Progress Report on Yield Response to Grafting

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Why graft tomatoes?

Combine the features of two cultivars

<u>Scion:</u>
Fruit traits desired by processors, determinant growth habit

<u>Rootstock:</u>

- Resistance and/or tolerance to soil-borne disease and nematodes
- Increased abiotic stress tolerance

Source: www.mightymato.com
(Plug Connection, Vista, CA)

- Increased vigor & fruit size, fruiting over a longer period
- Mostly interspecific hybrids between cultivated tomato (*Solanum lycopersicum*) and wild species (typically *S. habrochaites*, less commonly *S. peruvianum* or *S. cheesmaniae*)

Most tomato rootstocks have been bred for greenhouse production, where they allow longer production cycles and tolerance of variable conditions (cold, hot, etc.)

Gene Miyao

1. Sterile trays & sterile media seeded 4 weeks before grafting

3. Grafting clips positioned half-way on rootstock stems

2. Both rootstock & scion plant stems clipped at ~45º angle

4. Scion stems align to rootstock angle with attention to match stem diameter

Occasional problems with overgrowth of the high vigor rootstocks, which then need to be hand removed

2018 field trial, north Delta

- Three scion varieties: N 6428, DRI 319 and HM 3887
- Three rootstocks: Maxifort, Multifort (both De Ruiter) and a pre-commercial, non-disclosed rootstock
- All combinations of the above, plus non-grafted controls
- Plots single bed by 65 ft, Replicated four times
- Plants produced by California Masterplant
- Transplanted May 30th, delayed harvest October 19th
- drip irrigated, no major disease problems in trial area
- Machine harvested, PTAB fruit quality measurements

Scion	Rootstock	Yield (tons/ac)		Increase	Soluble solids (°Brix)		PTAB Hue		PTAB pH
DRI 319	Maxifort	62.60	b	26%	5.10	d	21.1	ab	4.54
DRI 319	Multifort	56.93	bc		5.43	cd	20.9	bc	4.51
DRI 319	Non-disclosed rootstock	50.36	c		5.75	bc	20.9	bc	4.51
DRI 319	non-grafted control	49.83	c		5.70	bc	21.0	ab	4.49
HM 3887	Maxifort	79.55	a	55%	5.13	d	21.0	ab	4.51
HM 3887	Multifort	77.74	a	51%	5.08	d	21.1	ab	4.48
HM 3887	Non-disclosed rootstock	52.57	bc		6.30	a	20.4	c	4.49
HM 3887	non-grafted control	51.33	c		6.00	ab	20.9	bc	4.45
N 6428	Maxifort	86.38	a	50%	4.30	e	21.5	a	4.52
N 6428	Multifort	80.75	a	40%	4.60	e	20.9	bc	4.49
N 6428	Non-disclosed rootstock	60.85	bc		5.33	cd	20.4	c	4.47
N 6428	non-grafted control	57.73	bc		5.15	d	20.6	bc	4.50
	Mean	63.89			5.32		20.9		4.50
	LSD	11.20			0.45		0.6		ns
	Probability	*<0.0001*			*<0.0001*		*0.040*		*0.508*
	CV (%)	*12.182*			*5.85*		*2.05*		*1.00*
	GROUP CONTRASTS								
	Grafted	67.53	a	27%	5.22	b	20.9		4.50
	Non-grafted	52.96	b		5.62	a	20.8		4.48
	Contrast Probability	*<0.0001*			*0.0006*		*ns*		*ns*

Scion	Rootstock	8-Aug NDVI	5-Oct NDVI	5-Oct vigor (1 to 4)	5-Oct cover (%)	est. harvest date (day in October)
DRI 319	**Maxifort**	0.81	0.59	2.4	56	10.3
DRI 319	**Multifort**	0.80	0.57	2.0	51	10.5
DRI 319	**Non-disclosed rootstock**	0.79	0.50	1.4	40	5.5
DRI 319	**non-grafted control**	0.78	0.50	1.3	39	5.0
HM 3887	**Maxifort**	0.81	0.63	3.5	74	16.8
HM 3887	**Multifort**	0.80	0.63	3.6	75	17.3
HM 3887	**Non-disclosed rootstock**	0.74	0.52	1.8	45	10.8
HM 3887	**non-grafted control**	0.73	0.55	1.8	51	12.0
N 6428	**Maxifort**	0.85	0.66	3.9	85	17.3
N 6428	**Multifort**	0.84	0.64	4.0	80	15.5
N 6428	**Non-disclosed rootstock**	0.82	0.56	2.9	65	10.8
N 6428	**non-grafted control**	0.79	0.55	2.9	59	12.5
	Mean	0.8	0.6	2.6	60	12
	LSD	0.036	0.037	0.67	12.1	3.8
	Probability	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*
	CV (%)	*3.093*	*4.502*	*17.770*	*14.027*	*22.238*
	GROUP CONTRASTS					
	Grafted	0.81	0.59	2.8	63.5	12.7
	Non-grafted	0.77	0.53	2.0	49.6	9.8
	Contrast Probability	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*0.0027*

Grafting Evaluations: 2016-2018, Yolo-Solano area

	Y 2016 harvested yield Tons/A	% of non-grafted yield	Y 2017 harvested yield Tons/A	% of non-grafted yield	Y 2018 harvested Yield Tons/A	% of non-grafted yield
CLASS COMPARISONS:						
Grafted vs	60.4	110	49.9	119	83.5	108%
non grafted	55.2	100	41.9	100	77.1	100%
Probability	0.001		0.00		0.000	
FACTORS						
A. *Variety (scion)*						
Probability	0.000		0.00		0.000	
B. *Rootstock*						
Probability	NS		NS		0.000	
LSD 5%						
C. *Interaction (probability)*						
Variety x Rootstock	NS		NS		NS	
% CV	7		11		5	
Maximum scion x rootstock increase		115%		132%		120%

- ✓ Yield increase averaged 8 to 19%
- ✓ Increased 'vigor' and plant canopy, but delayed maturity
- ✓ No <u>Interaction</u> between rootstock x scion combinations tested
- ✓ Limited wild shoots emerging from rootstocks

UC Farm Advisor testing in commercial fields

Gene Miyao

Summary

2018 Walnut Grove trial:

- De Ruiter's rootstocks increased yield of three scions by an average of 39%
- High yielding plots had lower soluble solids, Maxifort-grafted plots had slightly poorer fruit color

From three other trials over three years:

- yield increases of 8 to 19%

From all trials:

- Grafting ncreased 'vigor' and plant canopy, but delayed maturity

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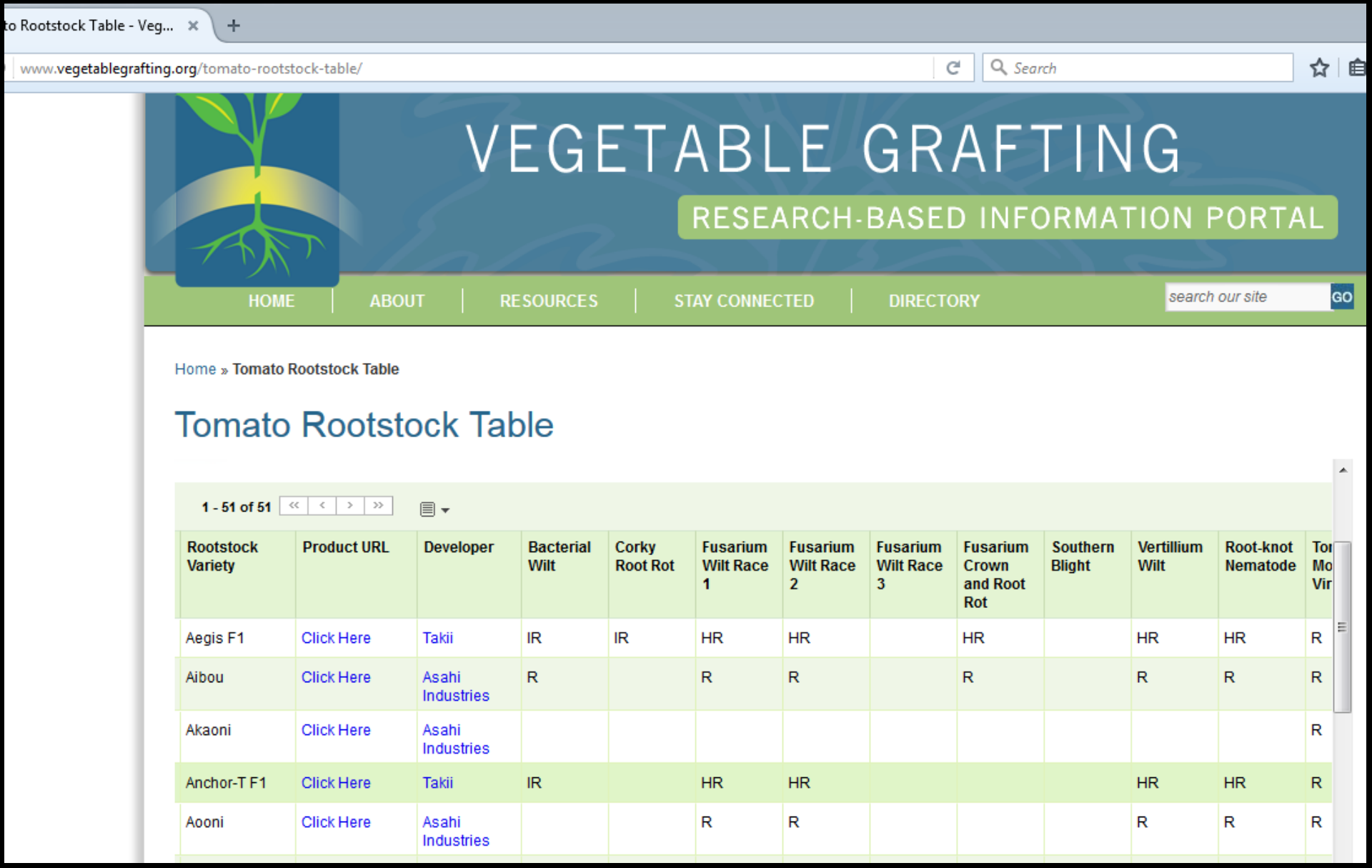
POTENTIAL ADVANTAGES	CHALLENGES
	High cost of establishment (rootstock seed, grafted plants)
	Greenhouse logistics: • Rootstock seed germination and uniformity challenges • Doubling greenhouse space for first month, plus special healing facility
Higher yield	• Potentially lower soluble solids? • Potentially slightly higher input costs? • Delayed harvest
Improved resistance to soilborne diseases	• Planting with union belowground may compromise disease resistance • Few/no rootstocks with F3,Vert race 2
Abiotic stress tolerance	Yield advantage may be greater at some sites than others
High vigor, better fruit cover, less sunburn	Perhaps greater need to manage vines with training or trimming?



Rootstock Variety	Product URL	Developer	Bacterial Wilt	Corky Root Rot	Fusarium Wilt Race 1	Fusarium Wilt Race 2	Fusarium Wilt Race 3	Fusarium Crown and Root Rot	Southern Blight	Vertillium Wilt	Root-knot Nematode	To Mo Vir
Aegis F1	Click Here	Takii	IR	IR	HR	HR		HR		HR	HR	R
Aibou	Click Here	Asahi Industries	R		R	R		R		R	R	R
Akaoni	Click Here	Asahi Industries										R
Anchor-T F1	Click Here	Takii	IR		HR	HR				HR	HR	R
Aooni	Click Here	Asahi Industries			R	R				R	R	R

www.vegetablegrafting.org

Vegetable Grafting Webinar Series

Members of the SCRI Grafting Project Team have organized a grafting webinar series. Each month a webinar will be offered, covering a different topic about the science and technology of vegetable grafting.

Upcoming Webinars:

Date: January 31, 2019
Time: 8 – 9 AM
Use of Vegetable Grafting for Soil-Borne Disease Management
Dr. Frank Louws, North Carolina State University
Sign up for this webinar: https://goo.gl/forms/wZDRprEYtlrLBRJv2

Past Webinars:

https://youtu.be/FwhFtknBE4o
Date: October 18, 2018
Title: **Developing a New Tomato Grafting Machine**
Presenter: **Yuji Masaki**, Kusakabe Kikai Co. Ltd., Osaka Japan

www.vegetablegrafting.org

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Morning Star (Calif. Sun Harvesting)

Fungicide Efficacy Evaluations for Powdery Mildew Control

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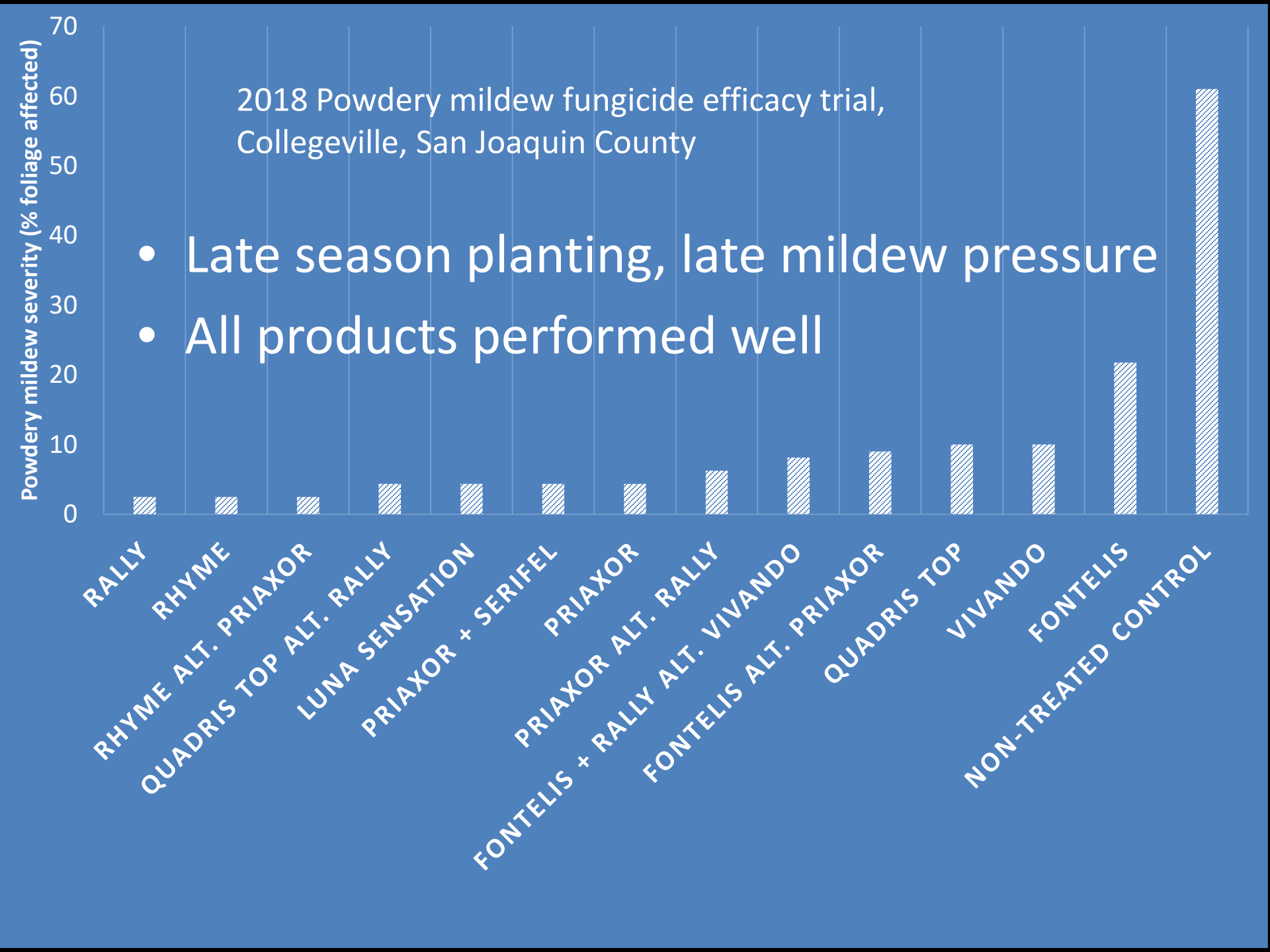

- Late season planting, late mildew pressure
- All products performed well

Union Island, San Joaquin Co., 2018	Mildew severity		Fruit biomass	Marketable yield	Fruit rot
Fungicide program	(% foliage affected)	NDVI	(tons per acre)	(tons per acre)	(percent fruit by weight)
Rhyme via drip at 6, 8 & 11 weeks, fb. foliar Rhyme at 14 weeks	40.0 c	0.45 a	78.6	68.1	1.34
Rhyme via drip at 3 & 8 weeks, fb. foliar Rhyme at 11 & 14 weeks	42.5 bc	0.43 a	86.9	73.7	0.70
Rhyme via drip at 6 & 8 weeks, fb. foliar Rhyme at 11 & 14 weeks	53.8 bc	0.41 a	80.4	68.9	0.55
Quadris Top foliar at 5, 8, 11 & 14 weeks	61.0 b	0.40 a	73.2	63.2	0.39
Non-treated control	81.8 a	0.35 b	87.5	75.0	0.80
Mean	55.8	0.407	81.3	69.8	0.75
P value	*0.0038*	*0.0114*	*NS*	*NS*	*NS*
CV	*22.8*	*8.1*	*13.2*	*13.3*	*53.8*

DRIP APPLICATION TRIAL IN PROCESSING TOMATOES, UNION ISLAND

- All programs reduced powdery mildew severity, but program with three drip applications was slightly superior
- Drip treatments likely less effective at controlling blackmold fruit rot
- No impact of programs on hand-harvested plot yield

FRAC Group	Chemical group	Trade names	Common names	Relative efficacy
11	Strobilurins, (Quinone outside inhibitors, QoI)	Quadris Flint Cabrio	azoxystrobin trifloxystrobin pyraclostrobin	+++ no data ++
7	Carboxamides (Succinate-dehydrogenase inhibitors, SDHI)	Fontelis	penthiopyrad	++
3	Triazoles (Demethylation inhibitors, DMI)	Rally Rhyme Inspire	myclobutanil flutriafol difenoconazole	++ +++ no data
11 + 3	QoI + DMI	Quadris Top	azoxystrobin + difenoconazole	+++
7 + 11	SDHI + QoI	Priaxor Luna Sensation	fluxapyroxad + pyraclostrobin fluopyram + trifloxystrobin	+++ +++
B6	aryl-phenyl-ketones	Vivando	metrafenone	++
U06	unknown	Torino	cyflufenamid (CA tomato registration pending)	+++
M02	inorganic	various products	sulfur	+++ (dust) ++ (sprayable)
F6	microbial (Bacillus)	various products	Bacillus amyloliquefaciens strains	+ (limited data)
Not classified	material of biological origin		plant extracts, etc.	
	inorganic salts	various products	potassium bicarbonate	+ (limited data)
	mineral oils		horticultural oils	

Summary
Tomato powdery mildew control

- We now have effective fungicides in several different chemical groups – making good rotation programs easier to plan
- Older products such as Rally and Quadris Top remain effective
- Sulfur dust remains one of the strongest materials; should form the backbone of a good program

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