Production Applications for GA, NAA, & Combination Seed Treatments

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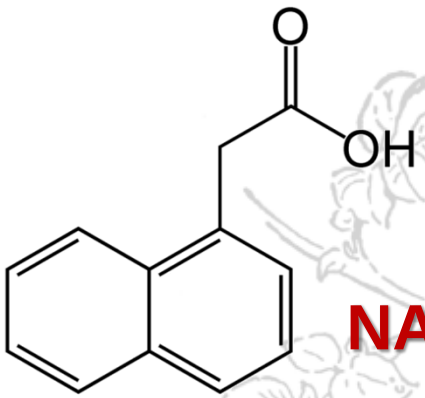
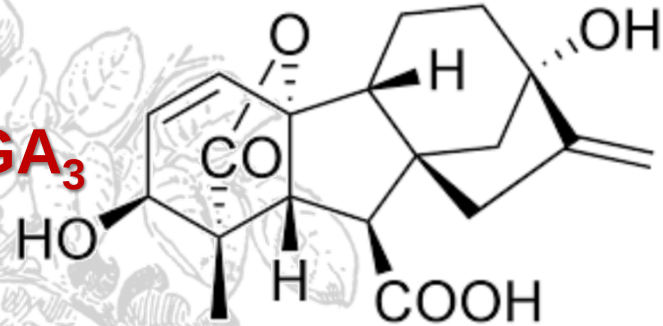
Plant Hormones



NAA

Naphthalene acetic acid



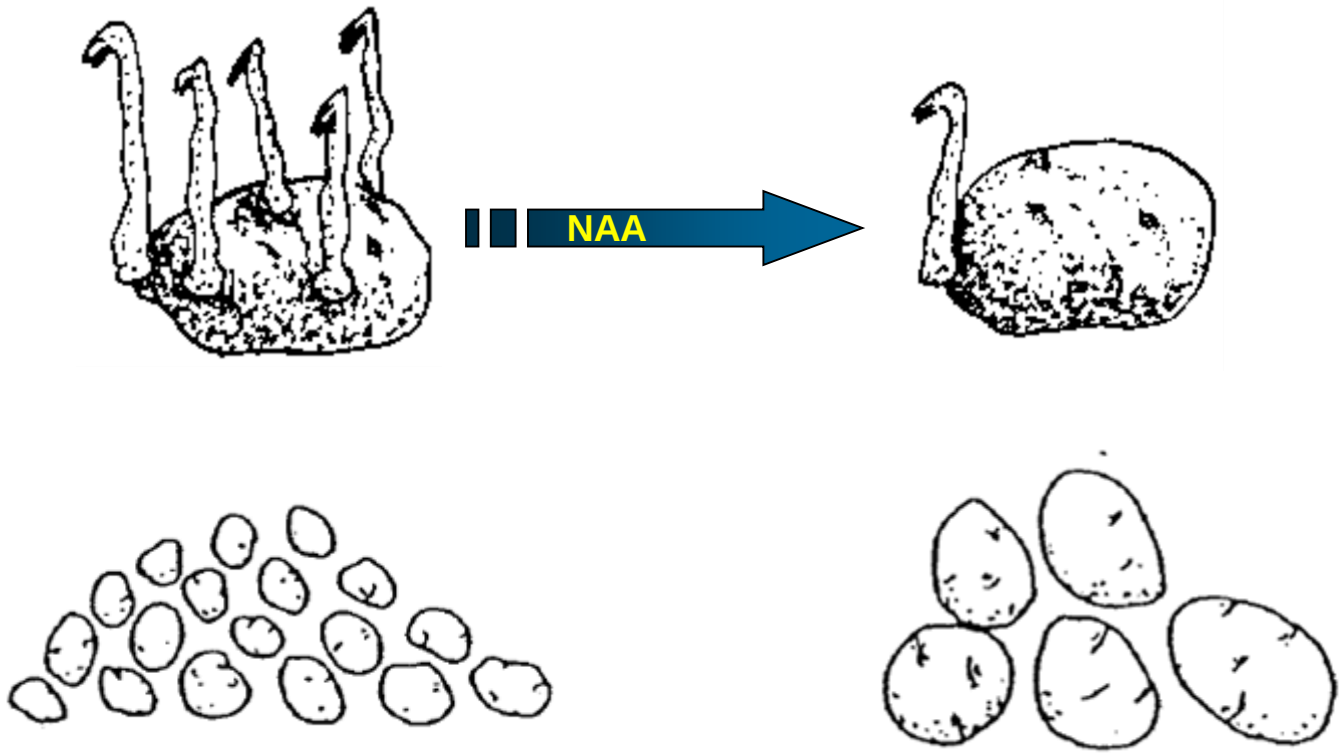
GA_3

Gibberellin

NAA & GA offer a direct approach for controlling **apical dominance** & tuber set to capitalize on:

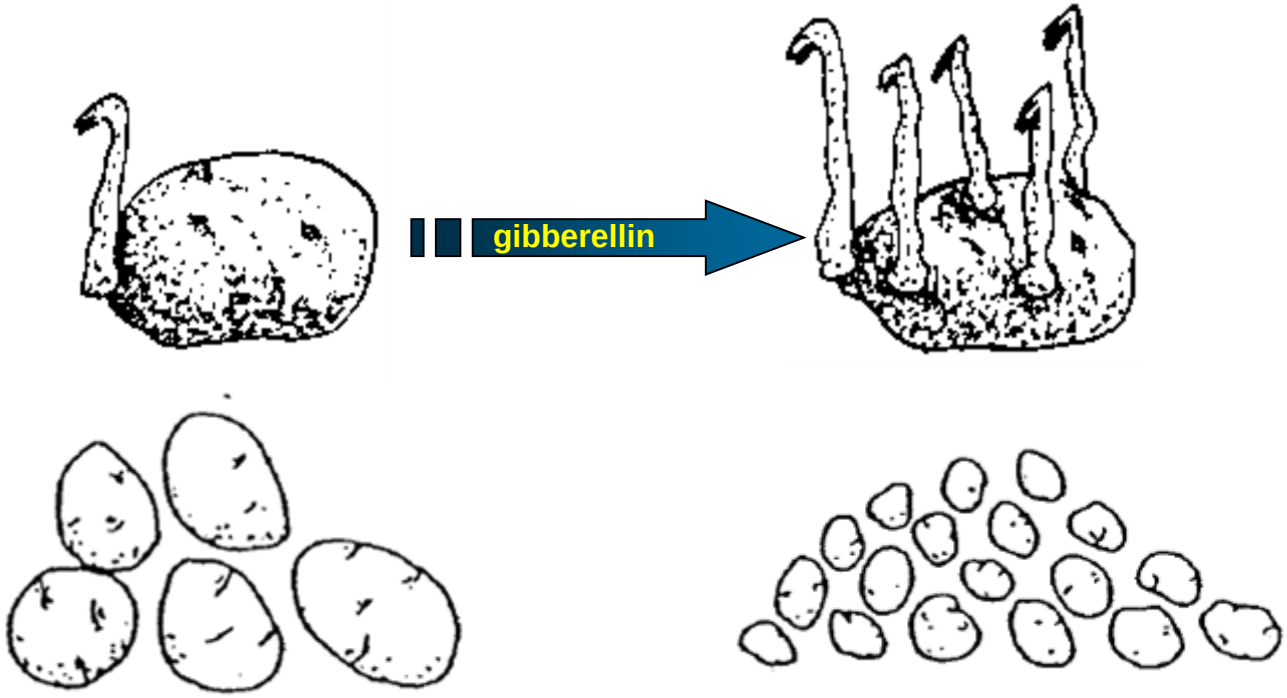
- Tuber size incentives
- Bruise-free incentives???
- Enhanced yield of raw product
  - ✓U.S. No. 1 Yield
  - ✓Tuber size x shape

NAA Application - ↓ stems & ↑ tuber size with auxin (NAA)…

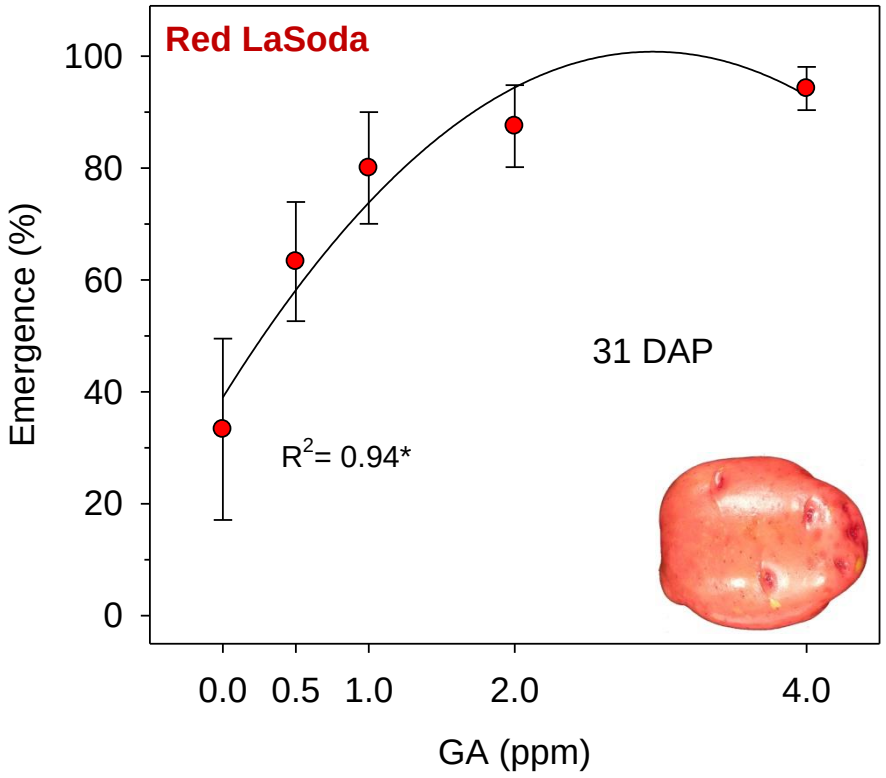


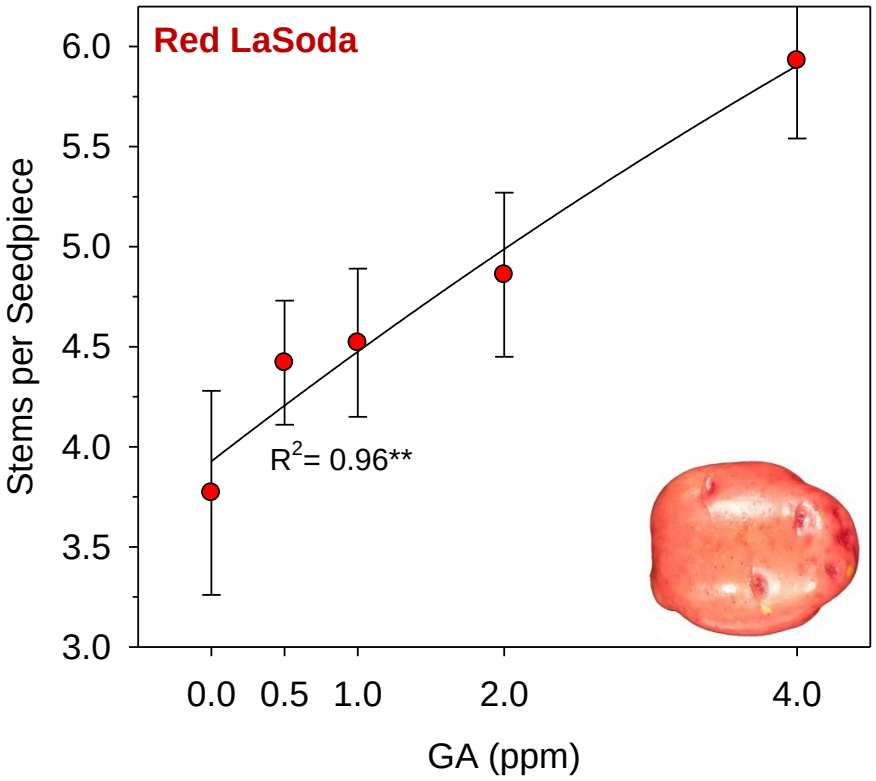
GA Applications - Hasten emergence, ↑ stems & tubers per plant, & ↓ tuber size…

e.g., Red/Specialty Increasing the yield of smaller tubers – creamers, baby bakers…



Treating Seed with Gibberellin Hastens Emergence & Increases Stem Numbers



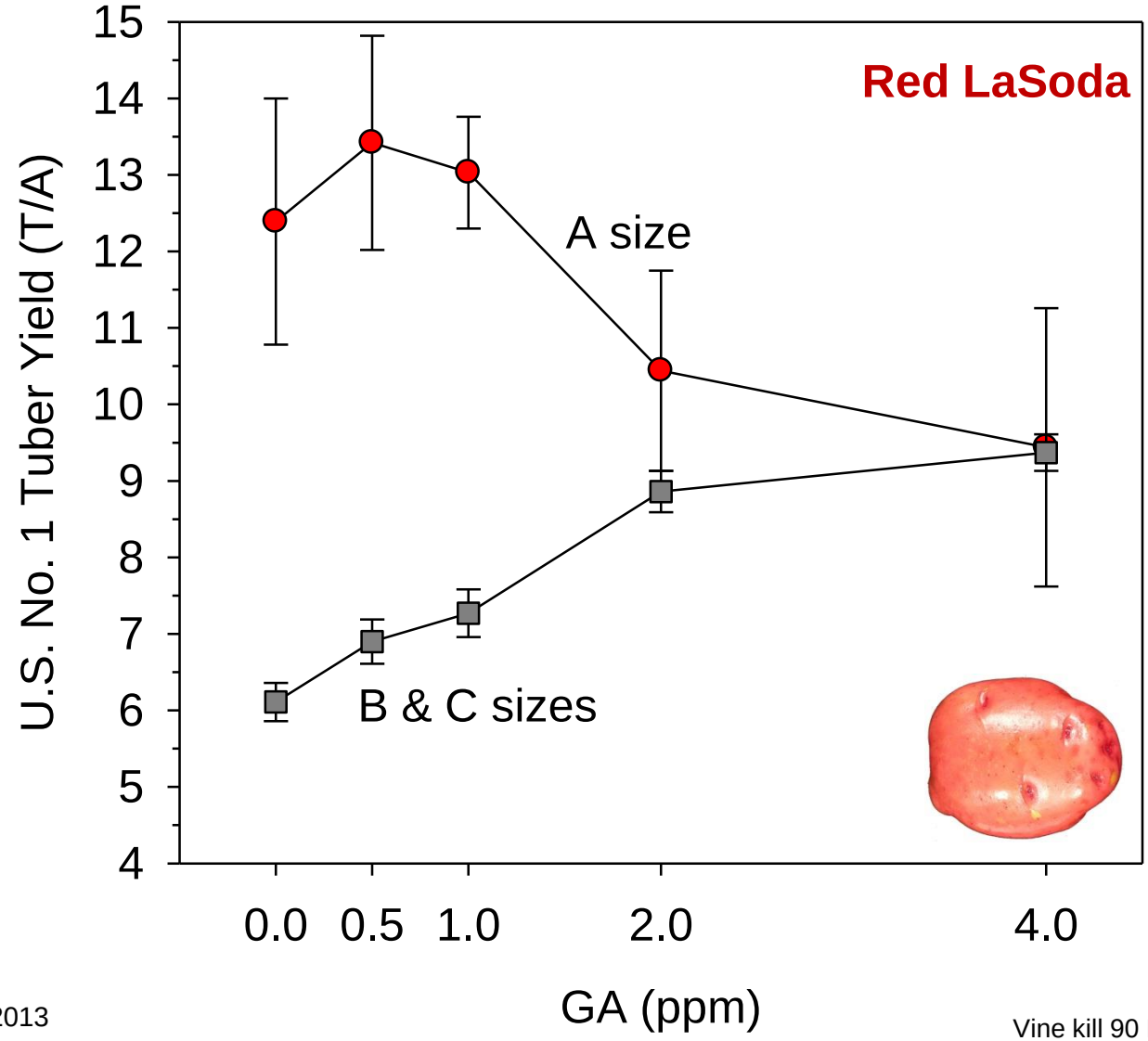


Red LaSoda, Yukon Gold, Chieftain, Cal White, Satina

Amer J Potato Res 2013

Gibberellin Shifts Tuber Size Distribution toward Smaller Tubers

(Red La Soda)



A = 5.6-8.7 cm
B = 5.1-5.6 cm
C = 2.8-5.1 cm

Amer J Potato Res 2013

Vine kill 90 DAP; Harvest 103 DAP

Gibberellins can Alter Tuber Size Distribution & Crop Value

(Red La Soda)

Red La Soda

GA ppm	Yield T/A	% Change in value from control			Total % Change
		A's (92-360 g)	B's (67-91 g)	C's (10-66 g)	
0	18.5	0.0	0.0	0.0	0
0.5	20.2	8.1	23.3	3.2	9.1
1	20.3	4.8	30.0	9.7	10.2
2	19.4	-16.1	36.7	51.6	11.4
4	18.7	-24.2	40.0	67.7	12.0

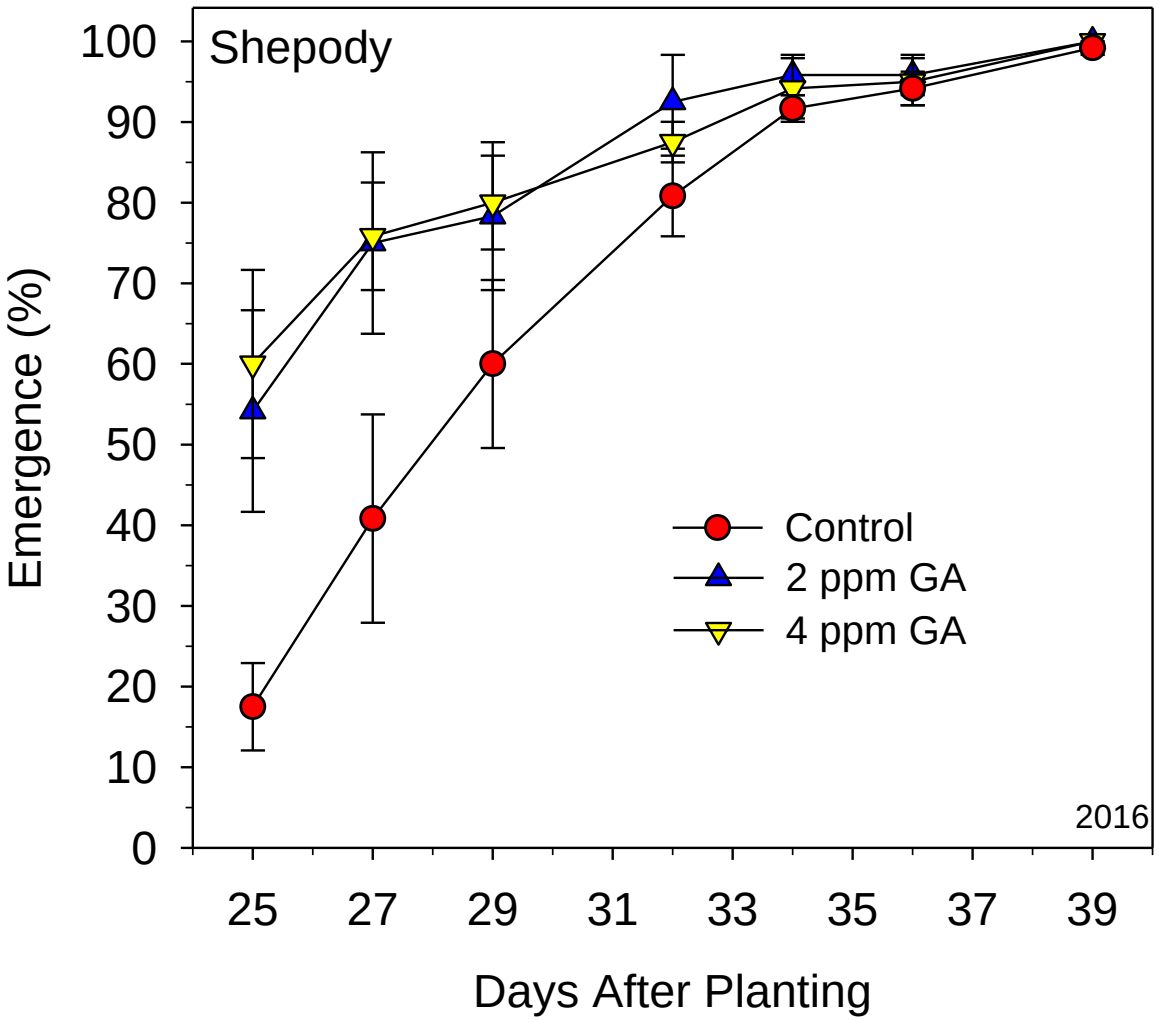
Blauer & Knowles (2013) *Am J Potato Res* 90:470-496

+10% ↑ Yld

Vine kill 90 DAP
Harvest 103 DAP

Shepody

GA Hastens Emergence in Shepody

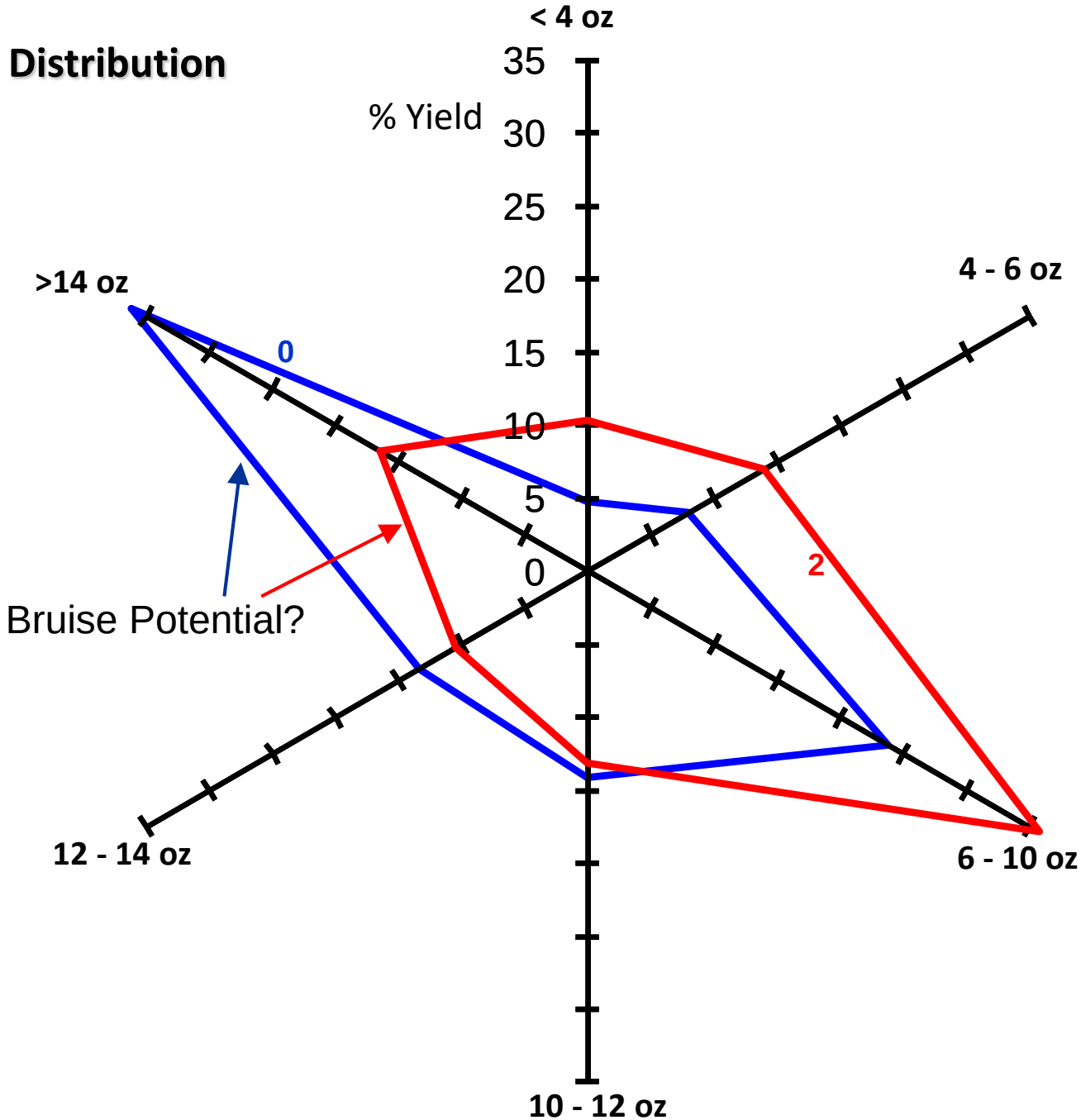


Shepody – Tuber Size Distribution

GA spray application

- Untreated control
- 2 ppm GA

	GA ppm + NAA	
	0	2
Mkt Yield (T/A)	33.4a	32.1ab
Stems/plant	1.9b	2.3a
Tubers/plant	5.9c	7.5a
Tubers/A (x10³)	116c	147a
oz/tuber	9.3a	7.0b
Process value (%)	0	-7.3
Seed value (%)	0	38.1

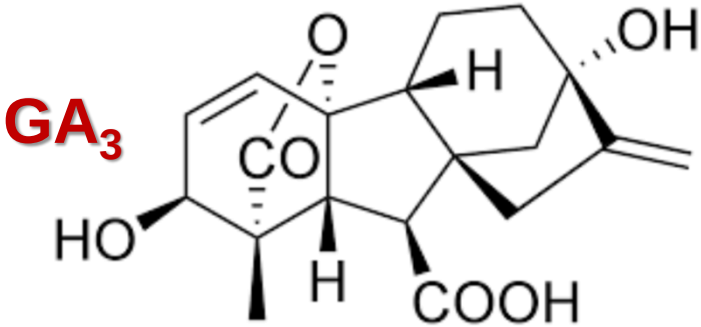


Amer J Pot Res 2018

2017

Gibberellin

- Hastens emergence, ↑ stems & tubers, ↓ tuber size
- Stimulates internode elongation of stems - tuber shape…



Ranger Russet

GA

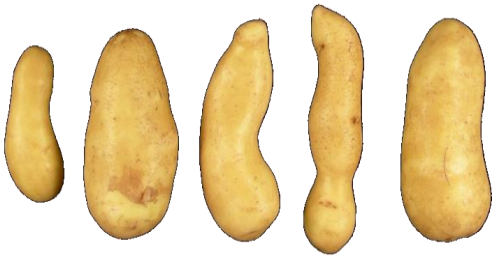
8 ppm

Yukon Gold

Blauer et al., 2013

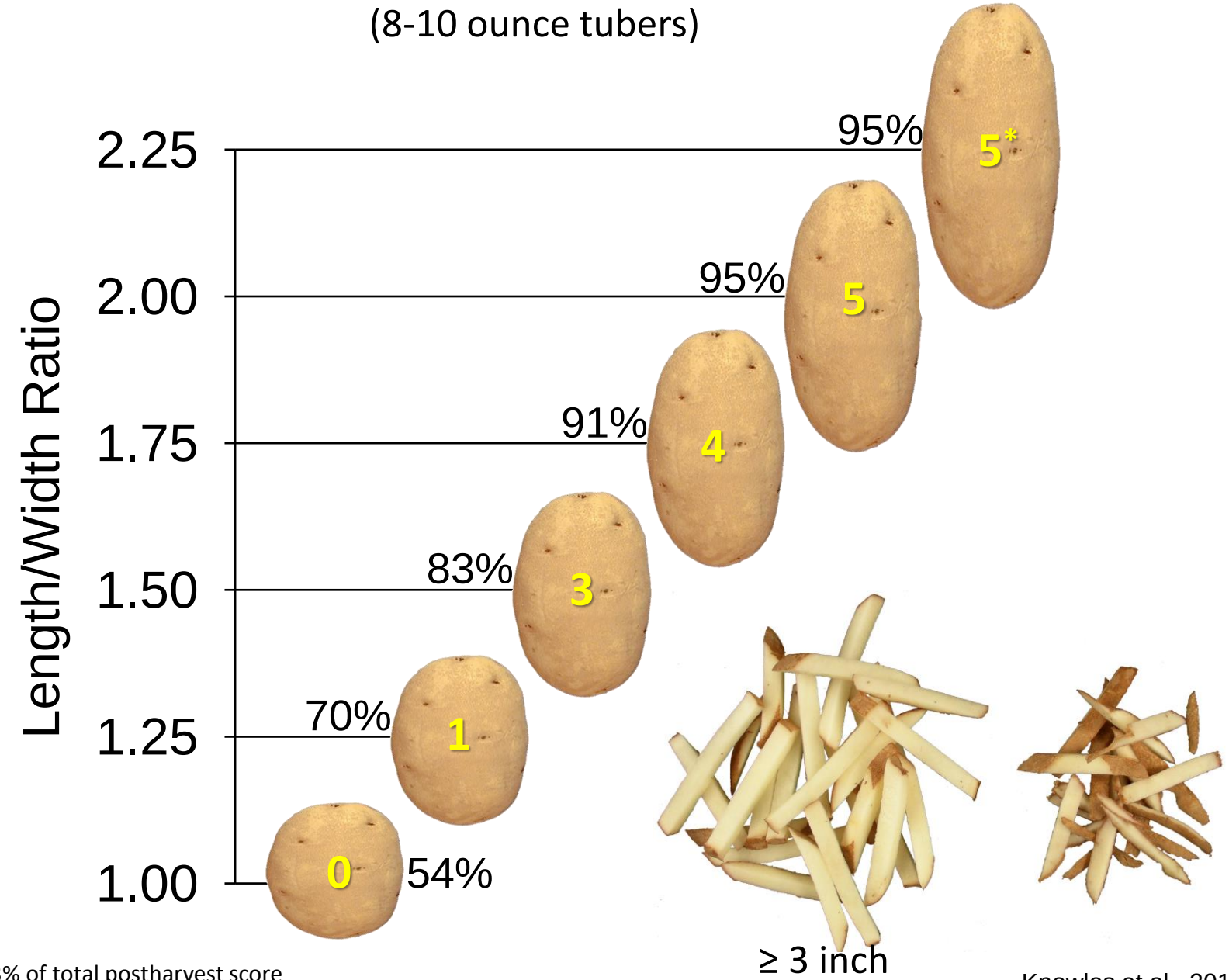
GA

10 ppm



French Fry Yield vs Tuber L/W Ratio

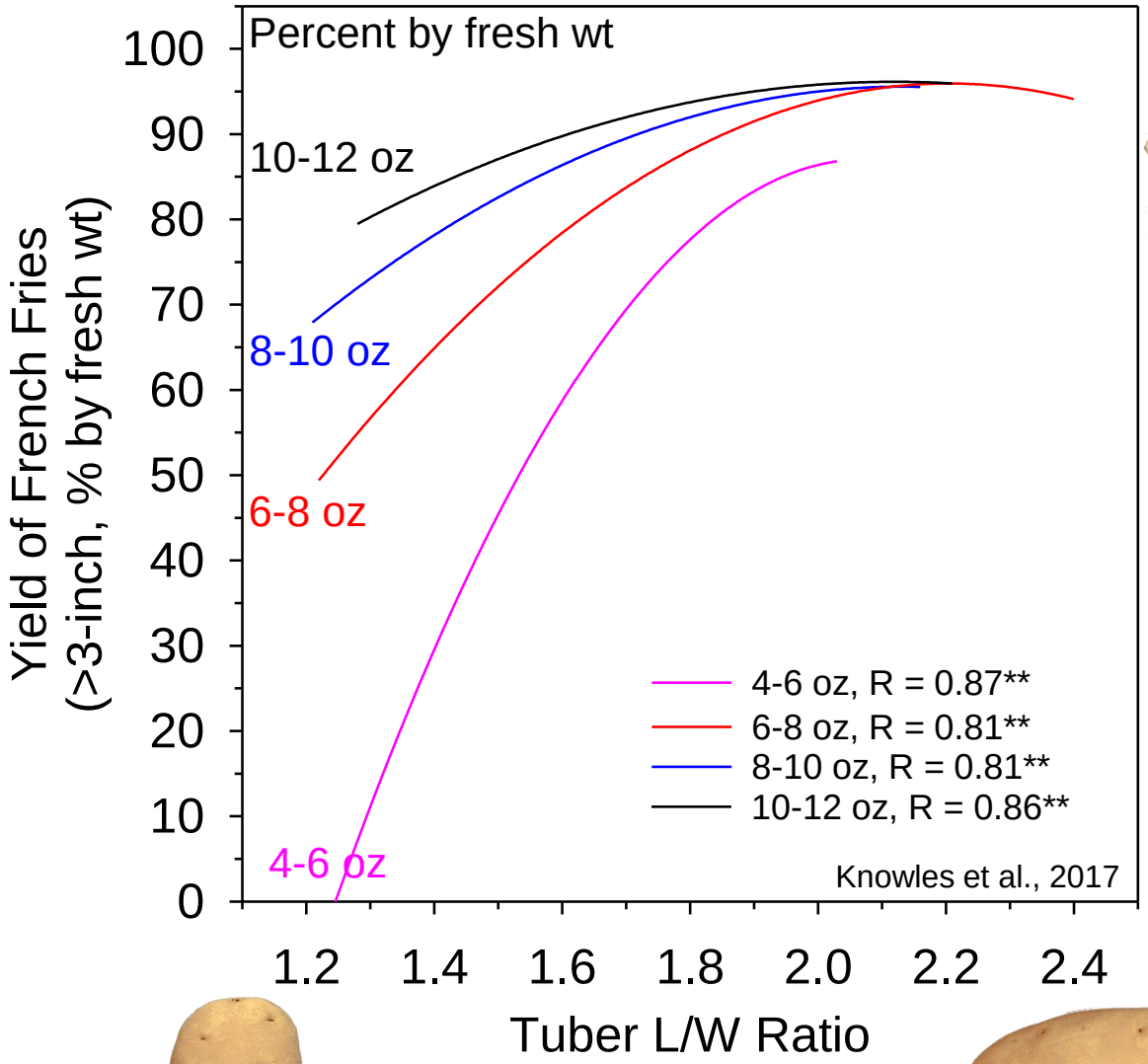
(8-10 ounce tubers)



*0-5 scale; L/W = 13% of total postharvest score

Knowles et al., 2017

Tuber Length to Width Ratio & Size Affect Yield of ≥3-inch-long French Fries



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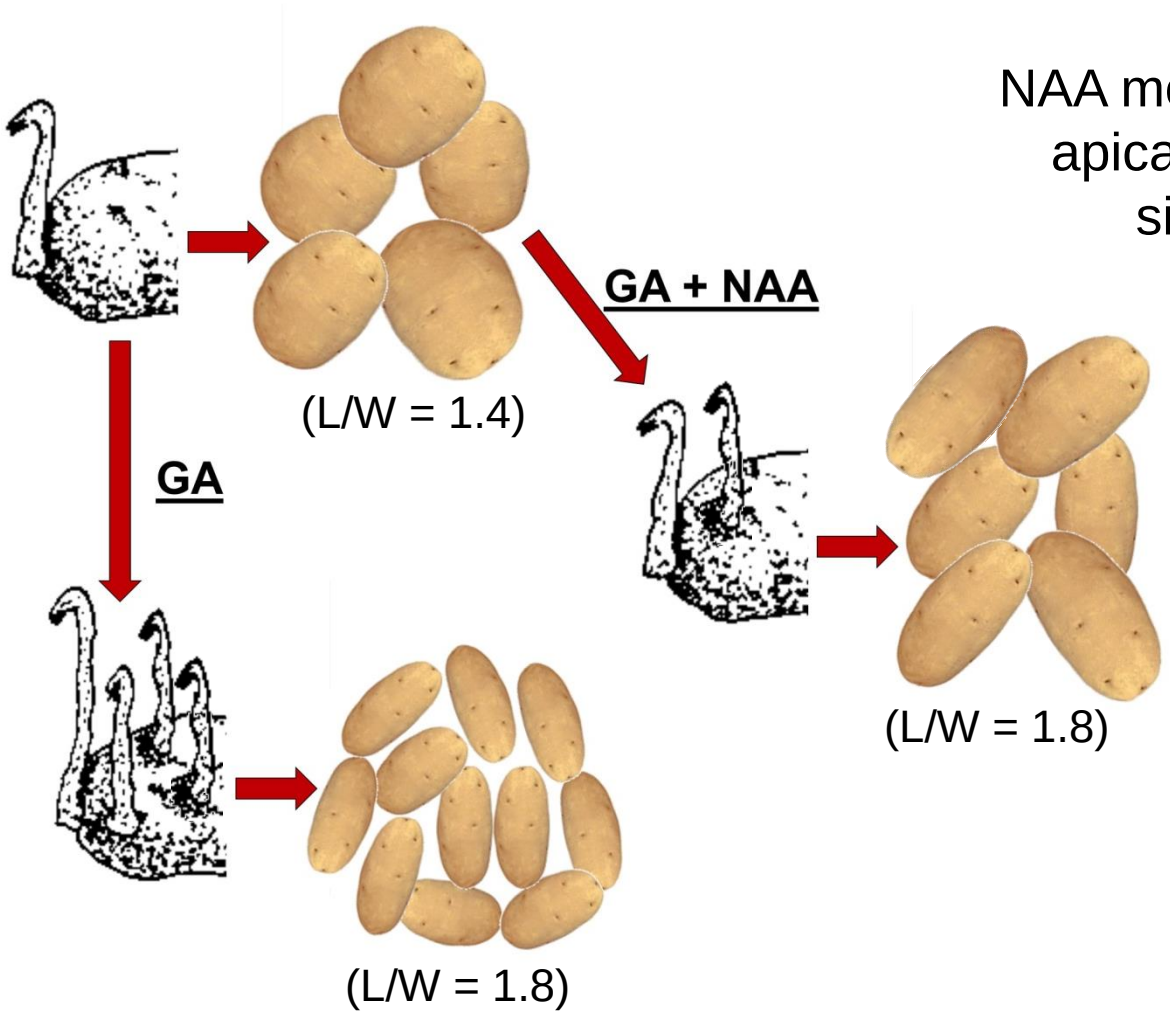
**P<0.001; n=43

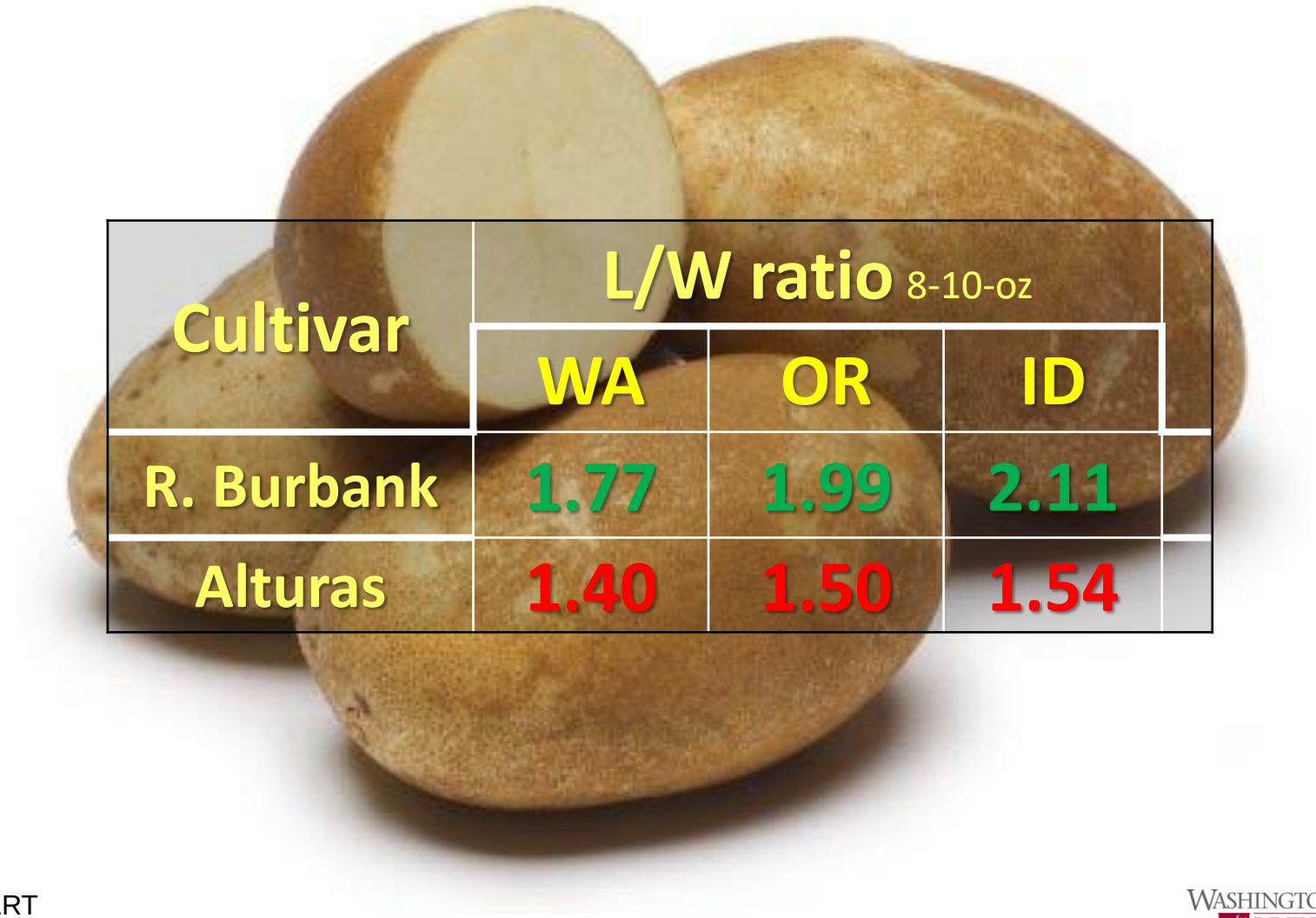
GA + NAA Combo Applications



NAA moderates GA effects on apical dominance & tuber size but not shape

Knowles *et al*.

Alturas - PNWVDP 2002 release



Cultivar	L/W ratio 8-10-oz		
	WA	OR	ID
R. Burbank	1.77	1.99	2.11
Alturas	1.40	1.50	1.54

2014, 2016 LTS & LRT
Knowles *et al*.

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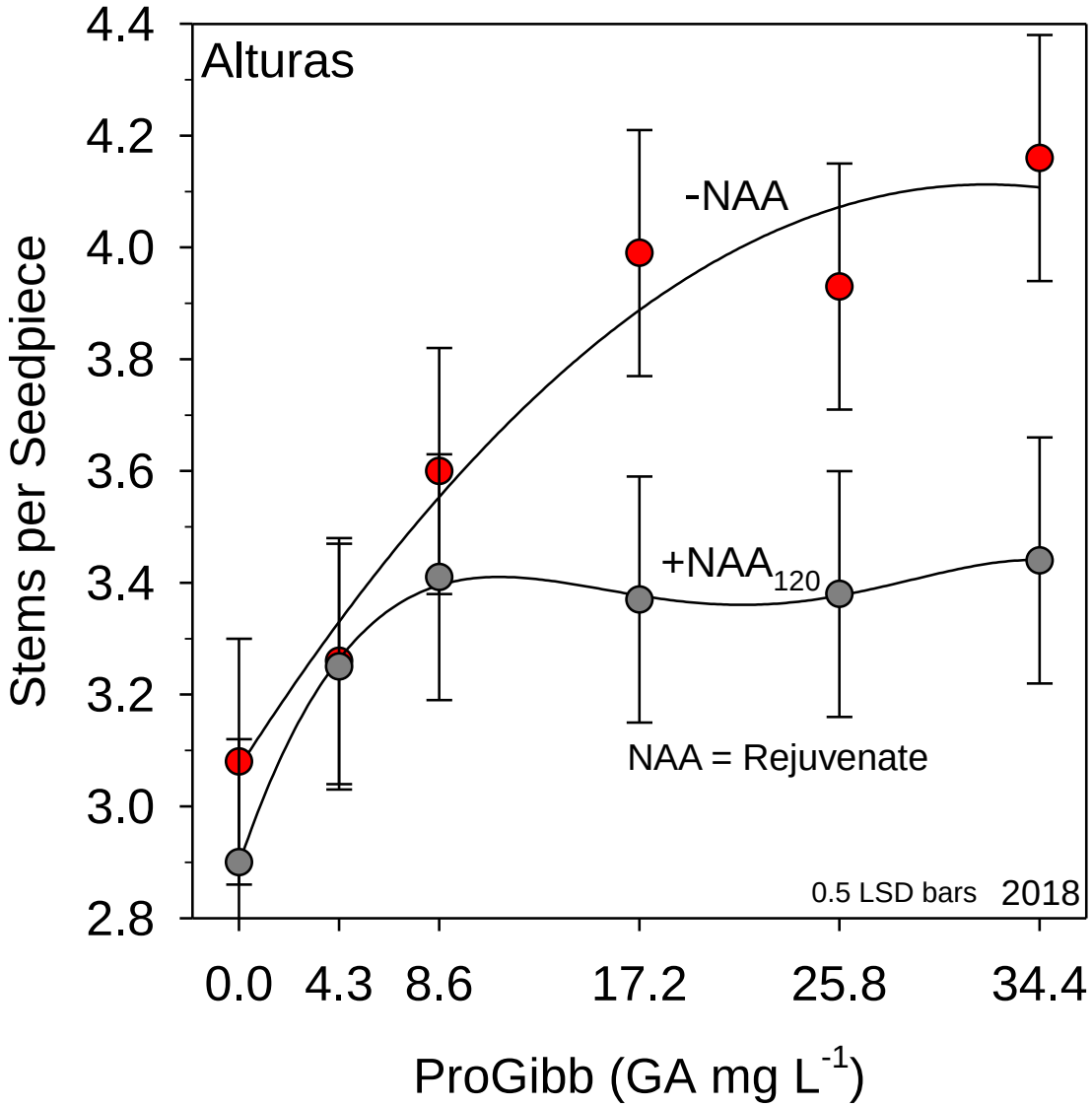
Rejuvenate (NAA) Attenuates GA-induced Increase in Stems of Alturas



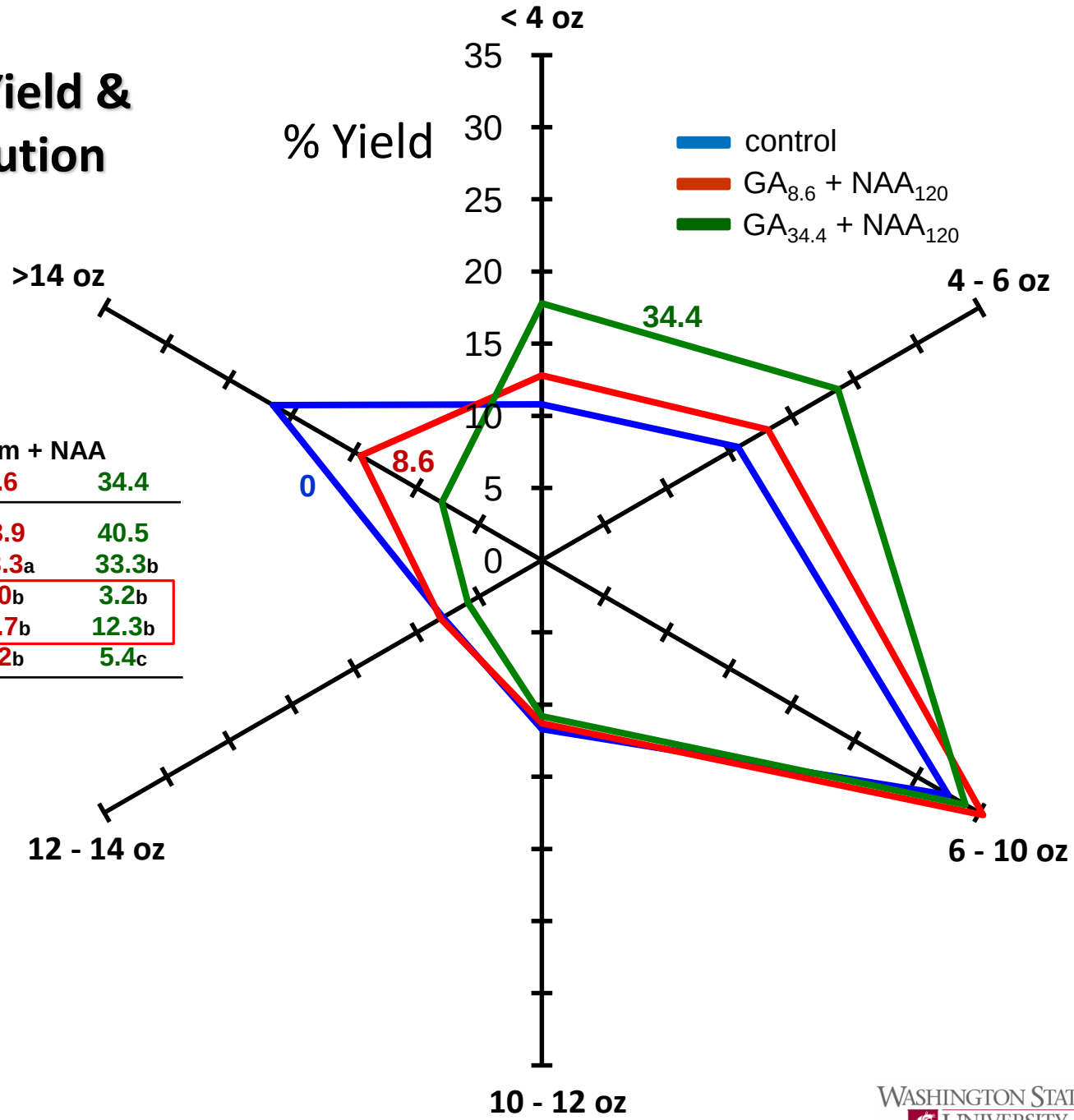
Bars = 0.5 $LSD_{0.05}$

NAA & GA, $P<0.001$; NAA x GA $P<0.01$

Alturas

GA + NAA Affects Yield & Tuber Size Distribution

	GA ppm + NAA		
	0	8.6	34.4
Mkt Yld (T/A)	42.8	43.9	40.5
U.S. 1 Yld (T/A)	37.6a	38.3a	33.3b
Stems/plant	2.4a	3.0b	3.2b
Tubers/plant	10.4a	11.7b	12.3b
oz/tuber	6.7a	6.2b	5.4c



2-yr 2018 & 19

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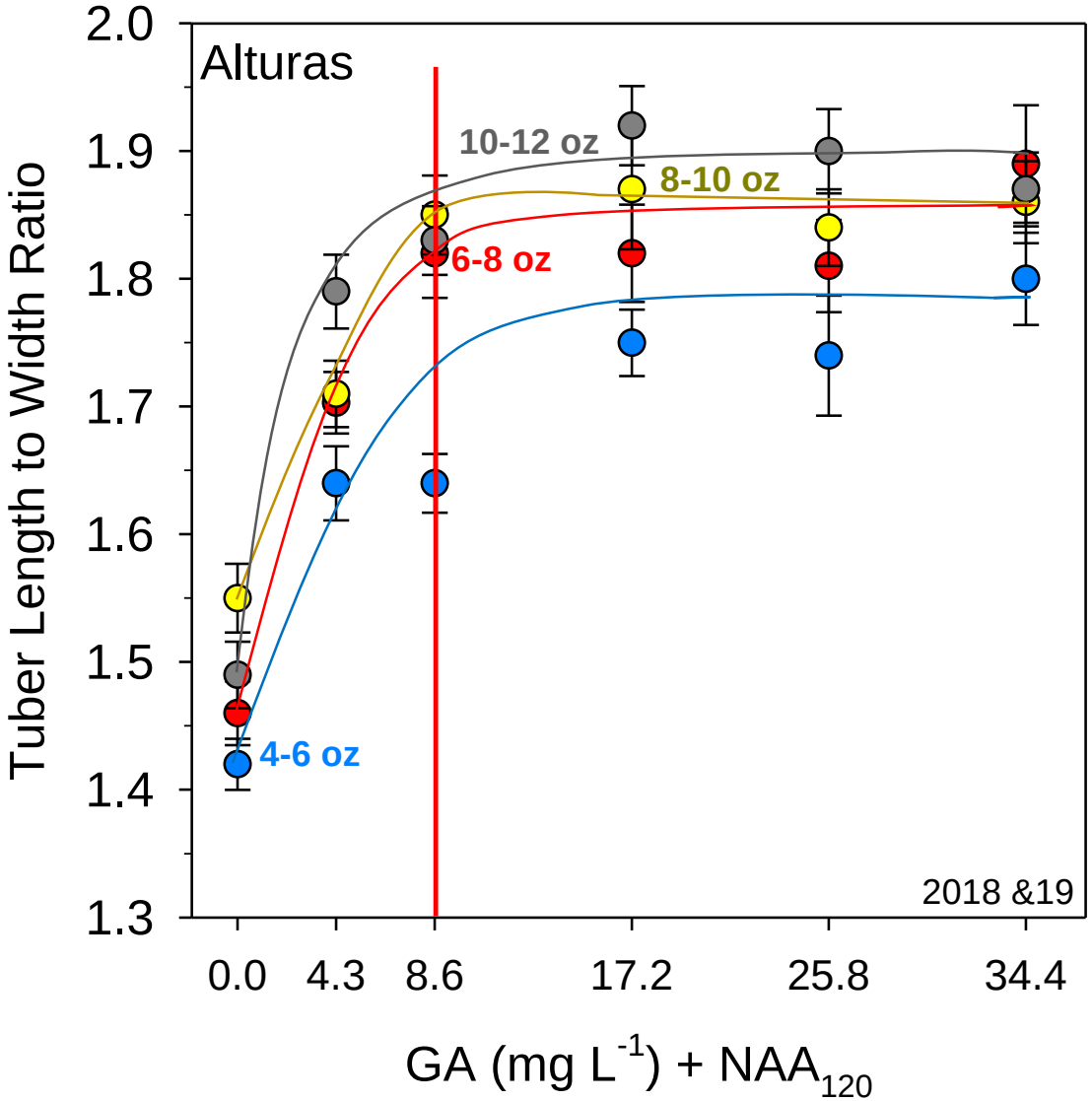
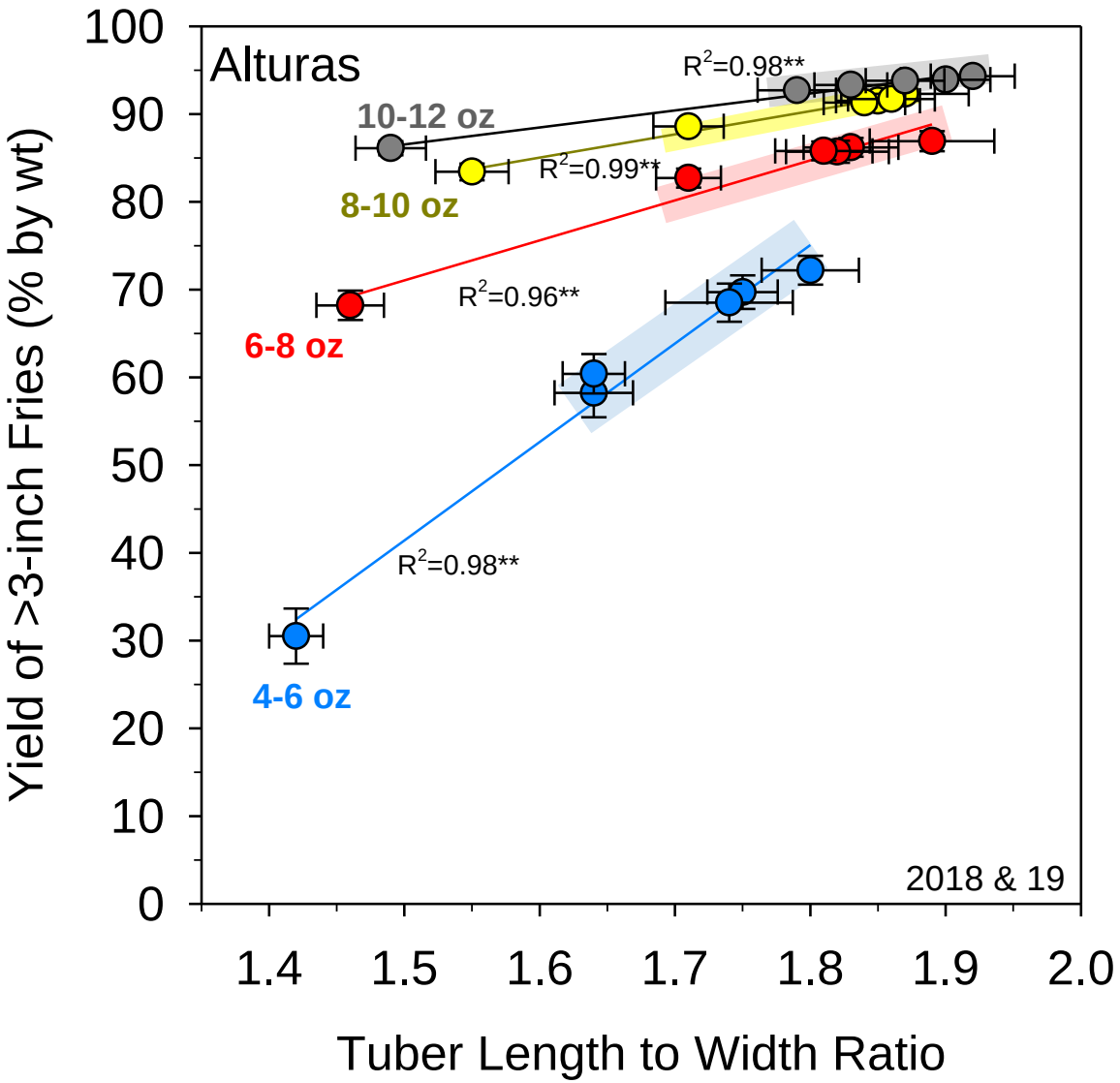
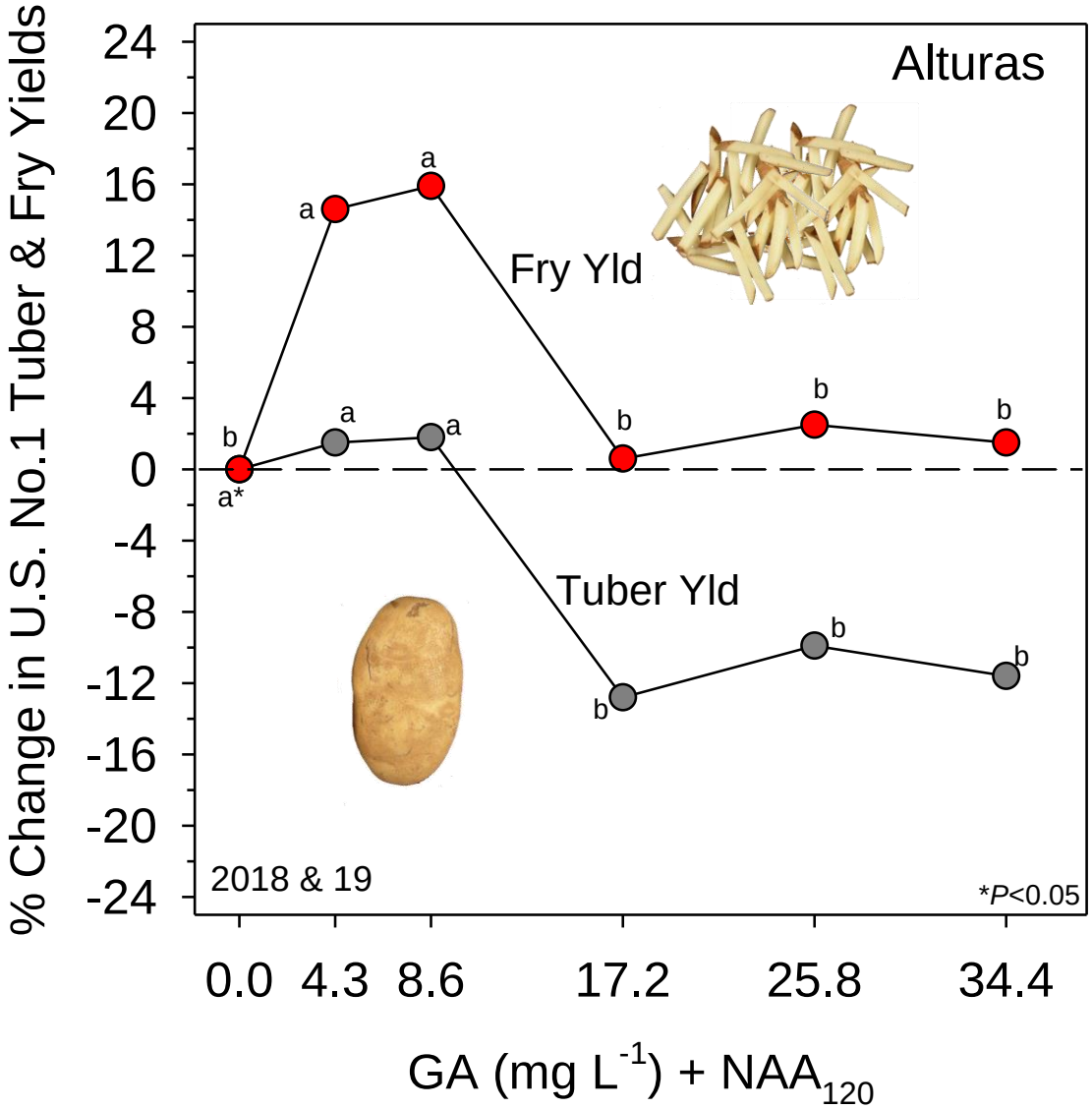
Increases in Tuber L/W Ratio with GA/NAA Combination Seed Treatment of Alturas



Effects of Increasing GA combined with NAA on Fry Yields by Tuber Size Class of Alturas



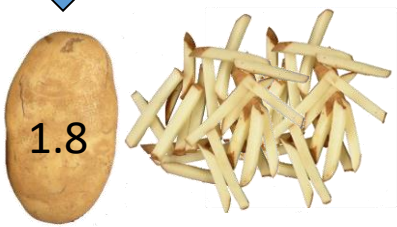
GA + NAA_{120} Increases Yield of Raw Product for Frozen Processing



Alturas – GA/NAA Affects Tuber Shape, Yield, & Raw Product Recovery

GA

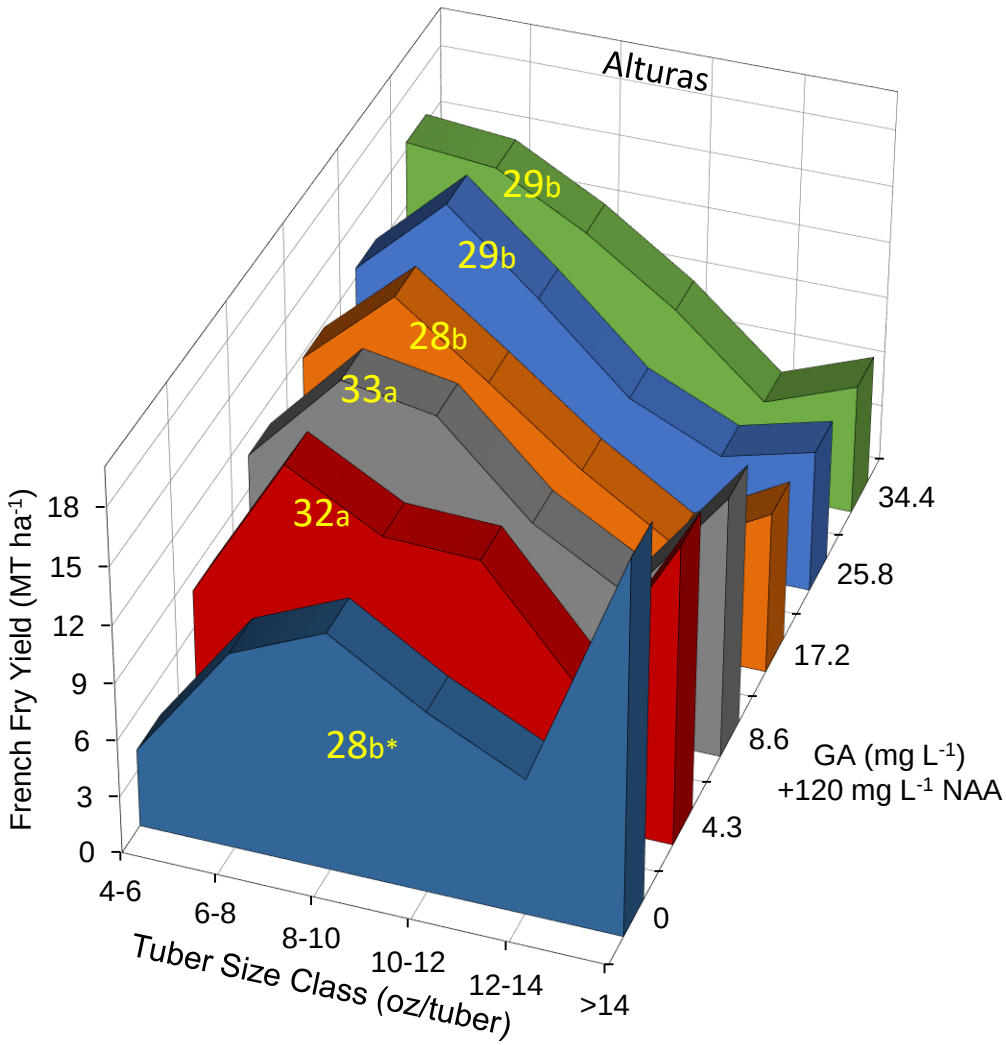
Tuber L/W



Alturas

GA/NAA (mg L^{-1})	Stem No.	Tuber L/W	US #1 T/A
0	2.4c	1.48d	37.6a
4.3/120	2.7b	1.71c	38.2a
8.6/120	3.0ab	1.79b	38.3a
17.2/120	3.0a	1.84a	32.8b
25.8/120	3.0ab	1.82ab	33.9b
34.4/120	3.2a	1.85a	33.3b

French Fry Yield

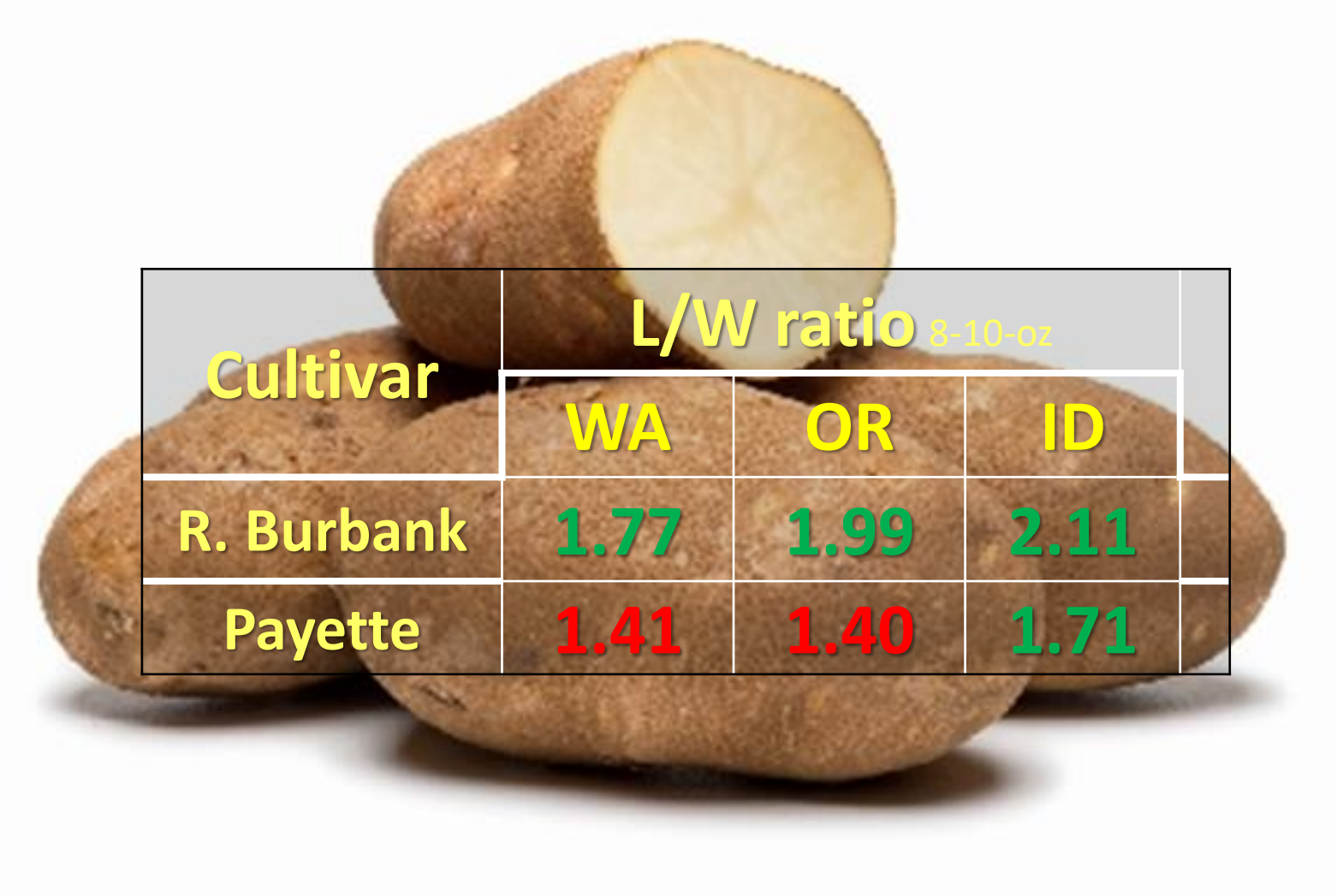


+16% Fry Yld, +4.5 T/A; 540 T/pivot

2-yr 2018 & 19 Alturas seed spray

*$P<0.05$; GA_{CT}, $P<0.01$

Payette - PNWVDP 2015 release



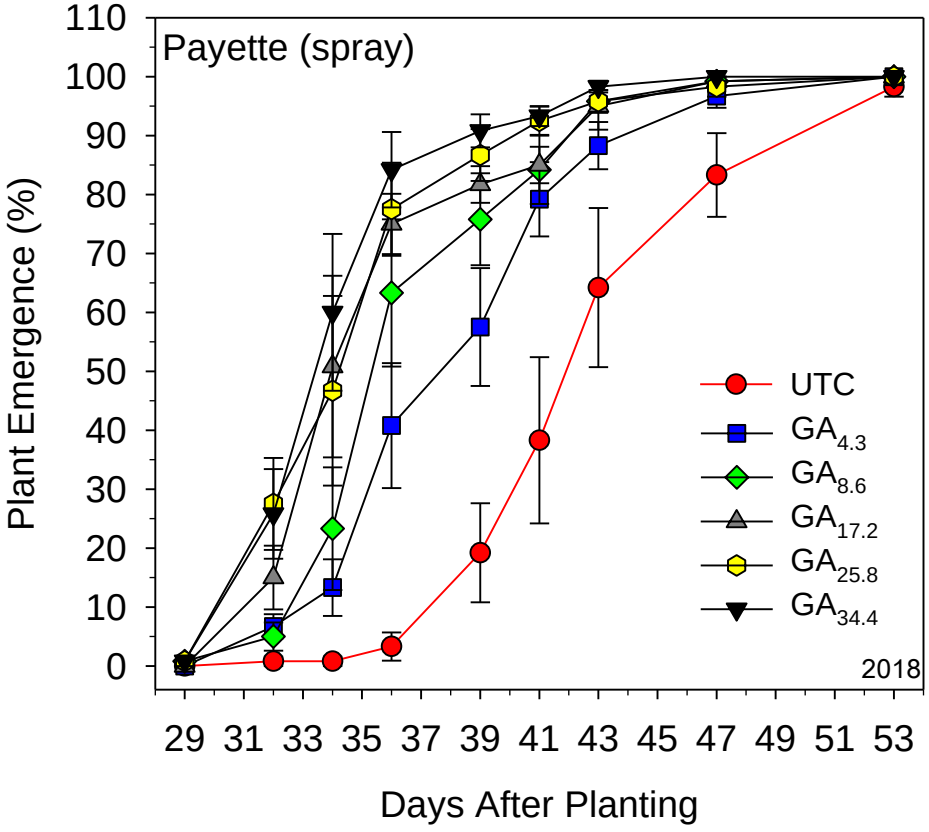
Cultivar	L/W ratio 8-10-oz		
	WA	OR	ID
R. Burbank	1.77	1.99	2.11
Payette	1.41	1.40	1.71

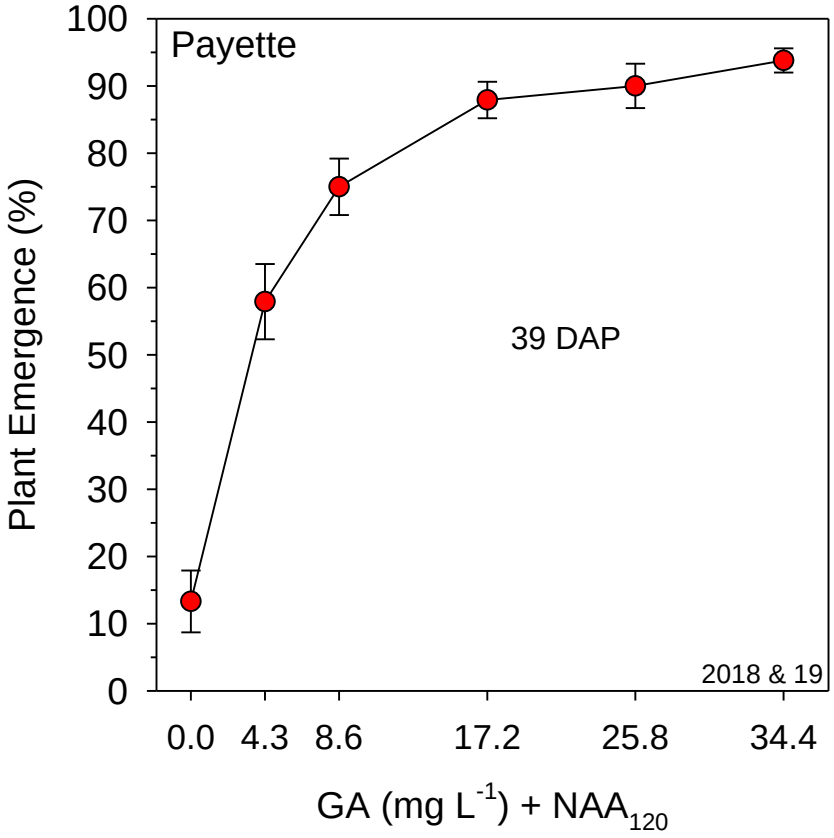
2014, 2016 LTS & LRT

Knowles *et al*.

Washington State University

GA + 120 ppm NAA Hastens Plant Emergence of Payette





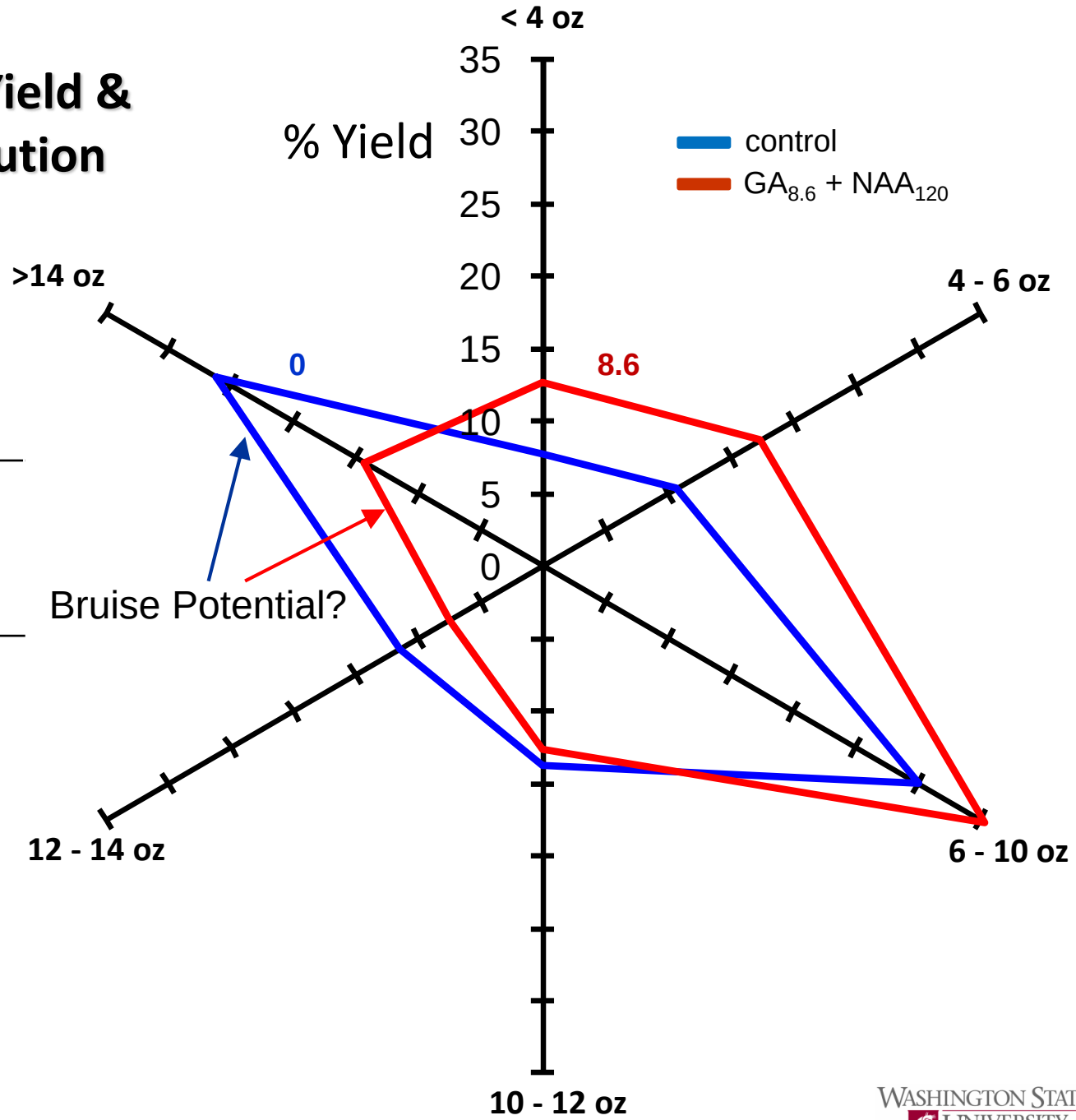
Final thoughts… Size & shape do matter!

- GA, NAA, and GA/NAA combination treatments constitute management options for hastening emergence and manipulating stem & tuber numbers, size, shape, and raw product recovery to enhance returns.
- Have a legitimate reason (strategy) for using these growth regulators alone or in combination.
- In combination, NAA moderates GA's effects on increasing stems & shifting tuber size distribution, while retaining the GA-induced effects on quicker emergence and shape.
- Concentrations matter - positive effects were achieved at relatively low concentrations when applied at 0.6 gal/ton of seed:
  - ✓ 2-9 ppm GA (ProGibb)
  - ✓ 120-150 ppm NAA (Rejuvenate)
  - ✓ Combo treatments - 4-9 ppm GA/120 ppm NAA
- Further work should assess the effects of tuber size distribution profiles on bruise-free.
  - ✓ Do profiles with high percentage oversize ↓ bruise-free? If so, managing for ↑ yields of 4 to 12-oz may enhance grower returns.

Ranger Russet

GA + NAA Affects Yield & Tuber Size Distribution

	GA ppm + NAA 0	8.6
Mkt Yld (T/A)	47.9	46.5
U.S. 1 Yld (T/A)	44.2	40.6
Stems/plant	2.6a	4.2b
Tubers/plant	9.9a	11.7b
oz/tuber	7.9a	6.5b



2019

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What does the literature say?

‘Tuber mass is the predominant factor dictating impact force…’

Geyer et al., (2009) Trans Am Soc of Agric Biol Eng 52:1267-1274.

“Large tubers (increased mass) are more susceptible to damage than small tubers… ***suggesting that a reduction in bruising will follow a reduction in the proportion of large to small ware sized tubers produced…*** Size and shape are genetically controlled and should be considered in selection for damage-resistant varieties.”

Hughes. J.C. (1980) Ann Appl Biol 96:344-349.

“With regard to tuber size, in harvesting operations large tubers are less well cushioned by soil than small ones and consequently suffer more internal damage than small ones…. In selection therefore, ***large-tubered varieties with high dry matter content would normally show the highest degree of internal damage.”***

Cole, C.S. (1980) Ann Appl Biol 96:354-357.