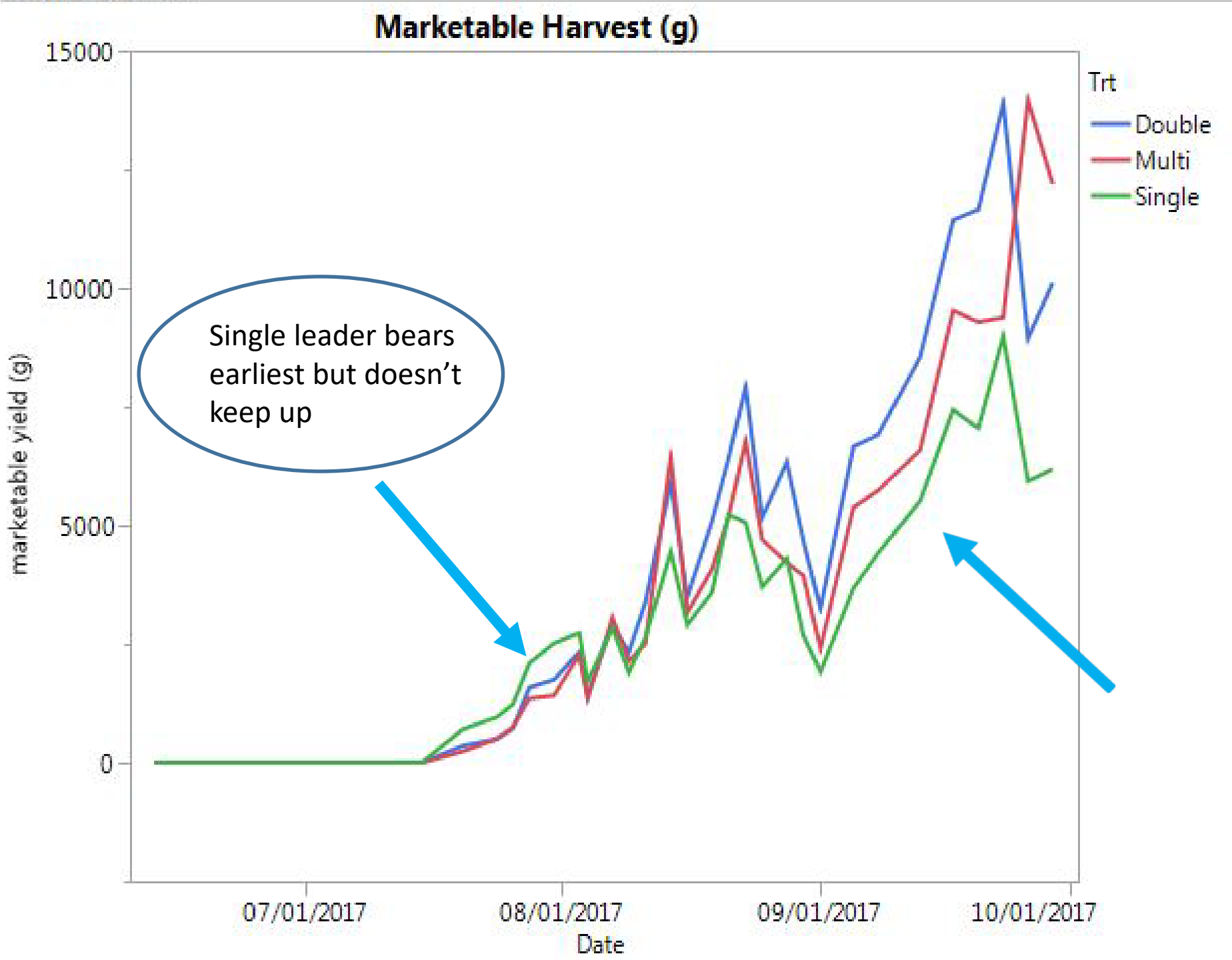
# 3 Treatments 9/4/17

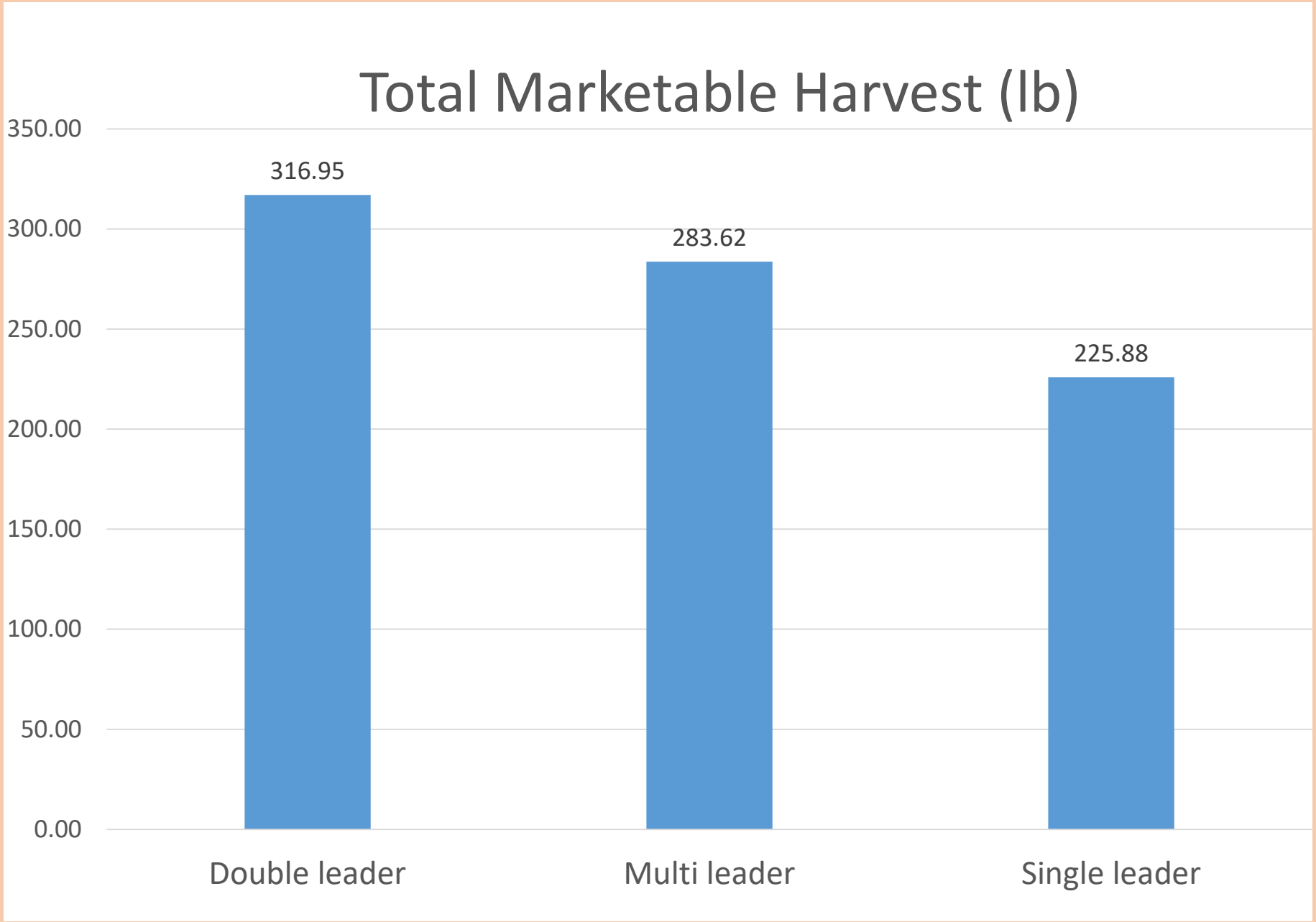
Single Leader

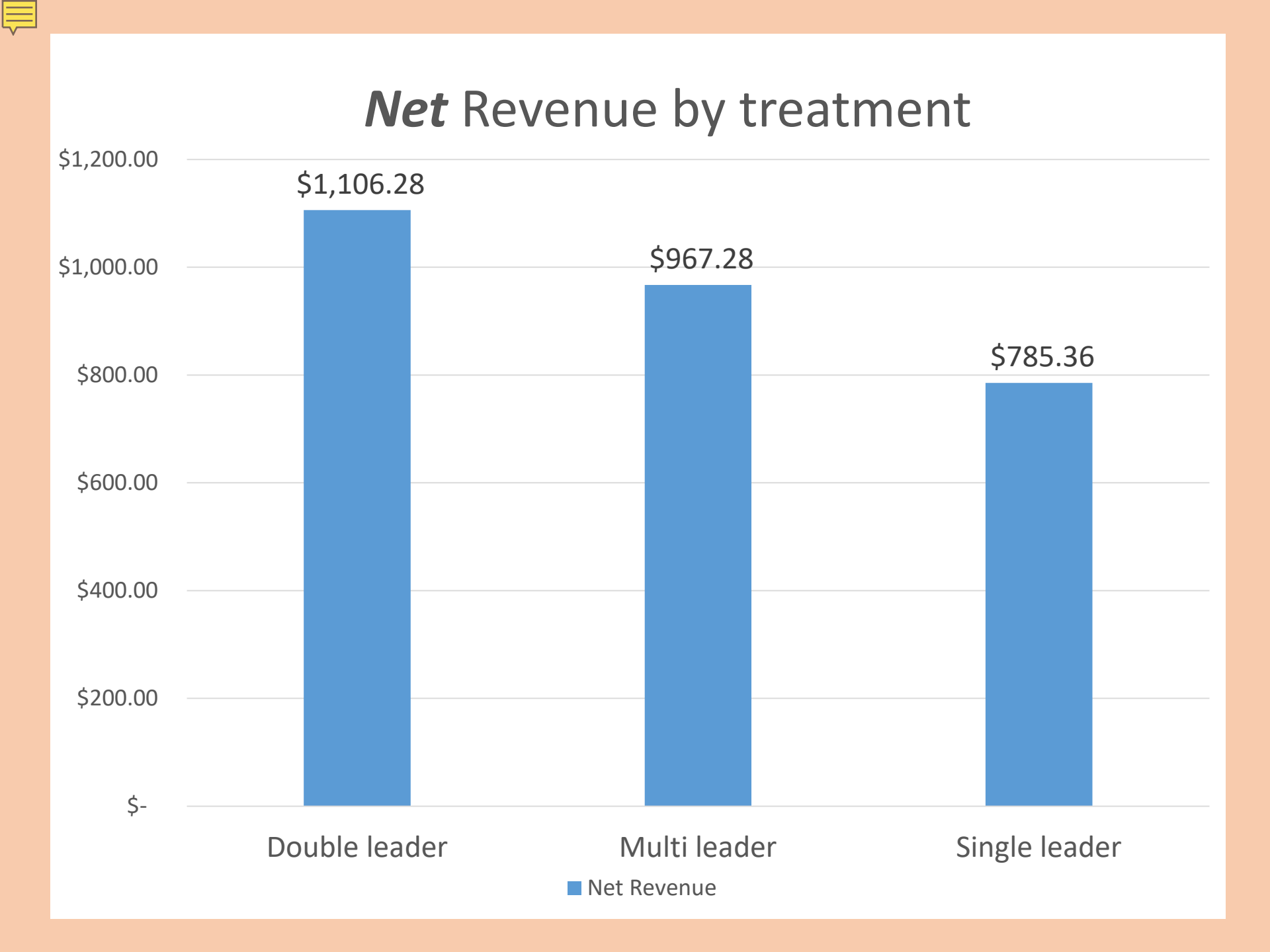
Double Leader

Multi Leader

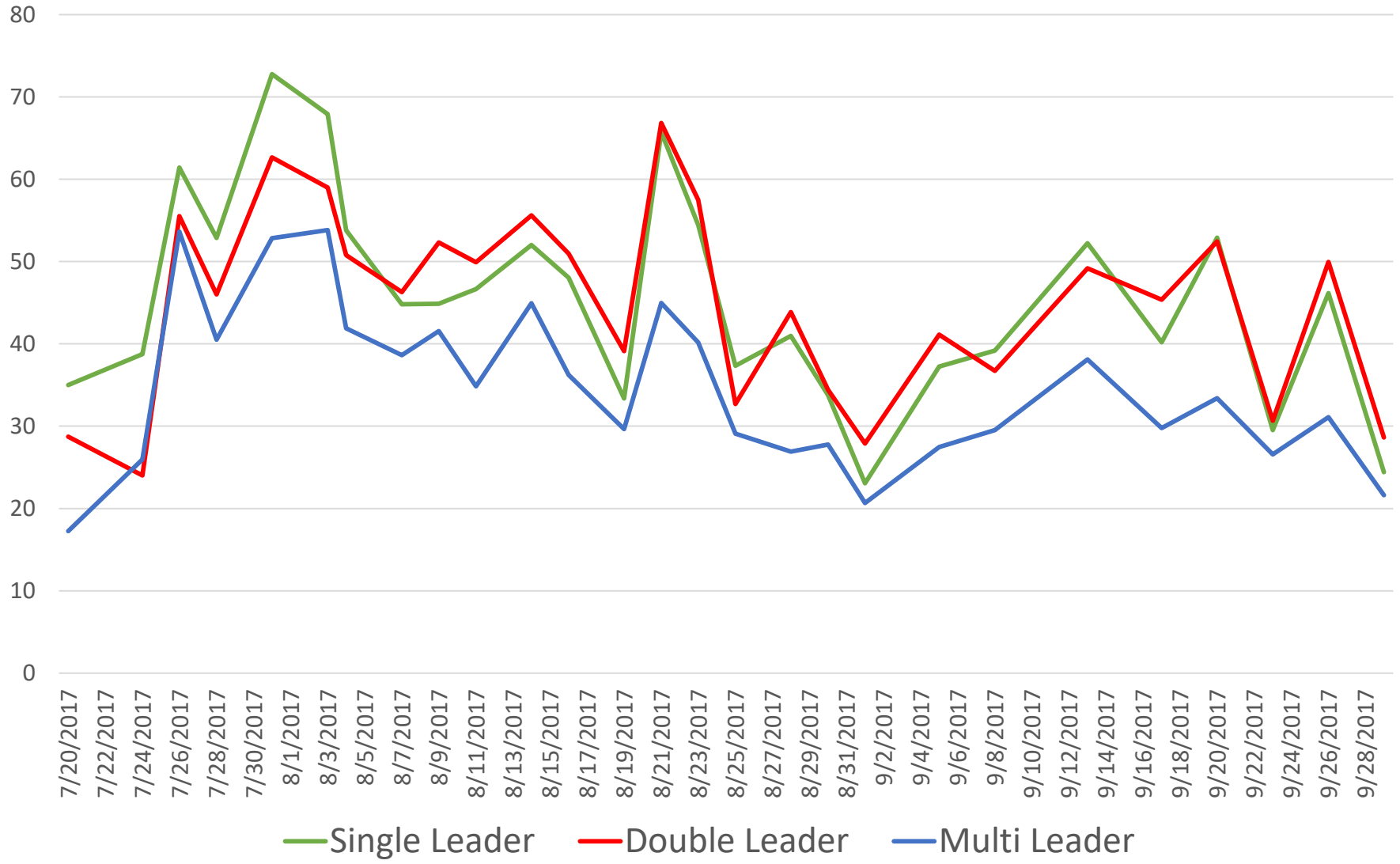

Total Pruning, Training and Harvest Labor (hrs)
20 plants in the double and multi leader treatment
28 plants in the single leader treatment
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
5.90
7.56
4.80
9.14
4.36
5.49
Double leader
Multi leader
Single leader
Total Pruning and Training Time (hours)
Total Harvest Time (hours)


Marketable Harvest (g)
15000
10000
5000
0
marketable yield (g)
Trt
Double
Multi
Single
Single leader bears earliest but doesn't keep up
07/01/2017
08/01/2017
09/01/2017
10/01/2017
Date

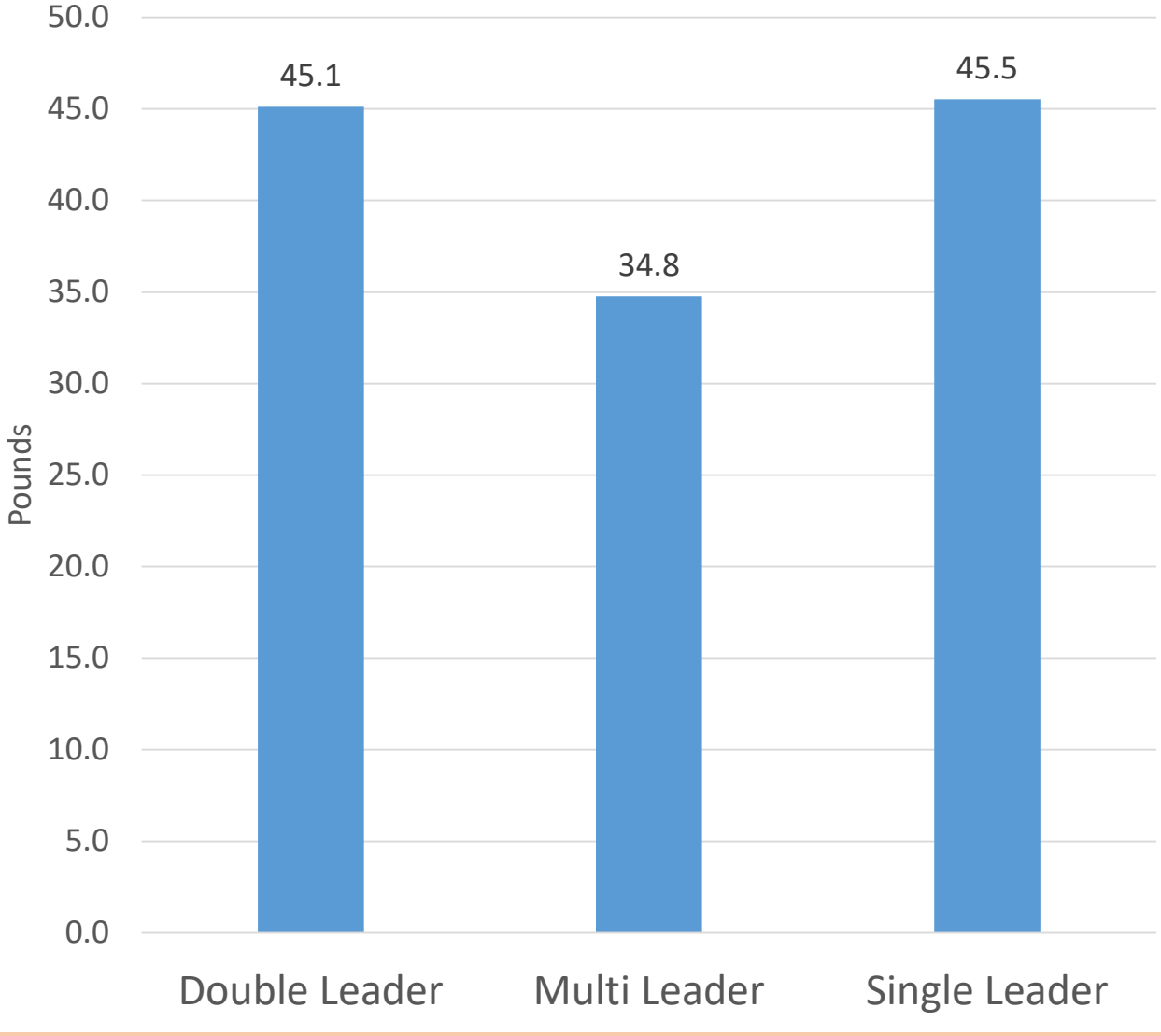

Total Marketable Harvest (lb)
350.00
300.00
250.00
200.00
150.00
100.00
50.00
0.00
316.95
283.62
225.88
Double leader
Multi leader
Single leader


Net Revenue by treatment
$1,200.00
$1,000.00
$800.00
$600.00
$400.00
$200.00
$-
$1,106.28
$967.28
$785.36
Double leader
Multi leader
Single leader
Net Revenue

# Cherry tomatoes (lbs) per hour of harvest



# Average cherry tomato yield per block per hour of harvest




Multi-leader 9/4/17

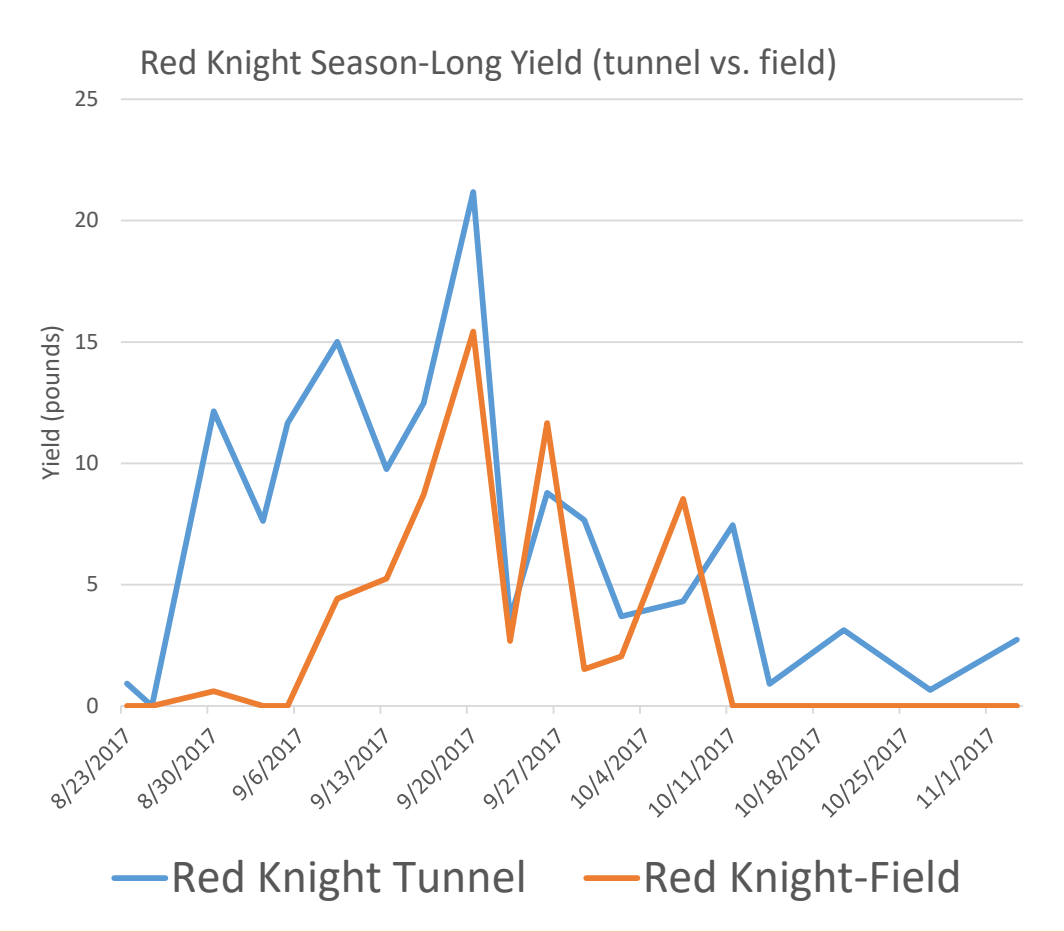
# And the winner is….. The Double Leader System

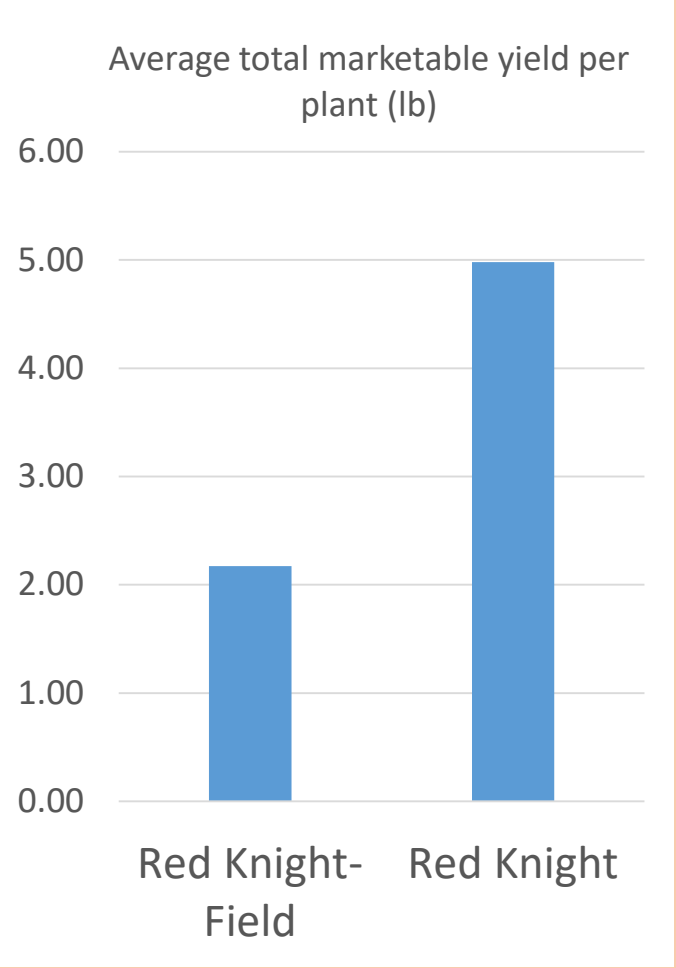
# High Tunnel Peppers

1. Inside vs Outside
2. Greenhouse varieties vs field varieties
3. Pruning/Training methods of greenhouse vars

# 2017 was especially harsh at first

# Red Knight inside and outside



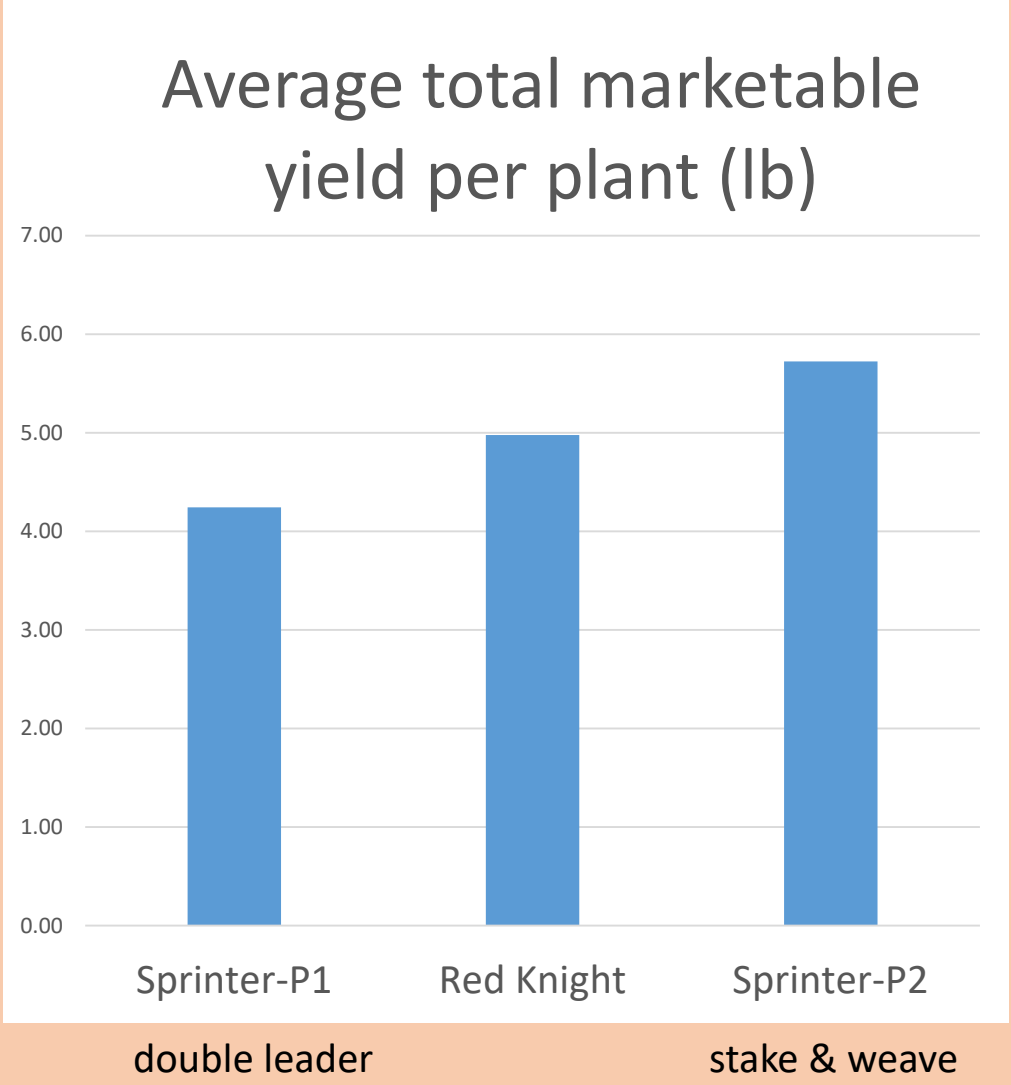
# Greenhouse vs Field Varieties

## Sprinter

- Bred for low-tech greenhouses
- Some heat recommended
- Indeterminate habit
- Double leader recommended

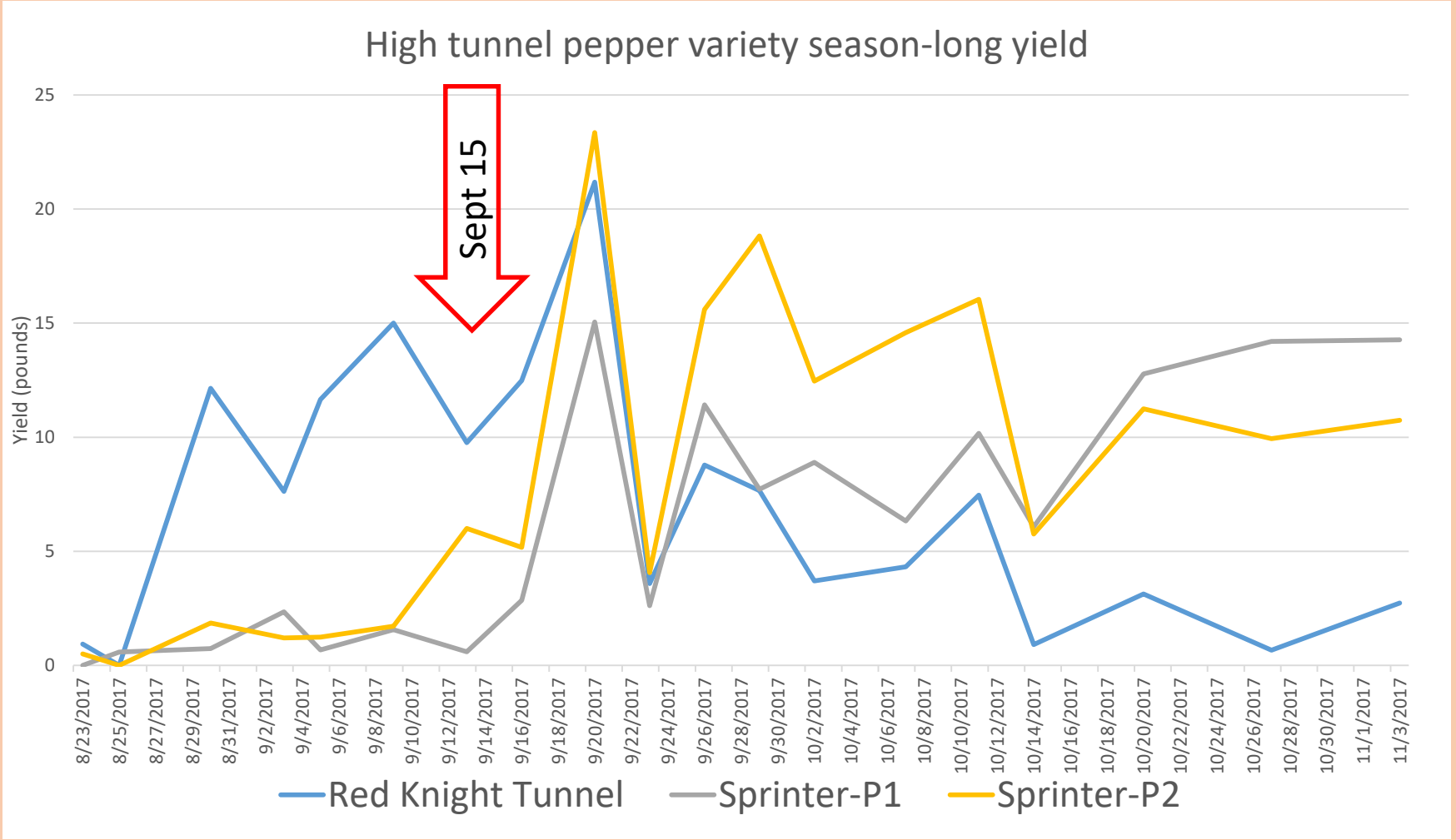
## Red Knight

- Classic field variety



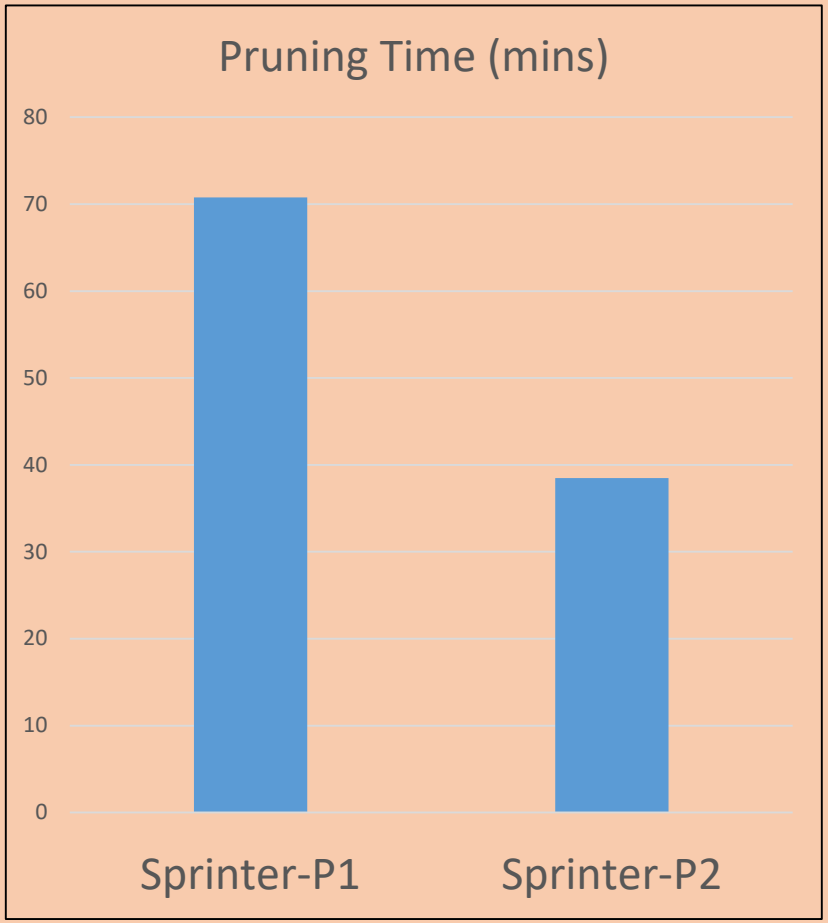
# Red Knight – Sprinter
## 9/3/17

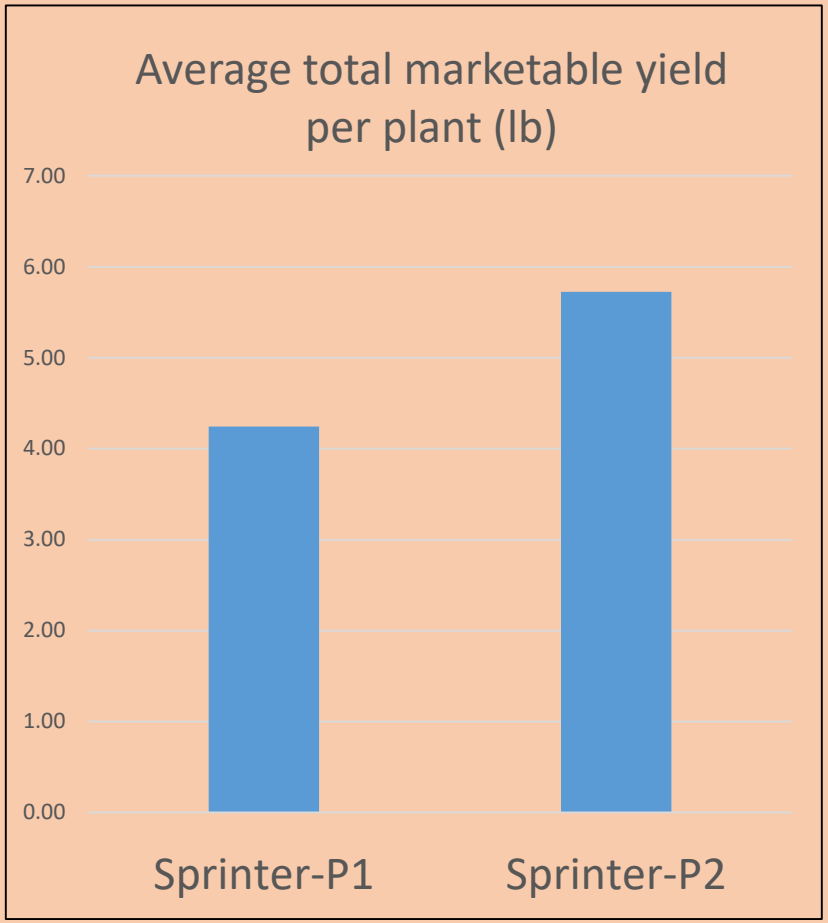
# Red Knight produced earliest then faded
# Sprinter came later then sustained



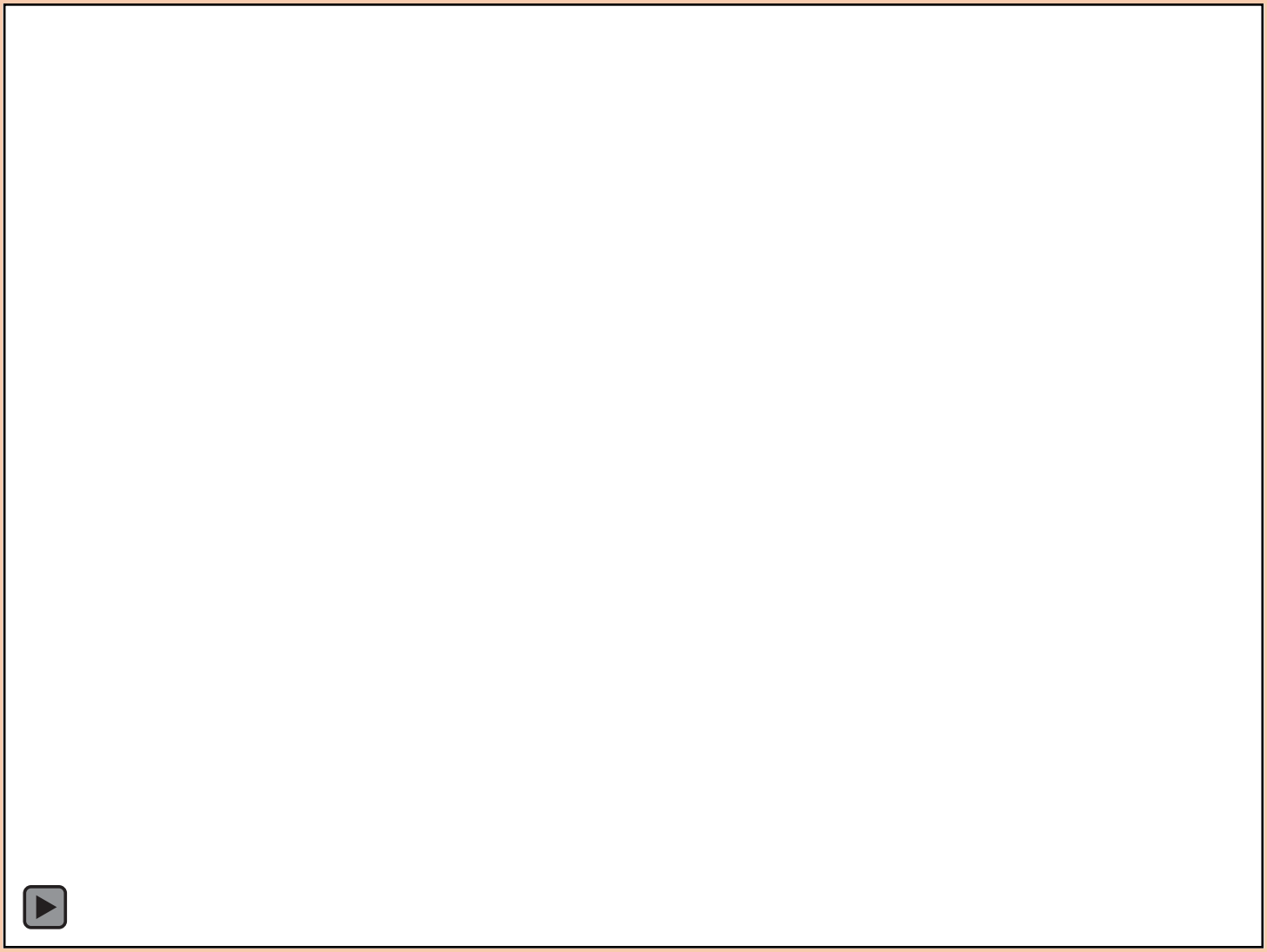
# Pruning/training methods for Sprinter types

## P-1 double leader, P-2 stake & weave



# Early Training of Sprinter to Double Leader 7/3/17



# Sprinter, 2 pruning methods
## 8/4/17

By November 3rd the double leader plants were finally hitting their stride.

How many fruits can you spy?

# Conclusions to our 3 questions

1. Field varieties yield more and earlier when grown in tunnels than outside.
2. Without heat, Sprinter was slow to yield.
3. Without heat, it was better to train Sprinter to the stake & weave system.

# Earliest warm season crops 2018

- Bush green beans
- Zucchini
- Red bell peppers

# Did using the high tunnel make a difference in earliest harvest?

Inside tunnel

- Planted 4/23
- 1 treatment covered except when temps >80
- 1 treatment not covered

Average air temps
May – 59F with 1.52” rain
June – 63F with 3.43” rain

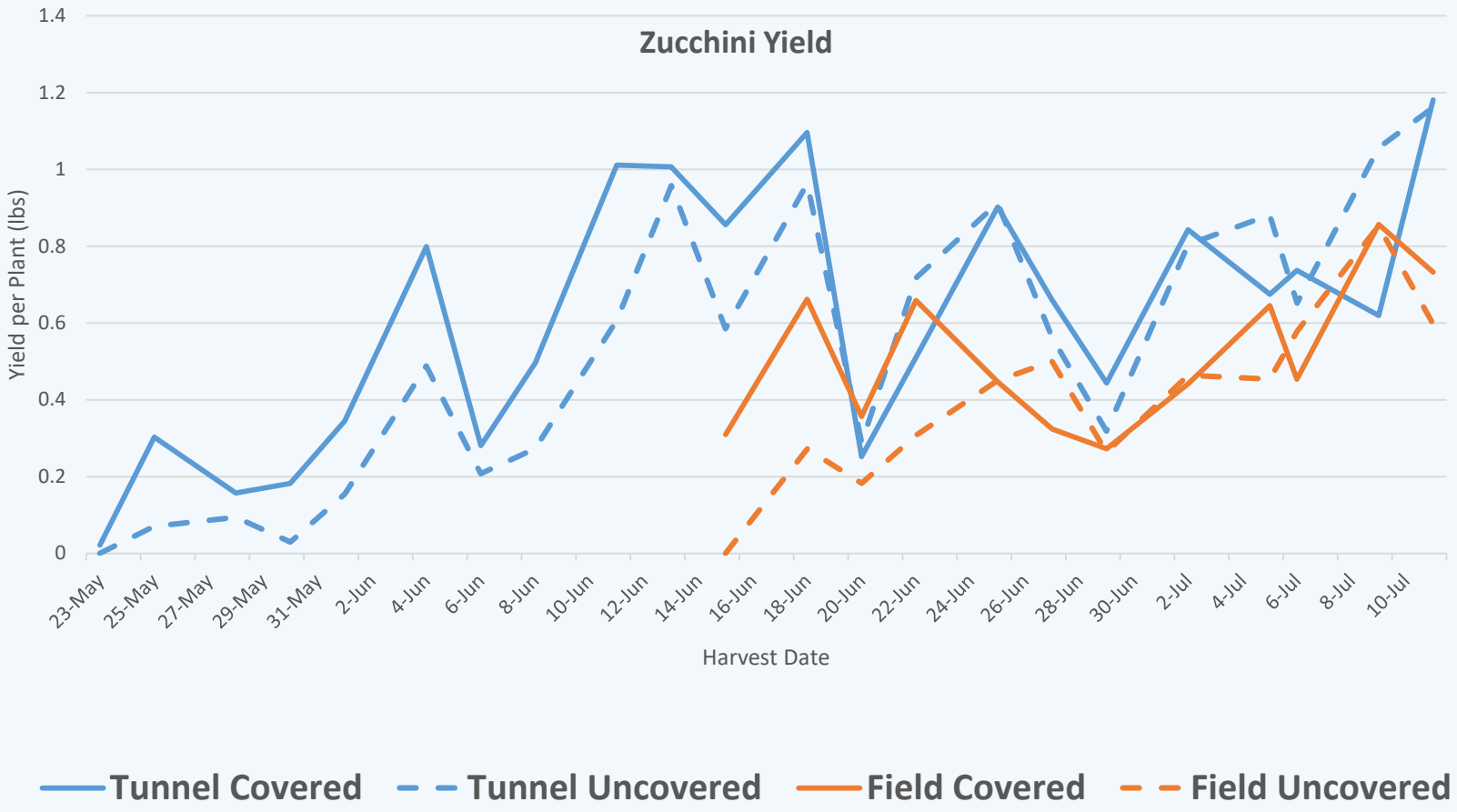
# Edge effect 6/1/18

# Outside the tunnel

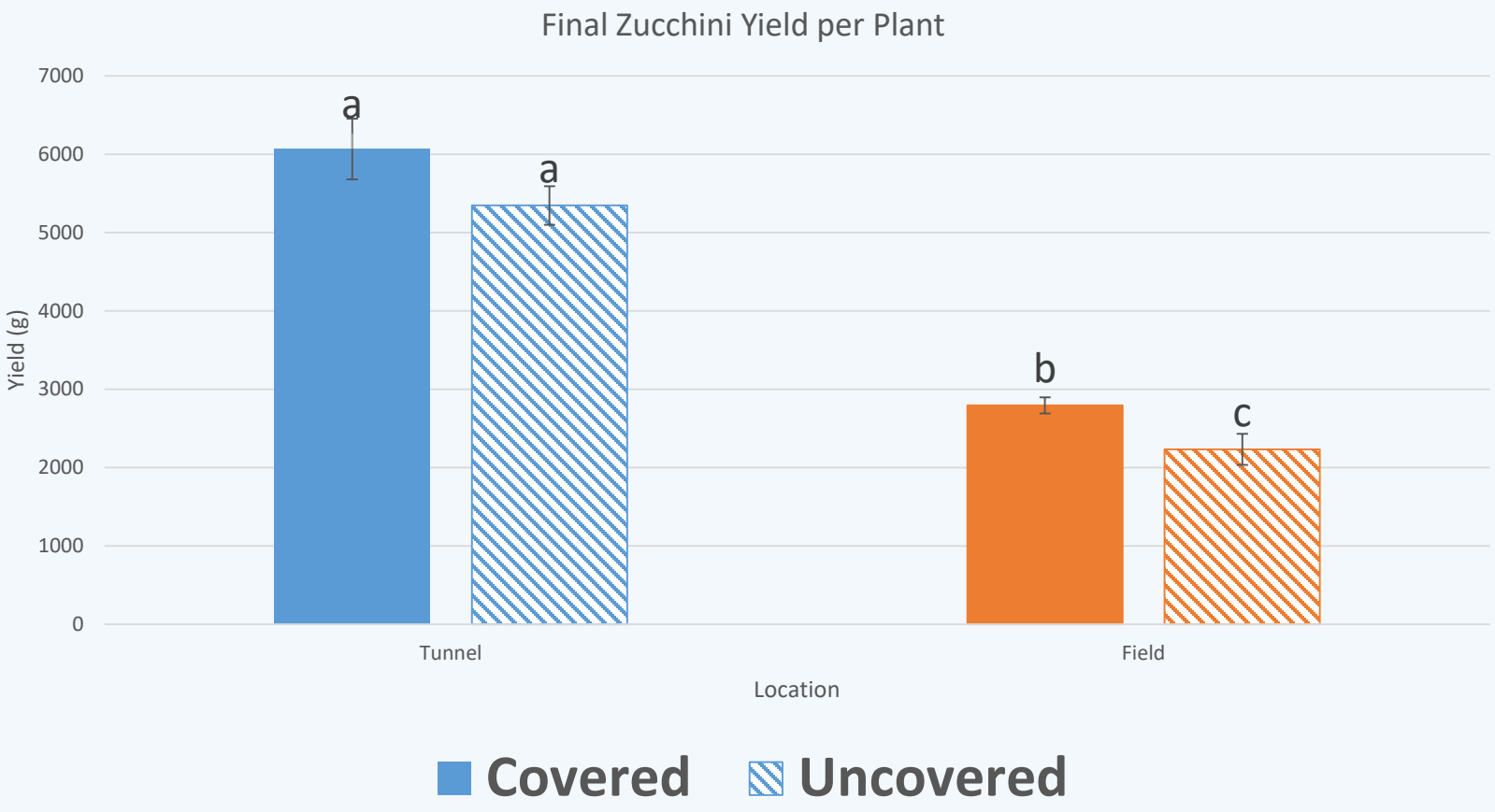
- Planted 5/17
- 1 treatment covered until June 14
- 1 treatment not covered

# 6/14/18 Rowcover removed from field plantings
# Rowcover left in place allows weeds to flourish

# Zucchini yield per plant

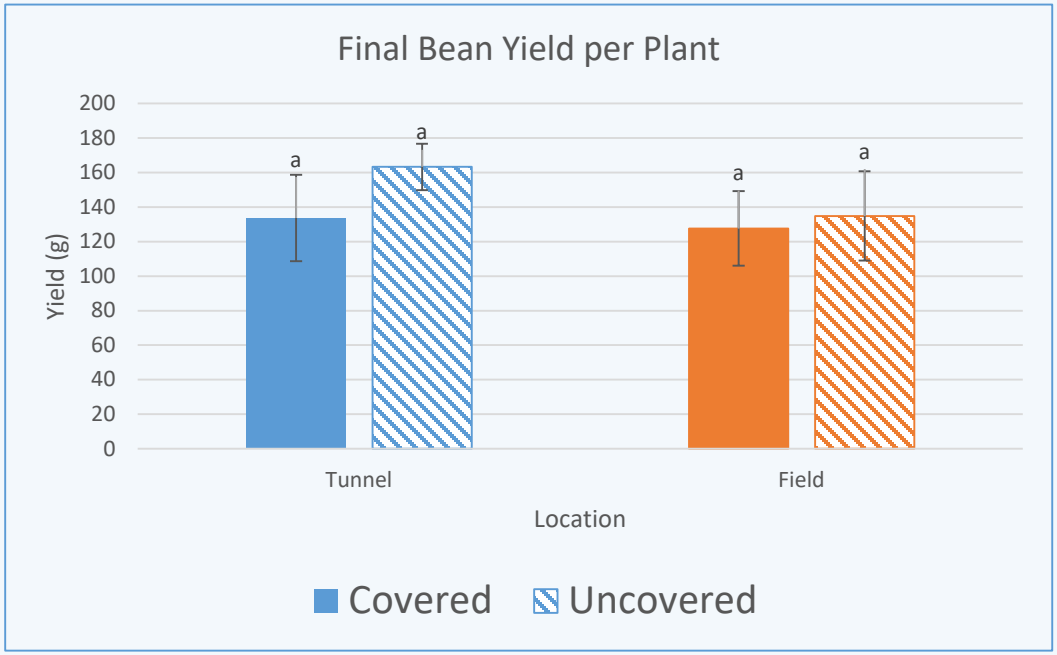


# Final zucchini yield
## as of July 11, 2018

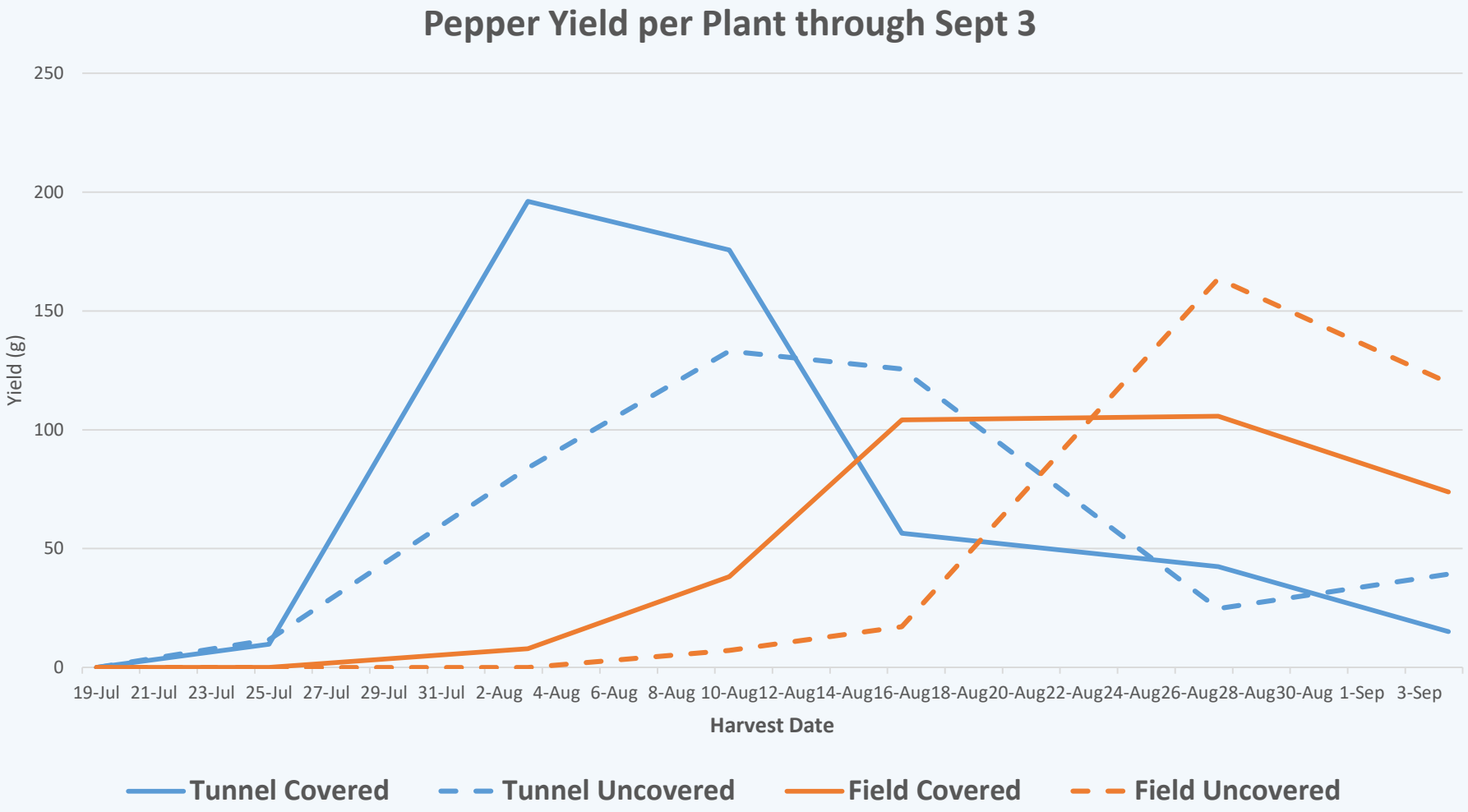


# Beans

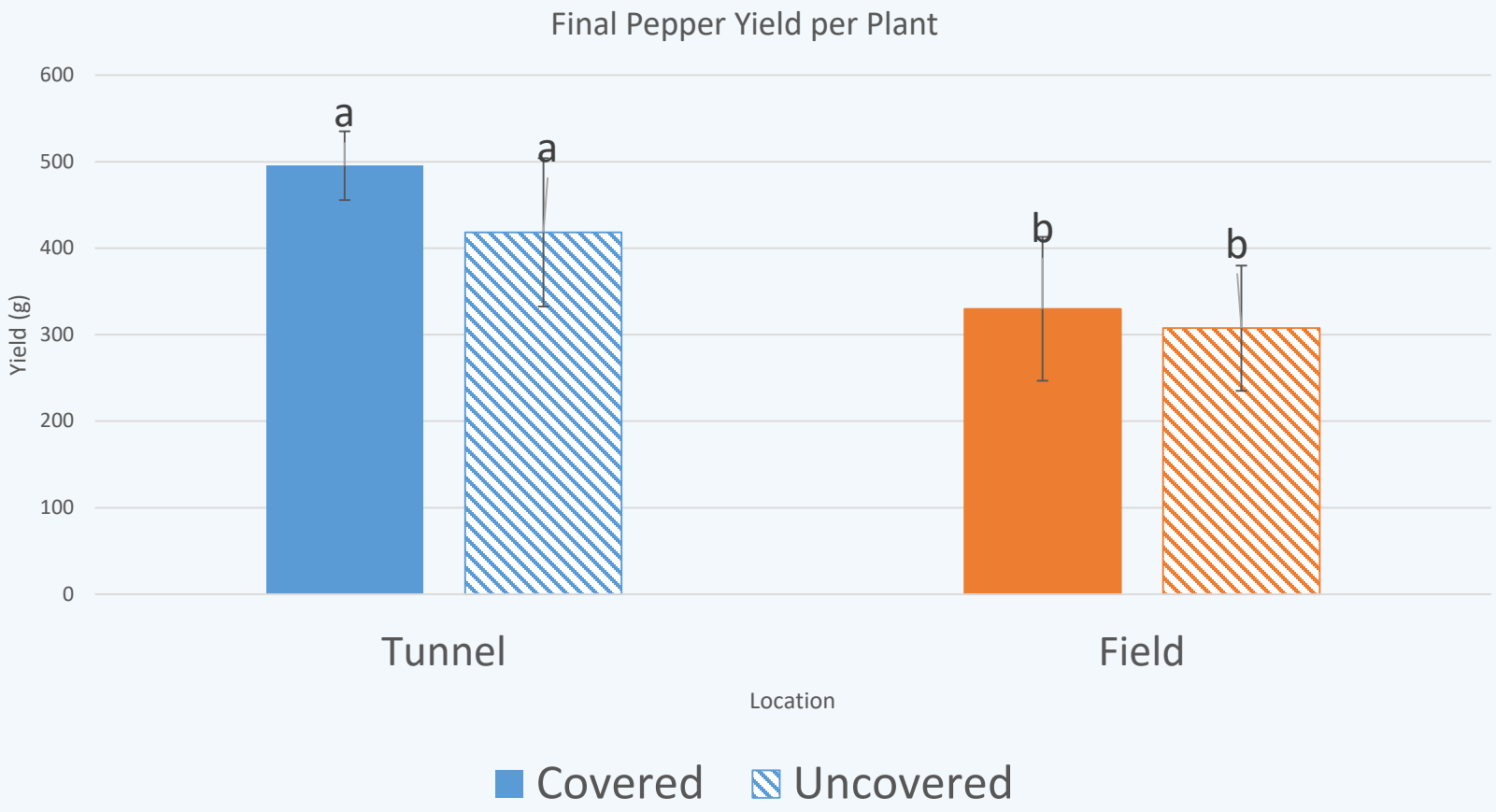
- Cool soil was the issue for germination
- Consider transplanting to push the season



# Peppers


Pepper Yield per Plant through Sept 3
250
200
150
100
50
0
Yield (g)
19-Jul
21-Jul
23-Jul
25-Jul
27-Jul
29-Jul
31-Jul
2-Aug
4-Aug
6-Aug
8-Aug
10-Aug
12-Aug
14-Aug
16-Aug
18-Aug
20-Aug
22-Aug
24-Aug
26-Aug
28-Aug
30-Aug
1-Sep
3-Sep
Harvest Date
Tunnel Covered
Tunnel Uncovered
Field Covered
Field Uncovered

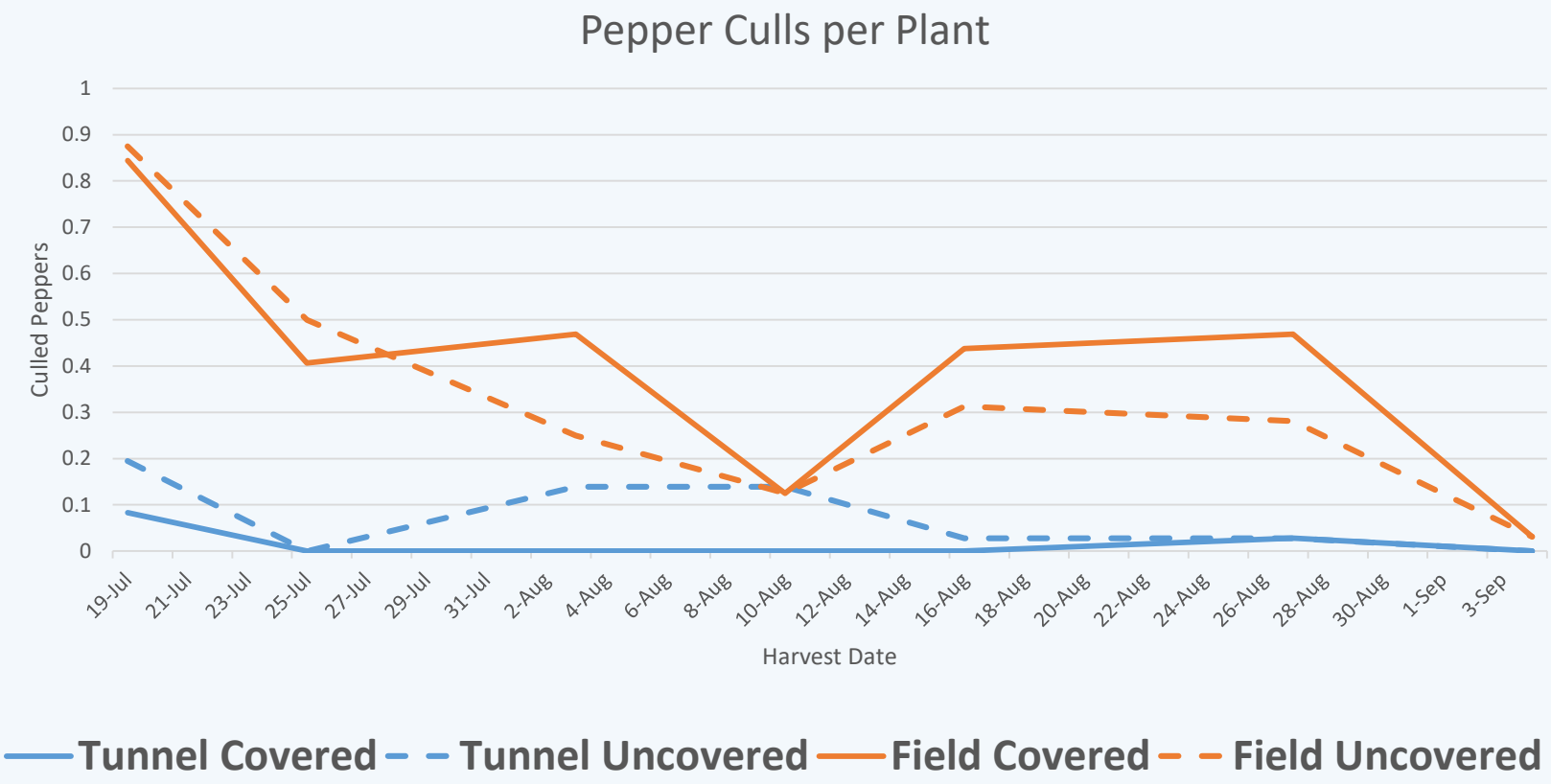
# Final pepper yield as of 9/4/18




Inside transplanted 4/23, outside transplanted 5/17

# Fewer culls inside tunnel than out

(sunscald and blossom end rot)



# What a difference the first month makes!

August 3, **2018**
(covered in front, uncovered in back)
**Transplant date 4/23**

August 4, **2017**
**Transplant date 5/25**

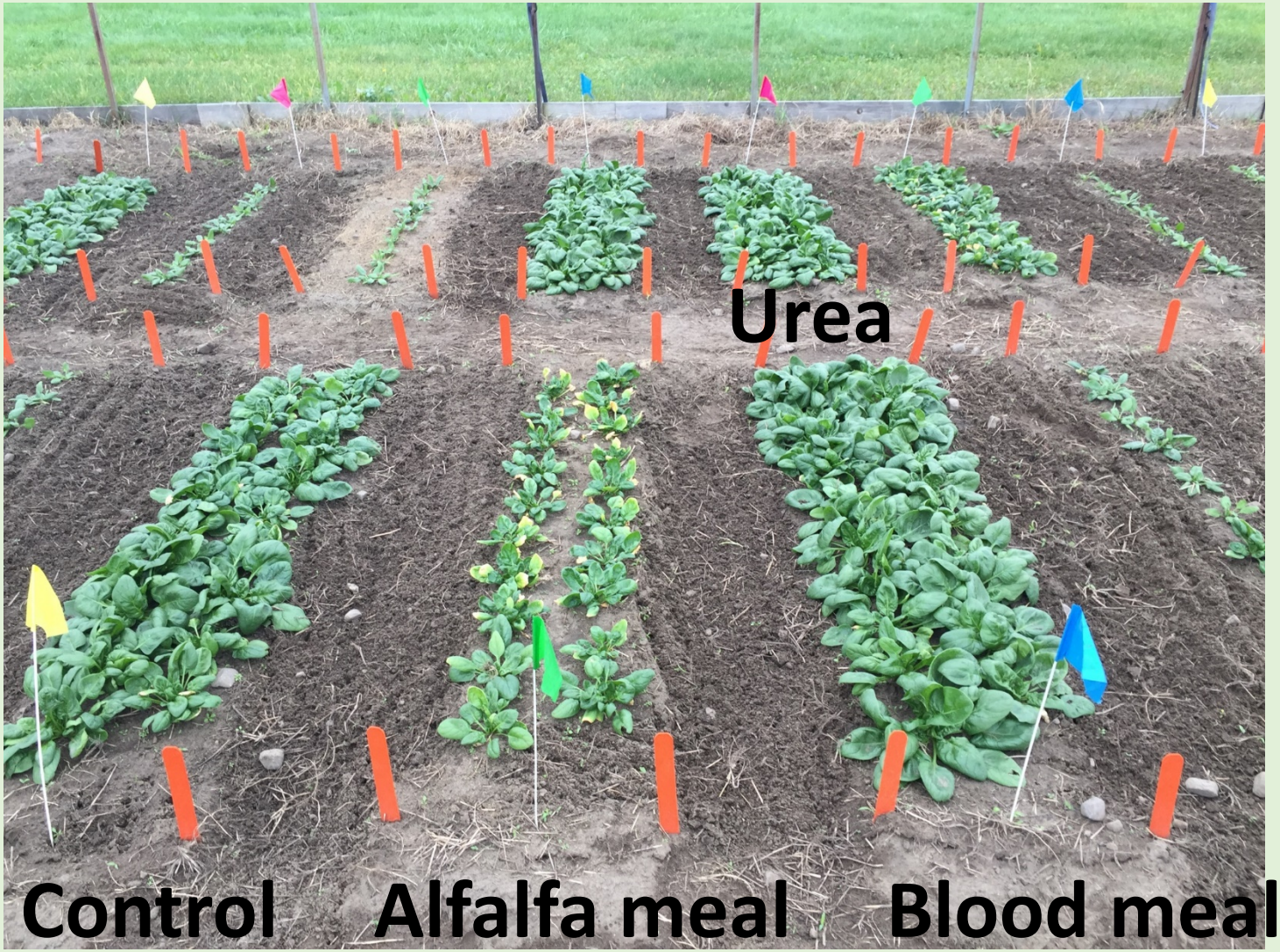
Both plantings are Red Knight

# Nitrogen uptake in winter spinach

# The treatments

- 2 plantings, 2 weeks apart
- Sowed seeds into 72 cell trays, transplanted out 4 weeks later
- Variety Space
- Treatments
  - Urea (130 lbs split)
  - Blood meal (130 lbs split)
  - Alfalfa meal (130 lbs)
  - Control

2 weeks after transplanting the early planting was showing differences between the treatments.
(yellow – control, green – alfalfa, blue – blood meal)


Urea
Control
Alfalfa meal
Blood meal

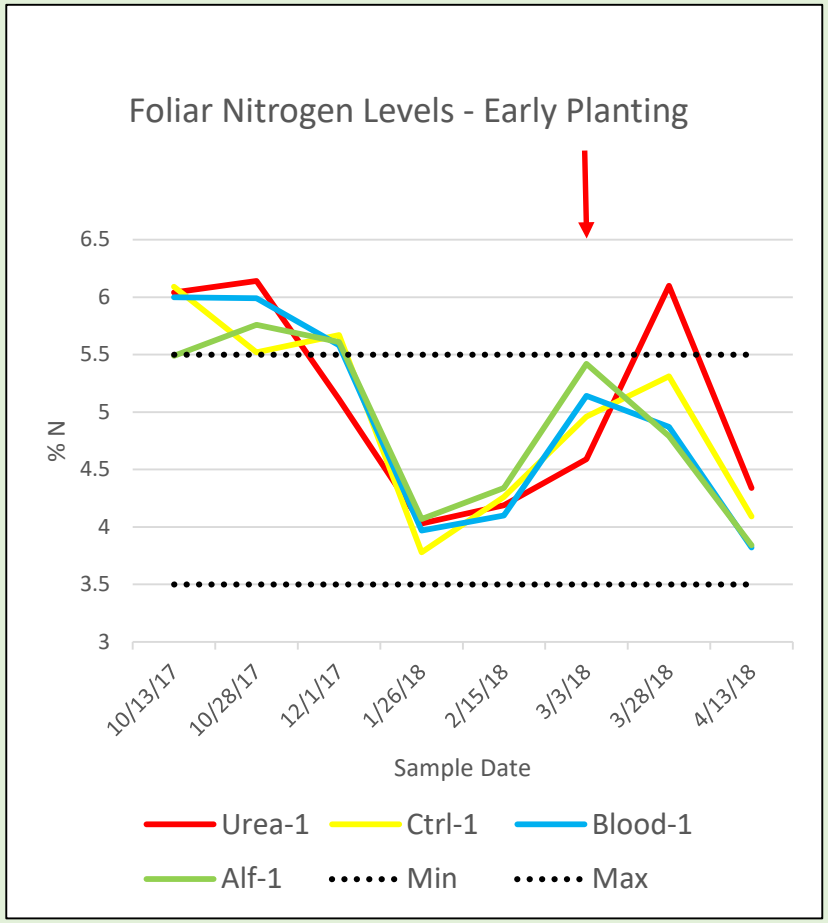
## Outside the tunnel:

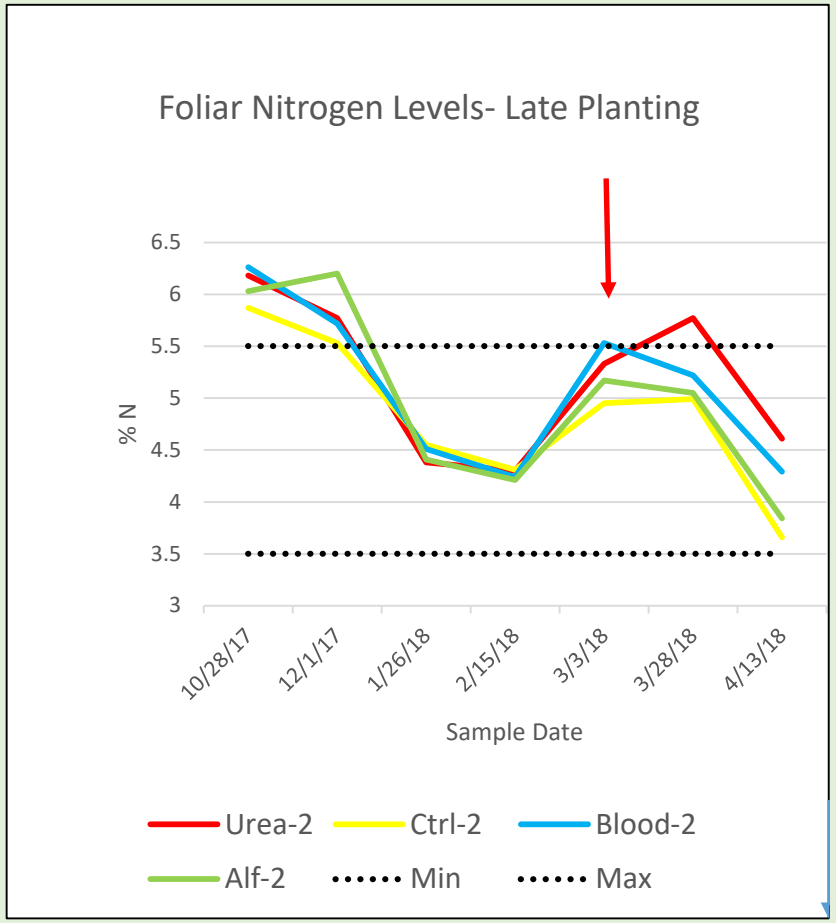
- The minimum air temperature was -15.7 in December and -19.5 in January
- There were 7 days each month, December and January, with temperatures below zero.

## Inside the tunnel:

- A double layer of rowcover was laid over low hoops once temps went below freezing.
- Minimum soil temperature (2” deep)  outside the rowcover by the north wall for the coldest location was 22.97
- Minimum soil temperature (2” deep) under the rowcover near the center of the tunnel for the warmest location was 27.54 degrees
- Minimum air temperature (12” above the soil) in the tunnel outside the rowcover was -14.01 degrees

| Temperatures inside the tunnel | | |
|---|---|---|
| Location | Min (°F) | Max (°F) |
| Soil temp 2” deep in center of tunnel, under row cover | 27.538 | 63.648 |
| Soil temp 2” deep north side of tunnel, without row cover | 22.968 | 64.888 |
| Air temp 12” above soil without row cover | -14.001 | 75.333 |
| | | |
| Temperatures outside the tunnel | | |
| 15 days below zero from late December to early Feb<br>Dec min temp was -15.7(°F) , Jan min temp was -19.5(°F) | | |

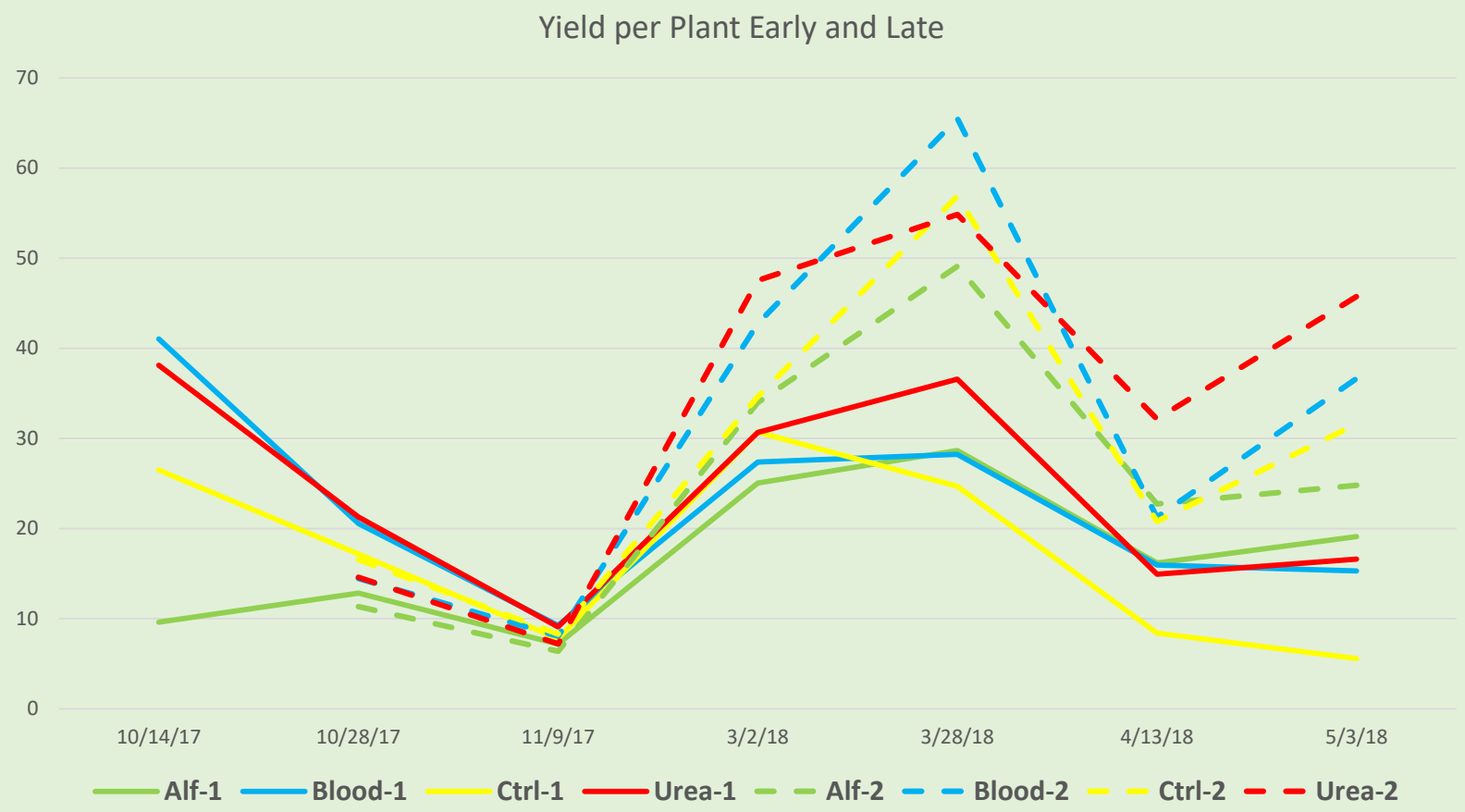


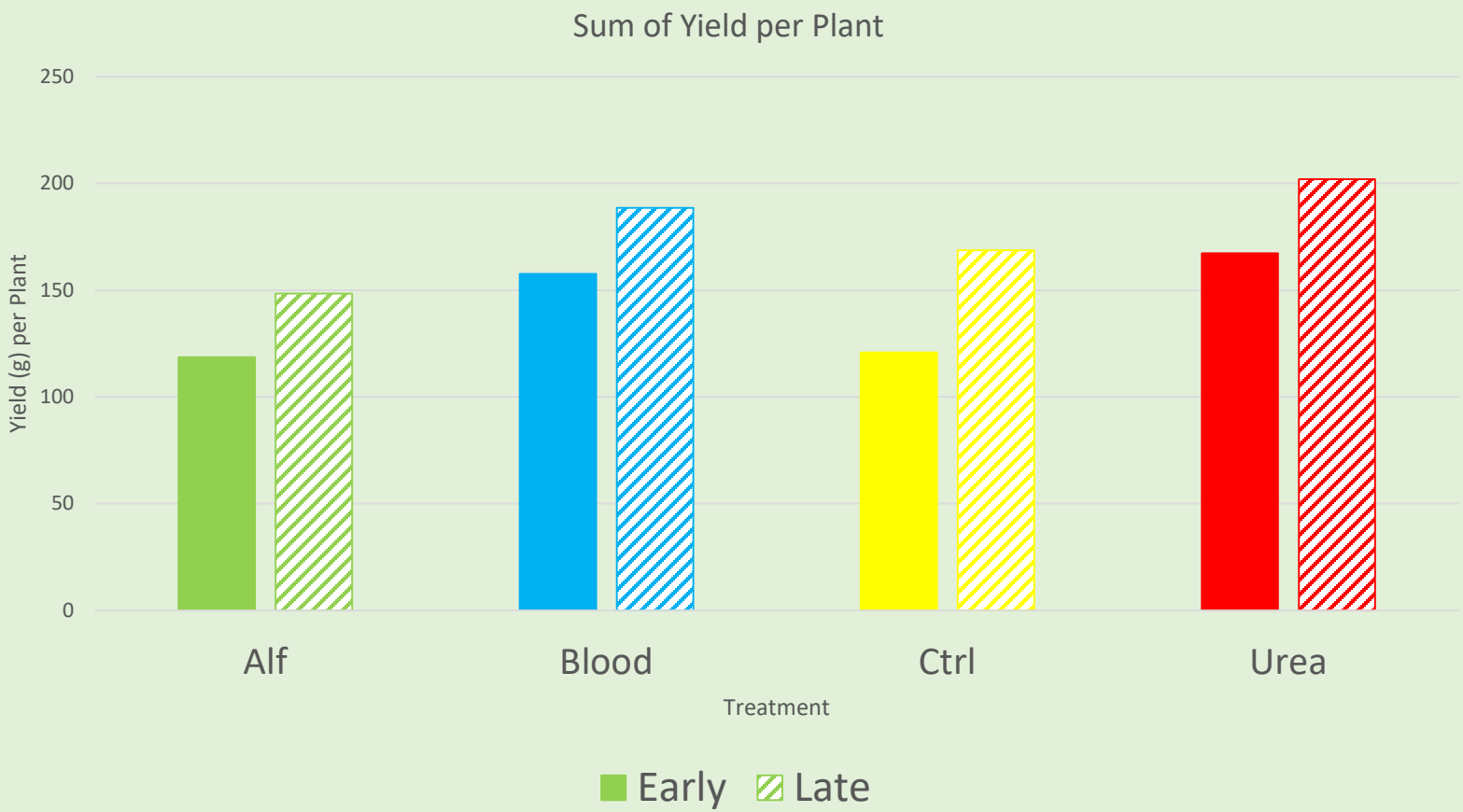

Red downward arrows indicate when the sidedressing of urea and bloodmeal occurred. Horizontal dotted lines show minimum and maximum levels of %N (nitrogen).

At no time did any of the treatments, including the control with no additional N, drop below the minimum level of N.

# Yield per treatment per plant over 7 harvests



# Total yield per plant per treatment



Cornell Cooperative Extension

Eastern NY Commercial Horticulture Program

# Questions?

- Amy Ivy – adi2@cornell.edu
- Judson Reid – jer11@cornell.edu
- Mike Davis – mhd11@cornell.edu
- https://enych.cce.cornell.edu/greenhouse_tunnels.php

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http://www.nnyagdev.org/

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