Improving Land Use Efficiency by Reducing Potato Row Width

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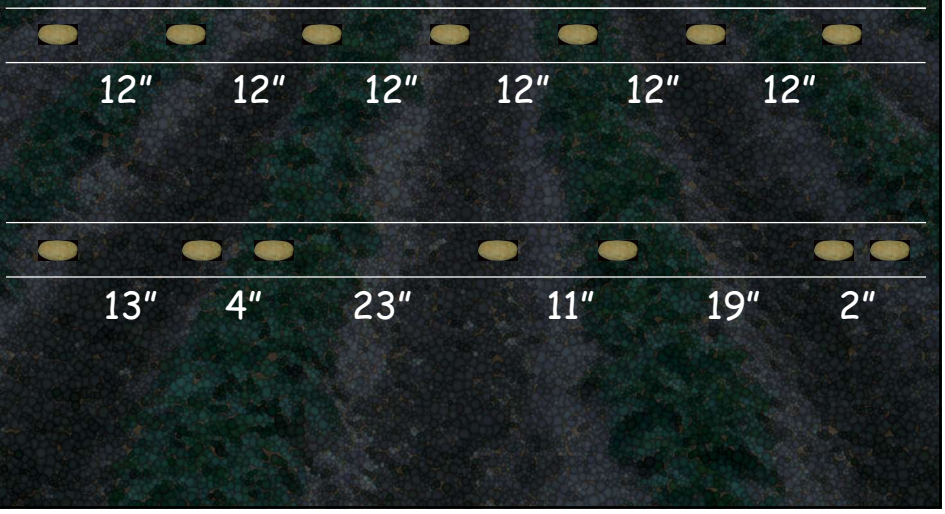
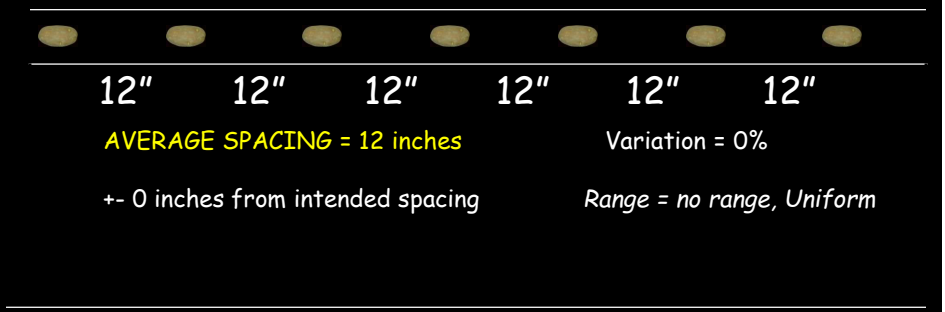
Why Manipulate the Spatial Arrangement of Seed Potatoes?

- The bottom line $
- Optimize tuber size profile for your market
  - Seed, little potatoes, processing
  - Optimize the most valuable tuber sizes
- Current planting configuration has issues
  - Tire rub – designated rows for tires
- Other people are doing it, so it must be good

Do Plant Population and Spatial Arrangement Refer to the Same Thing?



The Problem with Using "Average" Spacing as a Gauge

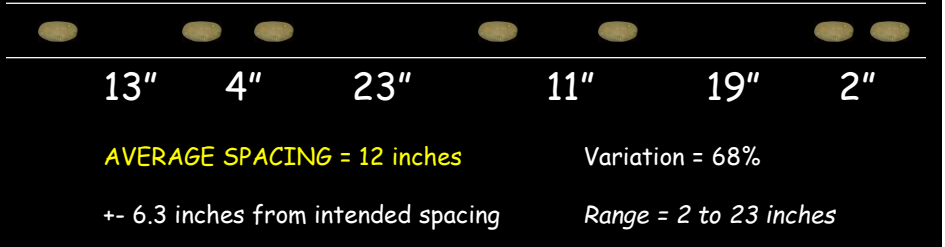


AVERAGE SPACING = 12 inches

Variation = 0%

+- 0 inches from intended spacing

Range = no range, Uniform



AVERAGE SPACING = 12 inches

Variation = 68%

+- 6.3 inches from intended spacing

Range = 2 to 23 inches


Narrow Spacing
1
2
3
Wide Spacing
1
2
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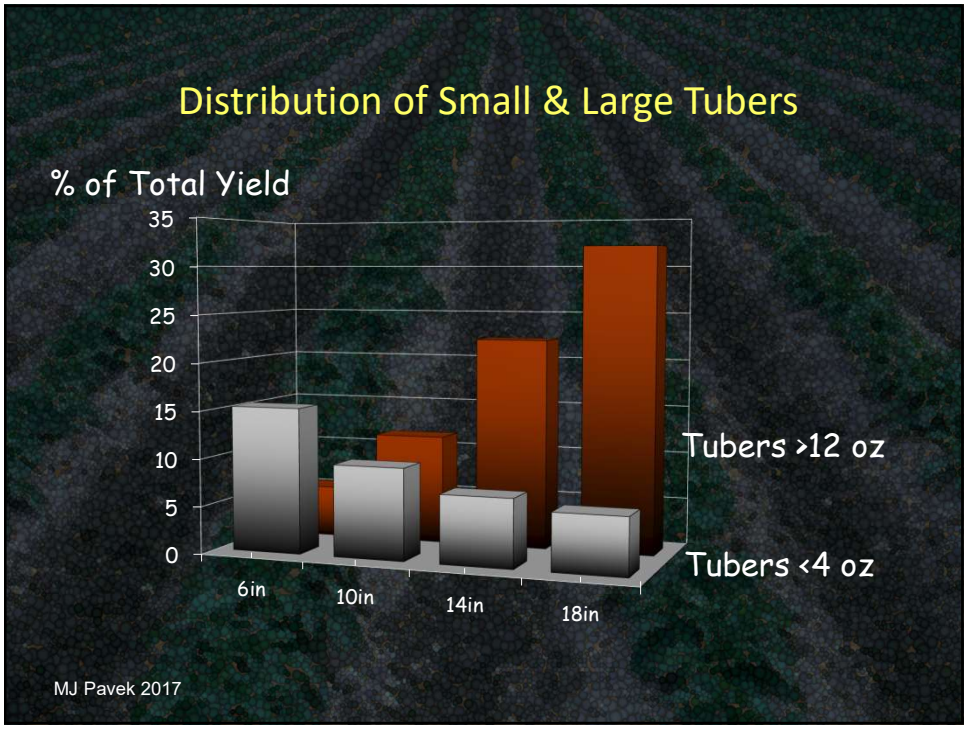
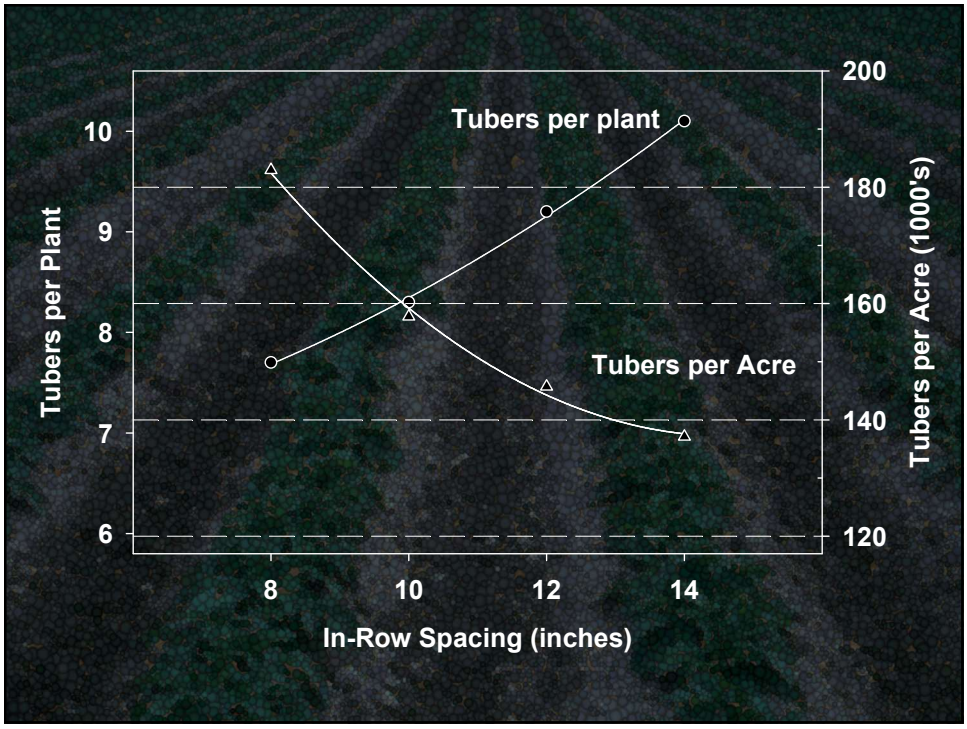
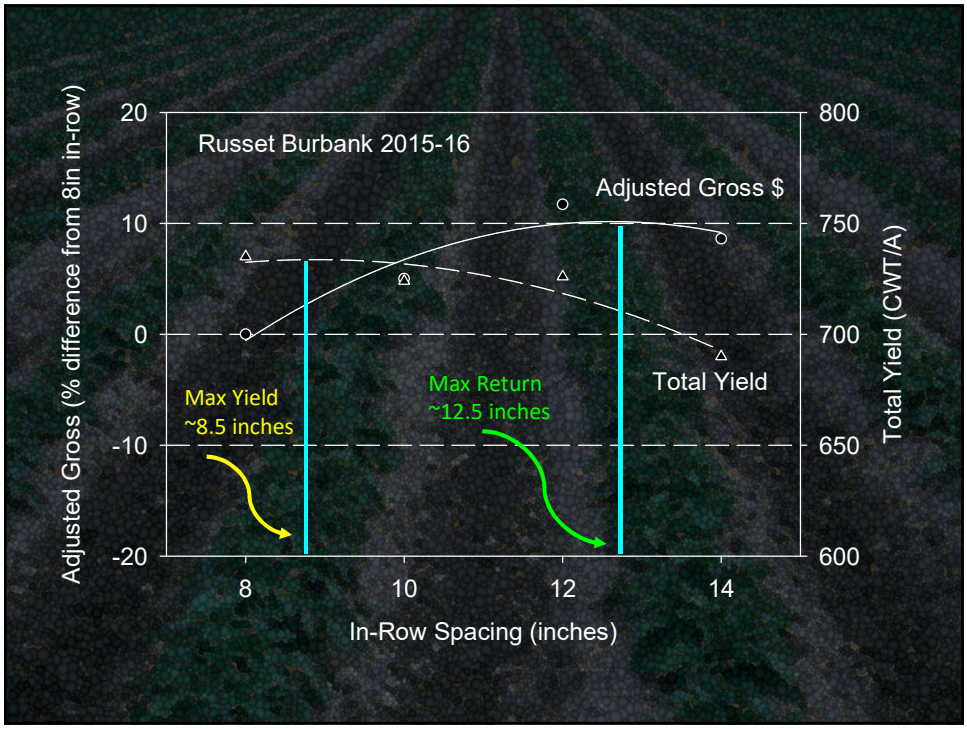
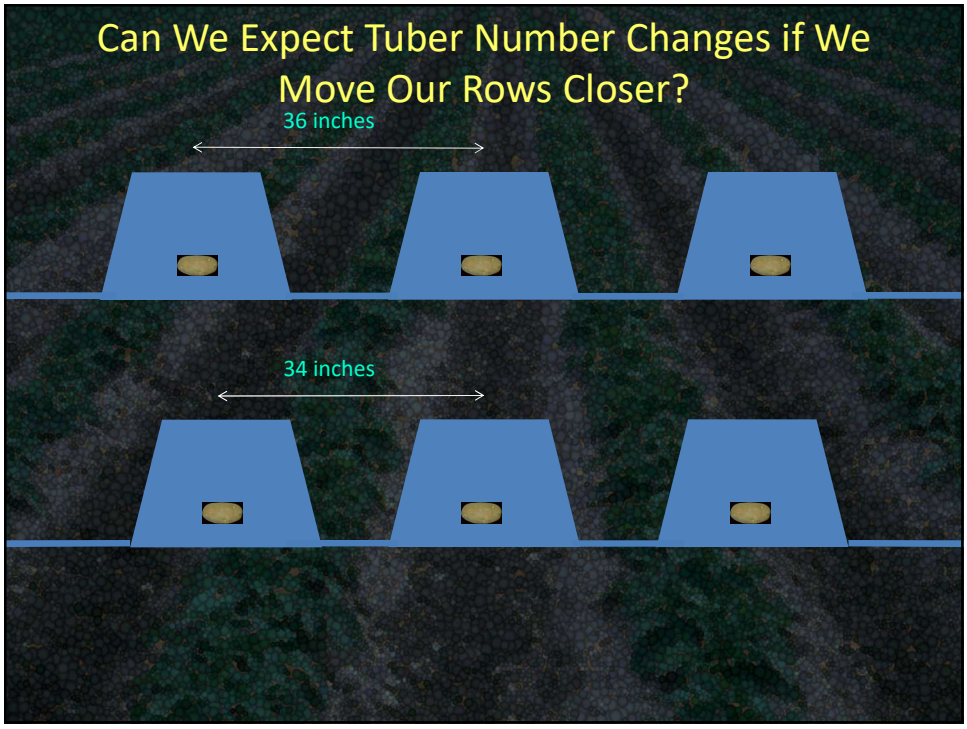

Distribution of Small & Large Tubers
% of Total Yield
35
30
25
20
15
10
5
0
6in
10in
14in
18in
Tubers >12 oz
Tubers <4 oz
MJ Pavek 2017


Tubers per plant
Tubers per Acre
Tubers per Plant
Tubers per Acre (1000's)
10
9
8
7
6
200
180
160
140
120
8
10
12
14
In-Row Spacing (inches)


Russet Burbank 2015-16
Adjusted Gross $
Total Yield
Max Yield
~8.5 inches
Max Return
~12.5 inches
Adjusted Gross (% difference from 8in in-row)
Total Yield (CWT/A)
20
10
0
-10
-20
800
750
700
650
600
8
10
12
14
In-Row Spacing (inches)


Can We Expect Tuber Number Changes if We Move Our Rows Closer?
36 inches
34 inches


Why do we make rows??

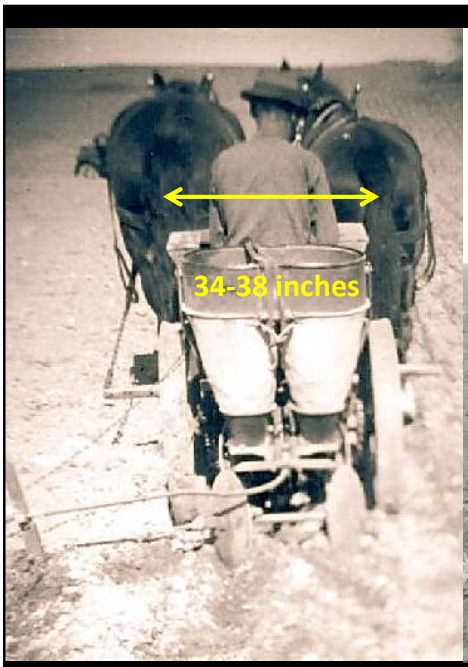
Purpose of a furrow, conventional row

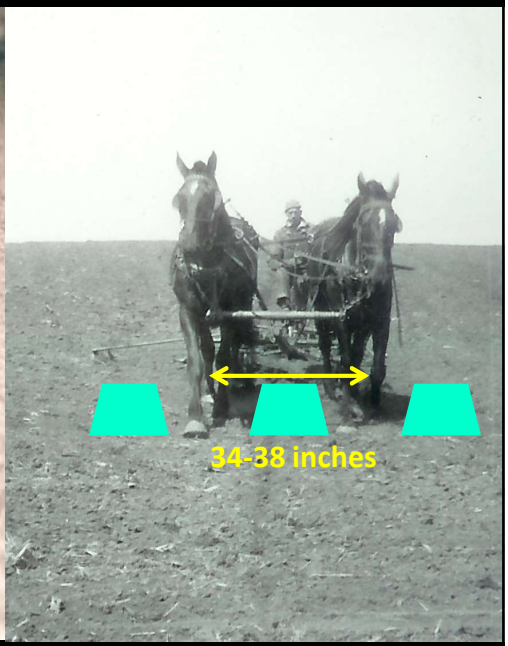
- Efficient, orderly use of space
- Guide equipment (and originally, horses, people), avoid smashing potatoes
  - Place for tires, harvester blades
  - Planter, cultivator, harvester
- Post-planting weed disruption
  - Cultivation, Drag-off
- Incorporation of fertilizer and herbicides
  - Allows placement and incorporation on each side of row
- Water drainage
  - keep seed piece above excessive water
- Furrow irrigation
- Space for potato growth, hill enlargement, increased seed piece depth
- Use of dammer diker: Erosion prevention, soil compaction mitigation

Potato Row Width History

- Potatoes not grown as field crop until mid 18th c. in Europe
  - During the Industrial Revolution (18th and 19th centuries), new working class created demand for cheap, energy-rich, non-cereal foods.
    - Hawkes, J.G. (1992), 1st ed. History of the potato. In The Potato Crop: The Scientific Basis for Improvement, P. M. Harris, ed. (London: Chapman and Hall), pp. 1–12.
- Rows centered two horses side by side
  - Plant
  - Cultivate – disrupt weeds, increase hill size
  - Harvest
- Row width increased from 27-28 in. when plows were horse-drawn, to 30 in. in England
    - Jarvis, R.H. (1971). Growing potatoes in wide rows. Experimental Husbandry Farms 78, 79–83.
- 1912, "…many places in the west, potatoes are planted into rows 36 inches apart…"
    - Source: The potato: a compilation of information from every available source (1912), Grubb and Guilford

How wide do we plant? Why?





Row Width Across the Globe

- US, Canada: Often between 32 and 38 inches
  - Washington: Columbia Basin 34, 22, (beds with 22 or 17); Western WA 36
  - Montana 36, 34 (beds with 26 or 18)
  - Oregon 34, 36
  - Canada 34-38
  - Idaho 36, 34, (beds with 26 or 18)
  - Midwest 34 and 36,
  - California 32 and 34
  - Seed and Specialty Crops 17 – 36
- UK – 36 inches
  - 1960's, Typically 28- to 30-inches
  - 1970's changed to 36 in.
  - Larger tyres, for destoning and decloding
  - Rather than 36"- 36" equal rows, 38 inch wheel row, then 34"-34", 38 inch wheel row.
- Most of continental Europe currently uses 30 inch spacing (skinny tires)
  - Netherlands – some now at 90 cm (35 inches; Bernik et al., 2009)
  - (Stalham et al., 2016, personal communication)


dewulf
dewulf

Are we as efficient with our land as possible?

- Thirty-four inch rows are standard in C. Basin
  - Were 34 inch rows too wide?
  - How does this differ by variety?
  - Continuous need for efficiency
    - Land
    - Water
    - Fertilizer
    - Crop protectants
    - Etc

The Difficulty in Conducting Row Width Research (continued)

- Equipment changes, needs
  - Expensive, time consuming changes
  - Tractor track width
  - Planters
  - Cultivators
  - Vine beaters, sprayers, harvesters
- Cultural management
  - Irrigation (monitoring, amount)
  - Fertility
- Cultivate rows
  - Weeds, rip/dammer dike

Row Width Study

- Planted near Othello, WA
  - WSU Research Farm
- 9 varieties
  - 2011-15 Alturas, RB, Umatilla R.
  - 2013-15 Alturas, Ranger, RB, R. Norkotah, Umatilla, Chieftain, Teton R.
  - 2014 Yukon Nugget
  - 2015 Mountain Gem Russet
- Did NOT focus on in-row spacing
  - Using in-row spacing that has worked for us, can we improve economic return by simply moving the rows closer?
- Management based on 34 inch rows
- 30, 32, 34, 36 in 2011-12
- 28, 30, 32, 34 in 2013-15

Plant Population

- 28 inches = 22,400 plants/A (21.4%)
- 30 inches = 20,900 plants/A (13.3 %)
- 32 inches = 19,600 plants/A (6.3% > 34)
- 34 inches = 18,500 plants/A

- The idea was to use the same level of inputs: Fertilizer, fungicide, herbicide, pesticide, (irrigation)

Potato Seed

Seed No./A*	(CWT/A)	Seed Cost Increase from 34 inch ($/A)
28 in = 22,400	(35.0)	$124
30 in = 20,900	(32.7)	$77
32 in = 19,600	(30.6)	$36
34 in = 18,500	(28.9)	$0

(*at 10 inch in-row spacing, 2.5 oz seed piece, $20 CWT)

Additional Variable Costs

(Fuel, Equip Depreciation, Labor, Etc)

- Keeping existing equipment row intervals cost an additional 5% ($225) per acre
  - eg. 8 row planter, 4 row harvester

Rows Added Per Acre	Extra Tillage Acres	Additional Variable* Costs/A due to Extra Passes/A
28 in = 15	0.17	$38.25
30 in = 10	0.12	$27.00
32 in = 4	0.05	$11.25

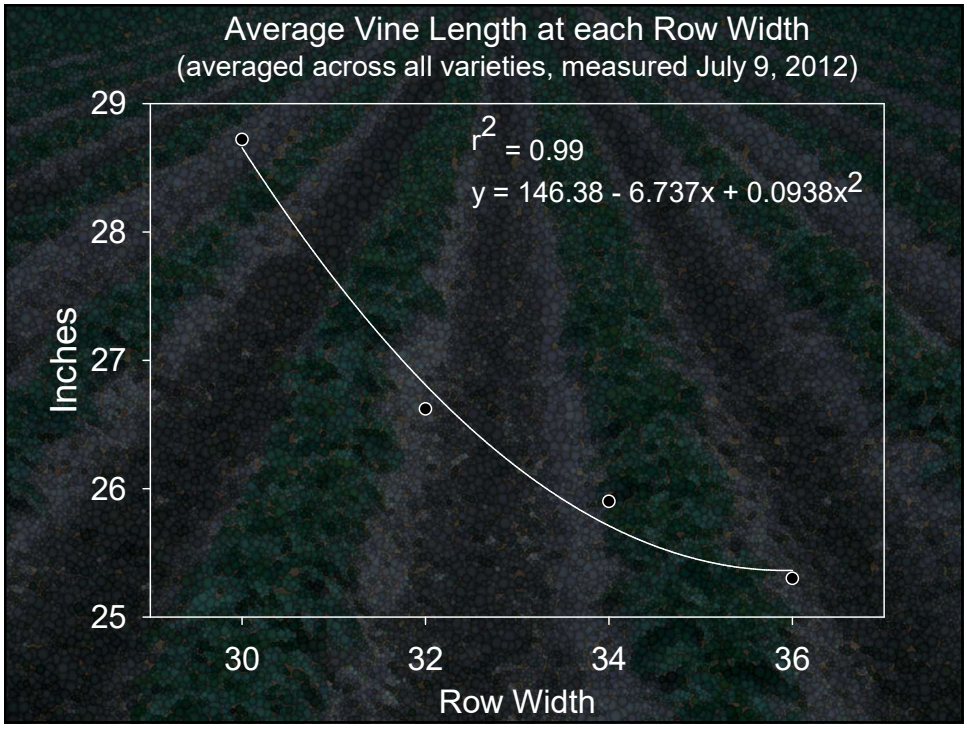
*Expense of $225/A multiplied by the number extra rows (in acres)

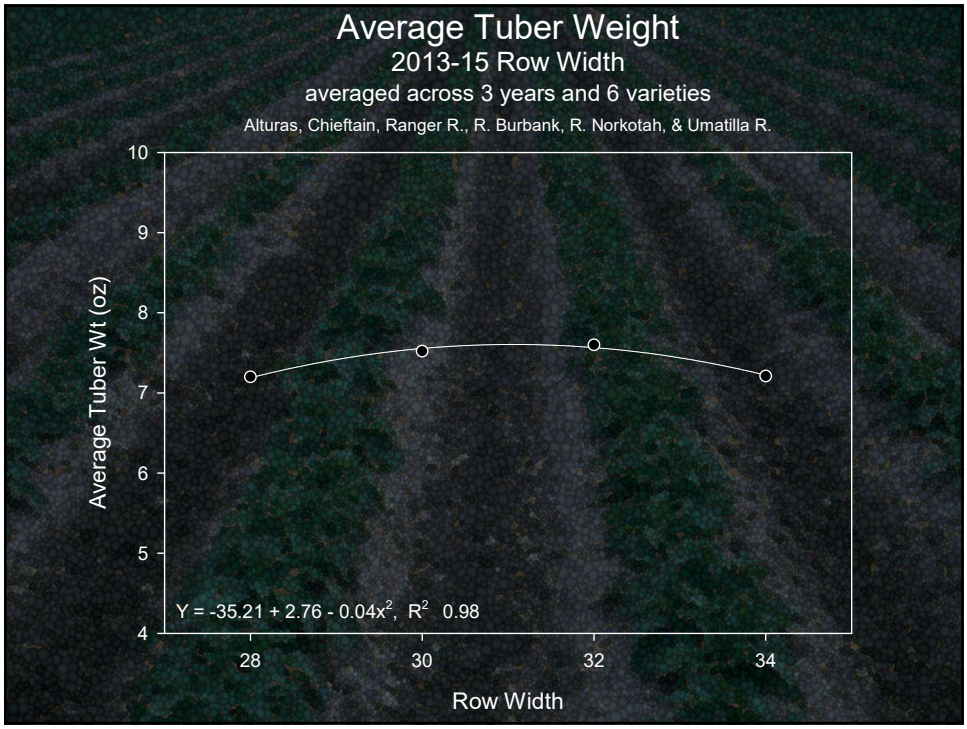

PMJ1

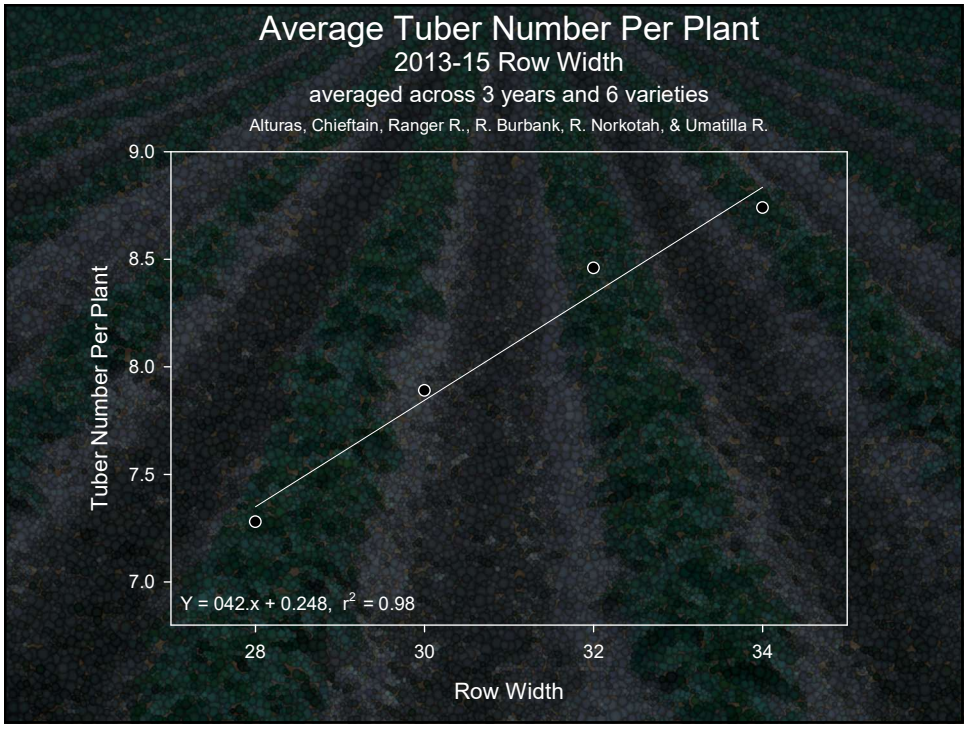

Results

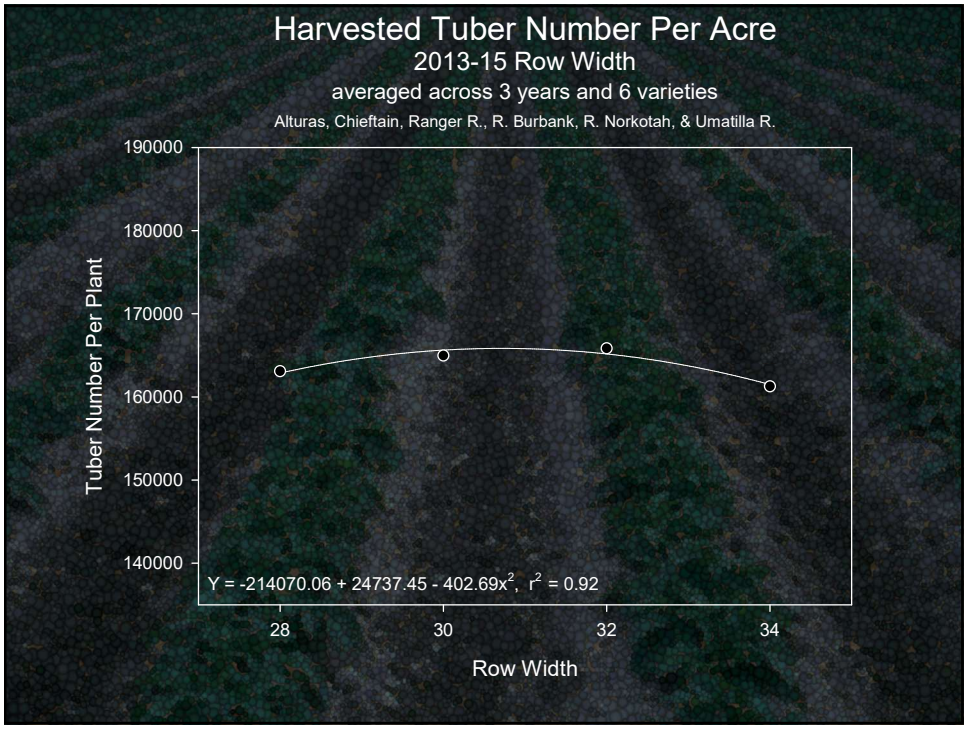
Slide 25

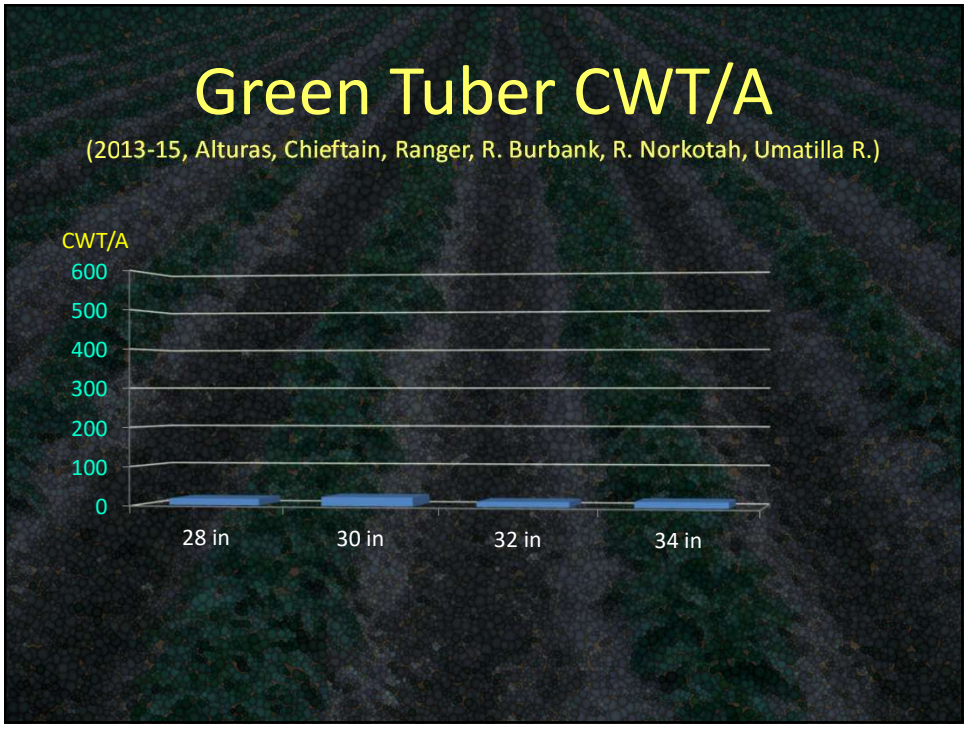
PMJ1 Pavek, Mark Joseph, 1/21/2016

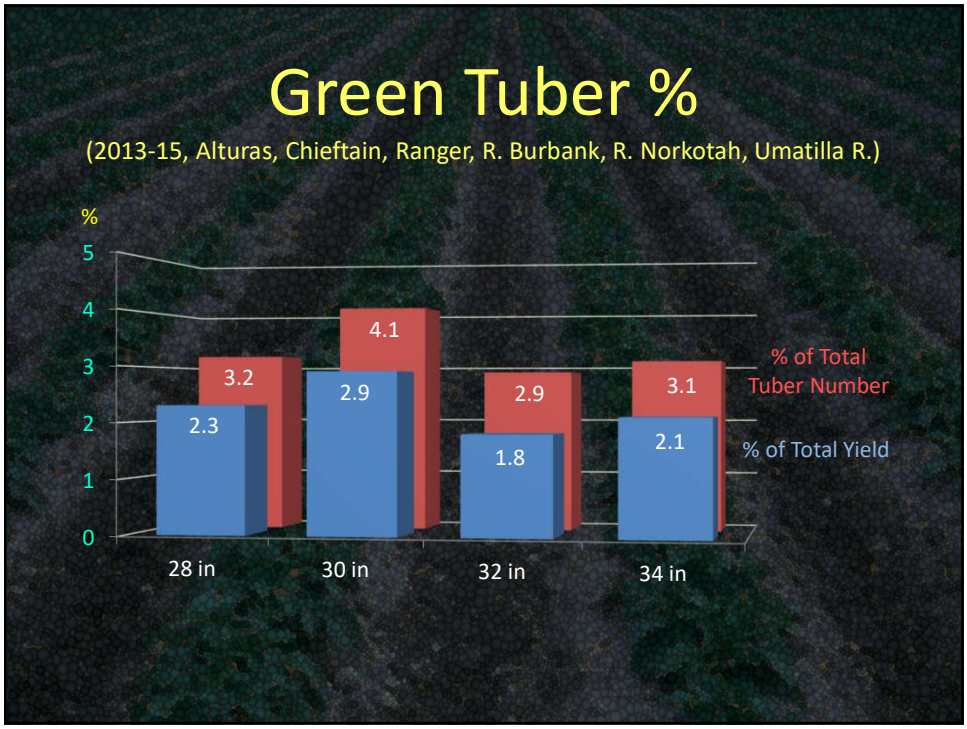

Average Vine Length at each Row Width
(averaged across all varieties, measured July 9, 2012)
r^2 = 0.99
y = 146.38 - 6.737x + 0.0938x^2
Inches
29
28
27
26
25
30
32
34
36
Row Width

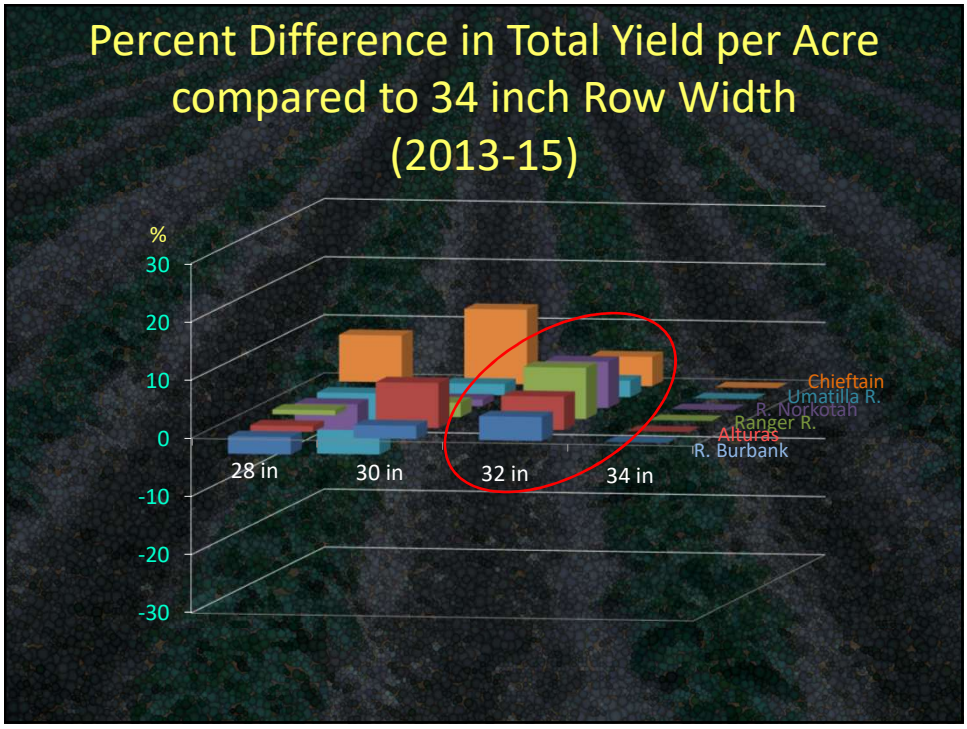

Average Tuber Weight
2013-15 Row Width
averaged across 3 years and 6 varieties
Alturas, Chieftain, Ranger R., R. Burbank, R. Norkotah, & Umatilla R.
Average Tuber Wt (oz)
10
9
8
7
6
5
4
Y = -35.21 + 2.76 - 0.04x^2, R^2 0.98
28
30
32
34
Row Width

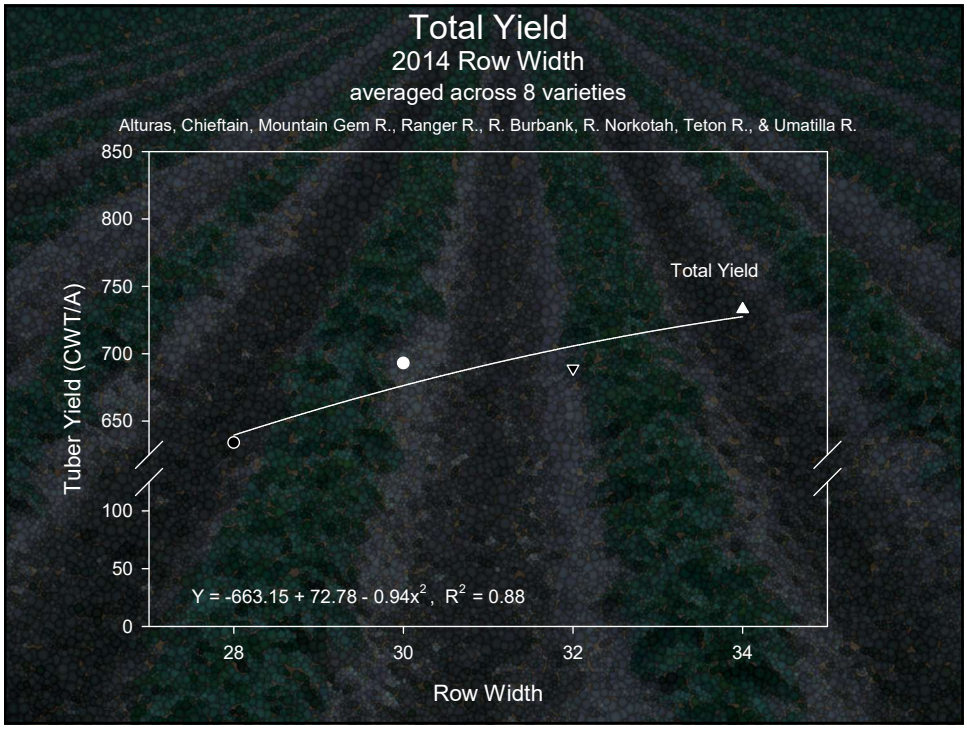

Average Tuber Number Per Plant
2013-15 Row Width
averaged across 3 years and 6 varieties
Alturas, Chieftain, Ranger R., R. Burbank, R. Norkotah, & Umatilla R.
Tuber Number Per Plant
9.0
8.5
8.0
7.5
7.0
Y = 042.x + 0.248, r2 = 0.98
28
30
32
34
Row Width

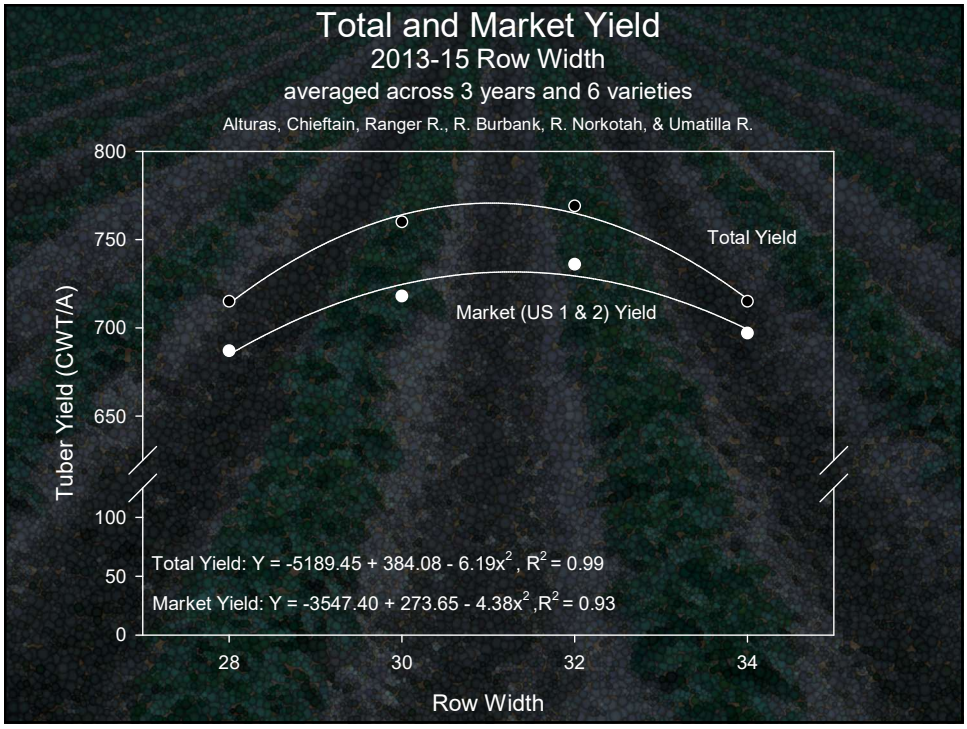

Harvested Tuber Number Per Acre
2013-15 Row Width
averaged across 3 years and 6 varieties
Alturas, Chieftain, Ranger R., R. Burbank, R. Norkotah, & Umatilla R.
Tuber Number Per Plant
190000
180000
170000
160000
150000
140000
Y = -214070.06 + 24737.45 - 402.69x2, r2 = 0.92
28
30
32
34
Row Width

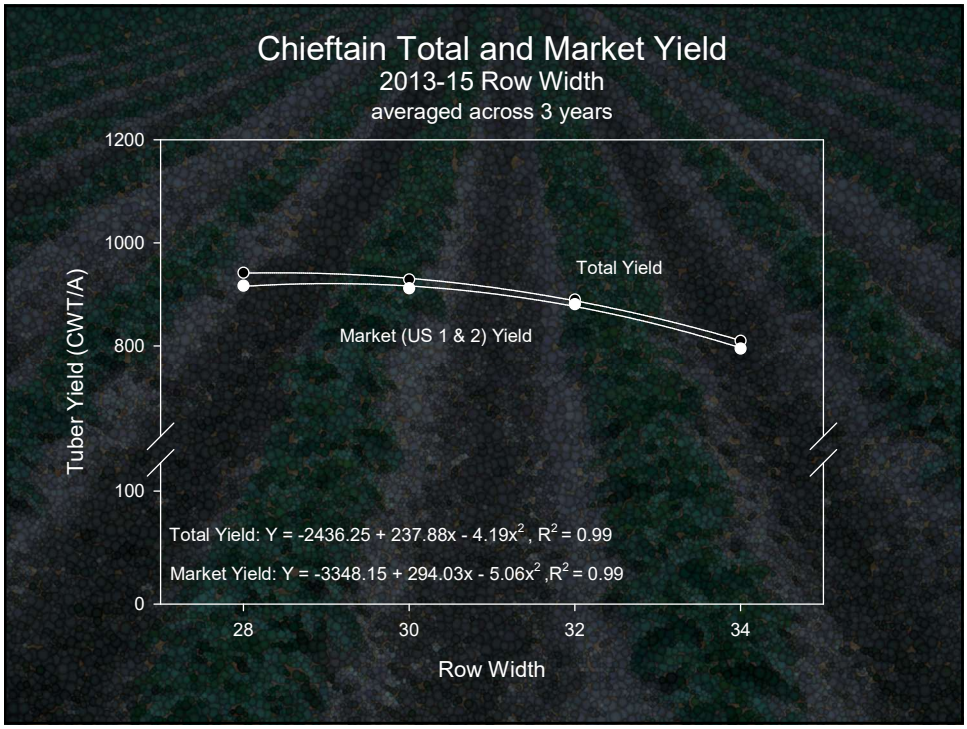

Green Tuber CWT/A
(2013-15, Alturas, Chieftain, Ranger, R. Burbank, R. Norkotah, Umatilla R.)
CWT/A
600
500
400
300
200
100
0
28 in
30 in
32 in
34 in

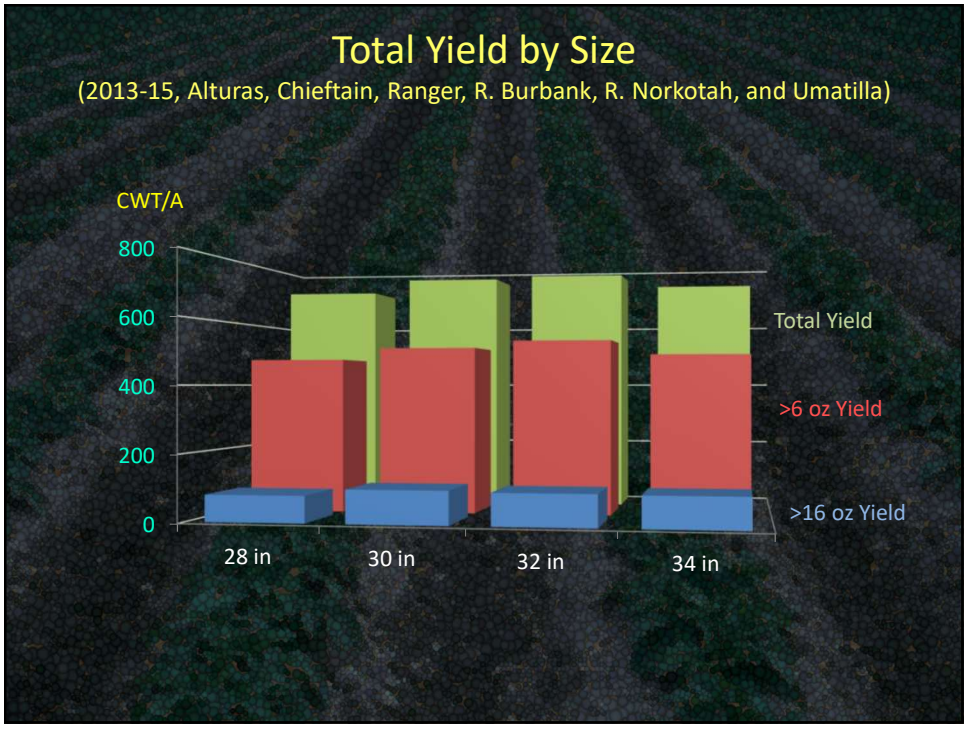

Green Tuber %
(2013-15, Alturas, Chieftain, Ranger, R. Burbank, R. Norkotah, Umatilla R.)
%
5
4
3
2
1
0
3.2
2.3
4.1
2.9
2.9
1.8
3.1
2.1
% of Total Tuber Number
% of Total Yield
28 in
30 in
32 in
34 in

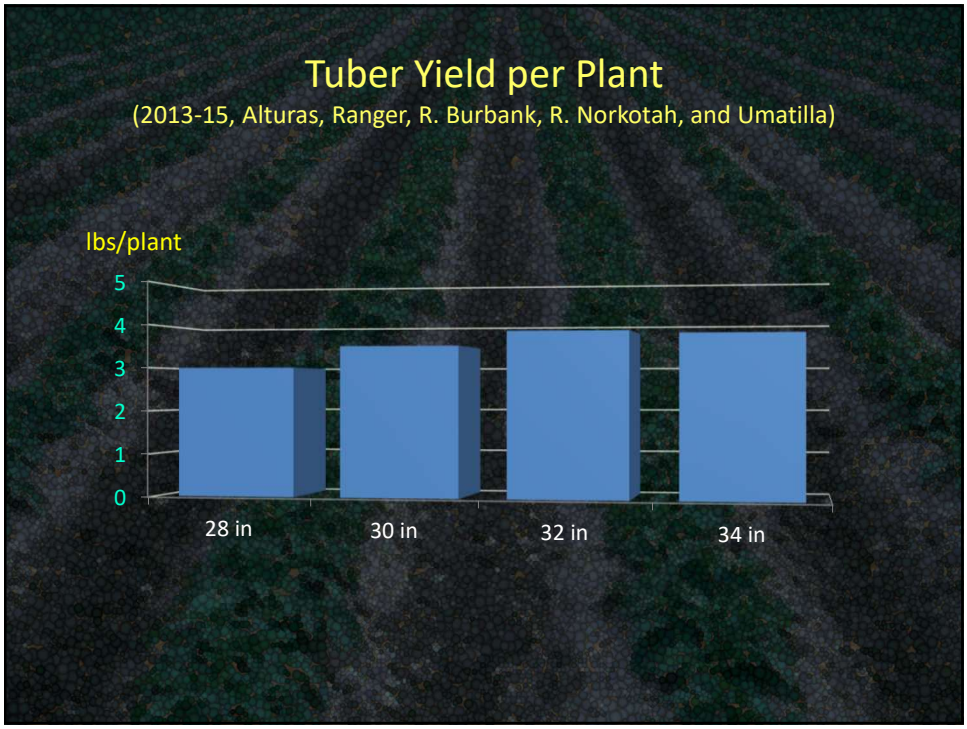

Percent Difference in Total Yield per Acre compared to 34 inch Row Width (2013-15)
%
30
20
10
0
-10
-20
-30
28 in
30 in
32 in
34 in
Chieftain
Umatilla R.
R. Norkotah
Ranger R.
Alturas
R. Burbank

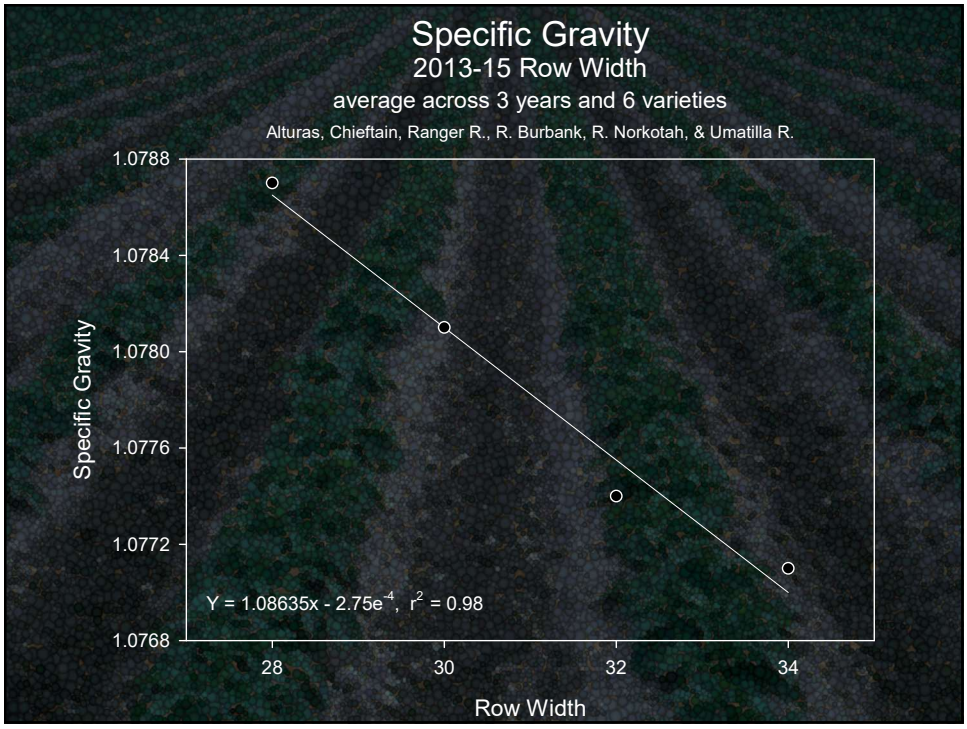

Total Yield
2014 Row Width
averaged across 8 varieties
Alturas, Chieftain, Mountain Gem R., Ranger R., R. Burbank, R. Norkotah, Teton R., & Umatilla R.
Tuber Yield (CWT/A)
850
800
750
700
650
100
50
0
Total Yield
Y = -663.15 + 72.78 - 0.94x2, R2 = 0.88
28
30
32
34
Row Width

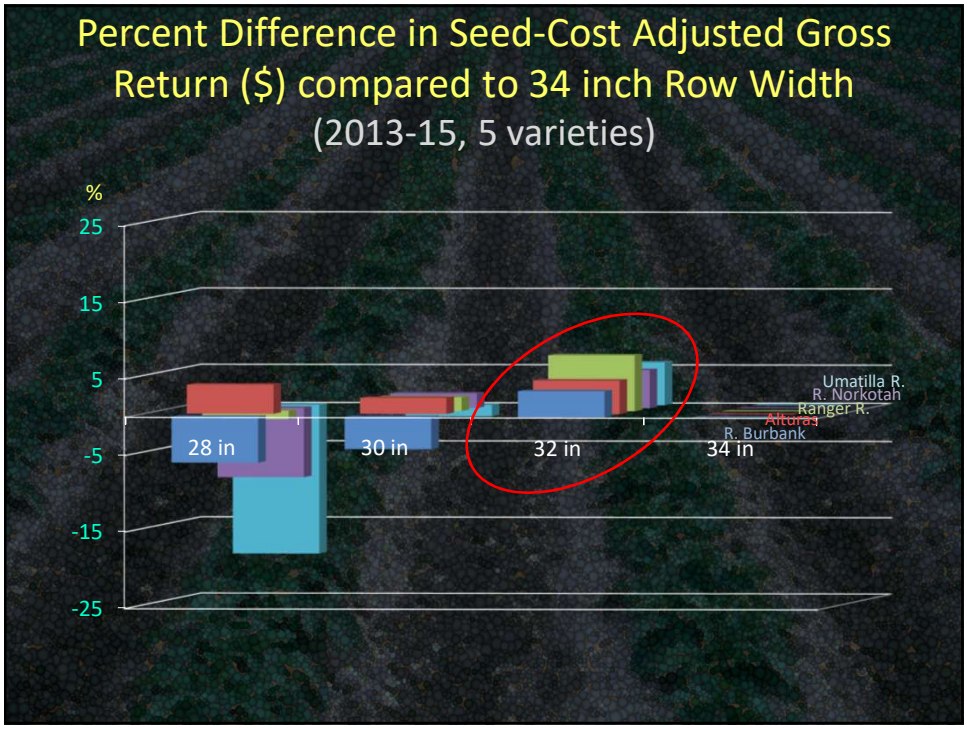

Total and Market Yield
2013-15 Row Width
averaged across 3 years and 6 varieties
Alturas, Chieftain, Ranger R., R. Burbank, R. Norkotah, & Umatilla R.
Tuber Yield (CWT/A)
800
750
700
650
100
50
0
Total Yield
Market (US 1 & 2) Yield
Total Yield: Y = -5189.45 + 384.08 - 6.19x2 , R2 = 0.99
Market Yield: Y = -3547.40 + 273.65 - 4.38x2 ,R2 = 0.93
28
30
32
34
Row Width

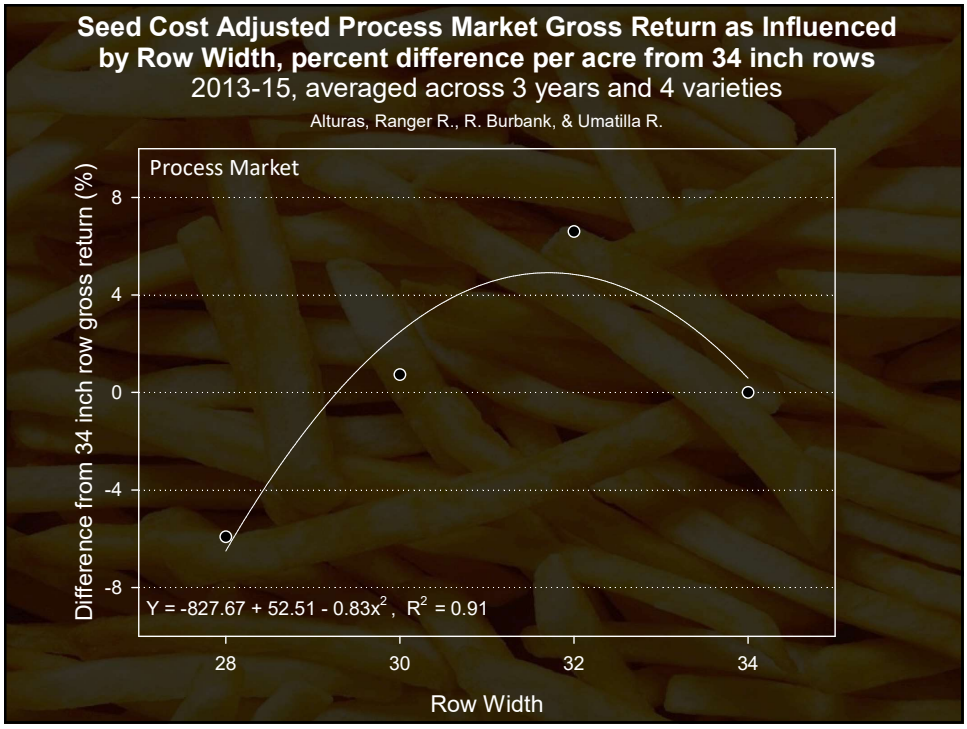

Chieftain Total and Market Yield
2013-15 Row Width
averaged across 3 years
Tuber Yield (CWT/A)
1200
1000
800
100
0
Total Yield
Market (US 1 & 2) Yield
Total Yield: Y = -2436.25 + 237.88x - 4.19x2 , R2 = 0.99
Market Yield: Y = -3348.15 + 294.03x - 5.06x2 ,R2 = 0.99
28
30
32
34
Row Width

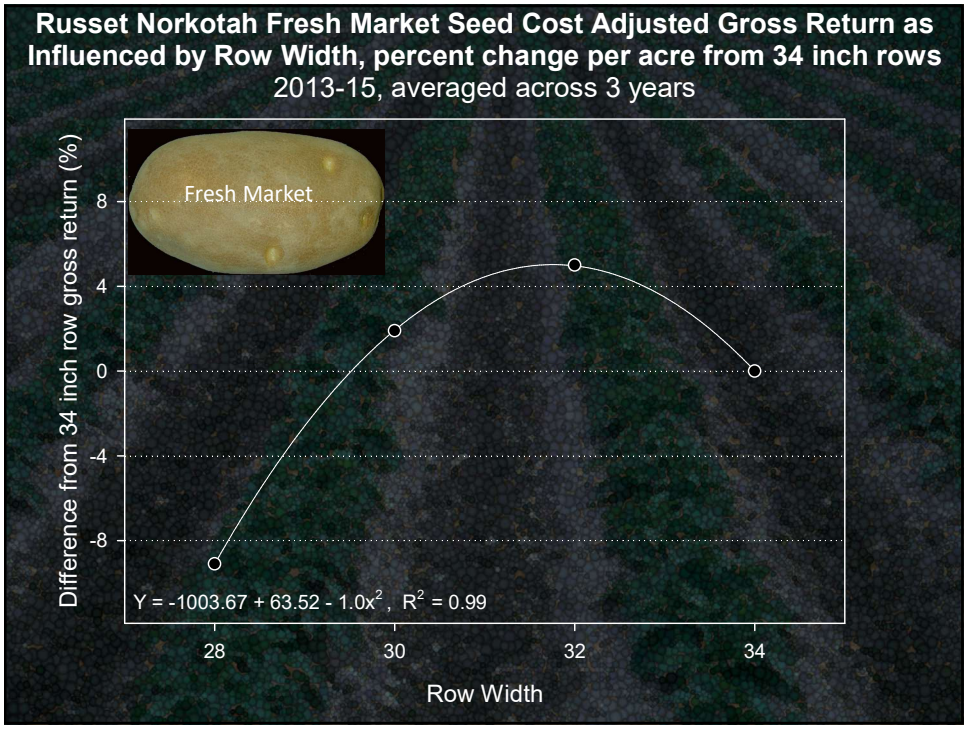

Total Yield by Size
(2013-15, Alturas, Chieftain, Ranger, R. Burbank, R. Norkotah, and Umatilla)
CWT/A
800
600
400
200
0
28 in
30 in
32 in
34 in
Total Yield
>6 oz Yield
>16 oz Yield


Tuber Yield per Plant
(2013-15, Alturas, Ranger, R. Burbank, R. Norkotah, and Umatilla)
lbs/plant
5
4
3
2
1
0
28 in
30 in
32 in
34 in


Specific Gravity
2013-15 Row Width
average across 3 years and 6 varieties
Alturas, Chieftain, Ranger R., R. Burbank, R. Norkotah, & Umatilla R.
1.0788
1.0784
1.0780
1.0776
1.0772
1.0768
Specific Gravity
Y = 1.08635x - 2.75e-4, r2 = 0.98
28
30
32
34
Row Width


Percent Difference in Seed-Cost Adjusted Gross Return ($) compared to 34 inch Row Width
(2013-15, 5 varieties)
%
25
15
5
-5
-15
-25
28 in
30 in
32 in
34 in
Umatilla R.
R. Norkotah
Ranger R.
Alturas
R. Burbank


Seed Cost Adjusted Process Market Gross Return as Influenced by Row Width, percent difference per acre from 34 inch rows
2013-15, averaged across 3 years and 4 varieties
Alturas, Ranger R., R. Burbank, & Umatilla R.
Process Market
Difference from 34 inch row gross return (%)
8
4
0
-4
-8
Y = -827.67 + 52.51 - 0.83x2 , R2 = 0.91
28
30
32
34
Row Width


Russet Norkotah Fresh Market Seed Cost Adjusted Gross Return as Influenced by Row Width, percent change per acre from 34 inch rows
2013-15, averaged across 3 years
Fresh Market
Difference from 34 inch row gross return (%)
8
4
0
-4
-8
Y = -1003.67 + 63.52 - 1.0x2 , R2 = 0.99
28
30
32
34
Row Width

Additional info

- Not affected by row width changes:
  - Hollow heart
  - Brown center
  - Internal brown spot
  - Tuber shape: length to width ratio
  - Blackspot bruise
  - Shatter bruise

Row Width Summary

- Reducing row width in WA is feasible
  - Irrigated, water is non-limiting
  - Inputs stay the same, other than irrigation
- Stable across varieties and time
  - Larger, indeterminate vines – Alturas, Ranger R.
  - Weaker, determinate vines – R. Norkotah, Teton R.
  - Intermediate indeterminate vines – R. Burbank, Umatilla, R., Mountain Gem R., Chieftain
- Net gain ($) by switching from 34 to 32 inch rows
  - ~ 3-5% increase, ~$100-$300/acre
  - ~ 3 % yield boost

Row Width Summary (continued)

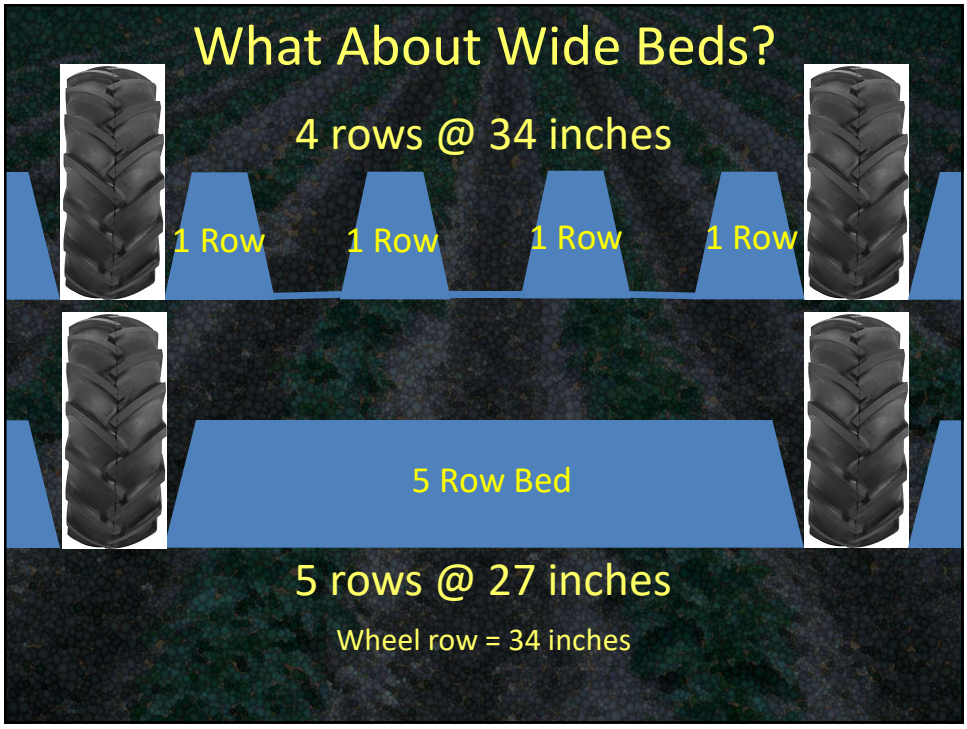
- In Columbia Basin of WA/OR
  - 34 inch rows appear to be wasteful, inefficient
  - Plants don't start seeing across-row competition until planted into 30 inch rows or less
    - In-row spacing 10-12 inches
  - Most varieties produced better $/A at 30 inches than 34 inches

Row Width Summary (continued)

- Growers switching row width should:
  - Plant test strips if possible
  - Consider
    - Tractor tire width
    - Equipment costs (depreciate out, then switch)
    - Equipment needs on other crops
- One size does not fit all:
  - Row width and spatial configuration varies by market
    - seed, little potatoes, processing, etc

Improving Land Use Efficiency

- Optimal plant spatial arrangement is likely different by market type
  - Little potatoes, seed, processing, etc
  - Bed planting vs rows
- Most systems can be improved
- On-farm row width research is difficult
  - Do what you can
- Soil water may be limiting factor
  - System must work in dry and wet years (stability)



Beds

- Conducive for high planting densities
  - more rows between wheel tracks, more tire room – less rub
  - Less room devoted to furrows
  - Intended to minimize average tuber size
  - Increase payable yield
- May be more efficient at capturing irrigation/rainfall than conventional row
  - compared to rows with out dammer diker pits
  - Lack of furrows will change water drainage
- More Soil = More insulation
  - Temperatures in the bed fluctuate less than those in rows
  - Offers a barrier to freezing temperatures
  - Insulating factor may delay emergence compared with rws

Beds (continued)

- Some inter-row post-planting operations and not possible in bed systems
  - Ripping/Dammer Dike possible, would need to modify equip
- Tractor horsepower requirements might increase when harvesting from beds as harvesters must sift through more soil than with conventional rows
- Too much moisture at harvest – more difficult to dry out than rows