Powdery Mildew Control in Tomatoes

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- Joyce Strand and Marty Martino, UC IPM
- Our cooperating growers and PCAs!

Tomato Powdery Mildew

Leveillula taurica (Oidiopsis sicula)

Symptoms

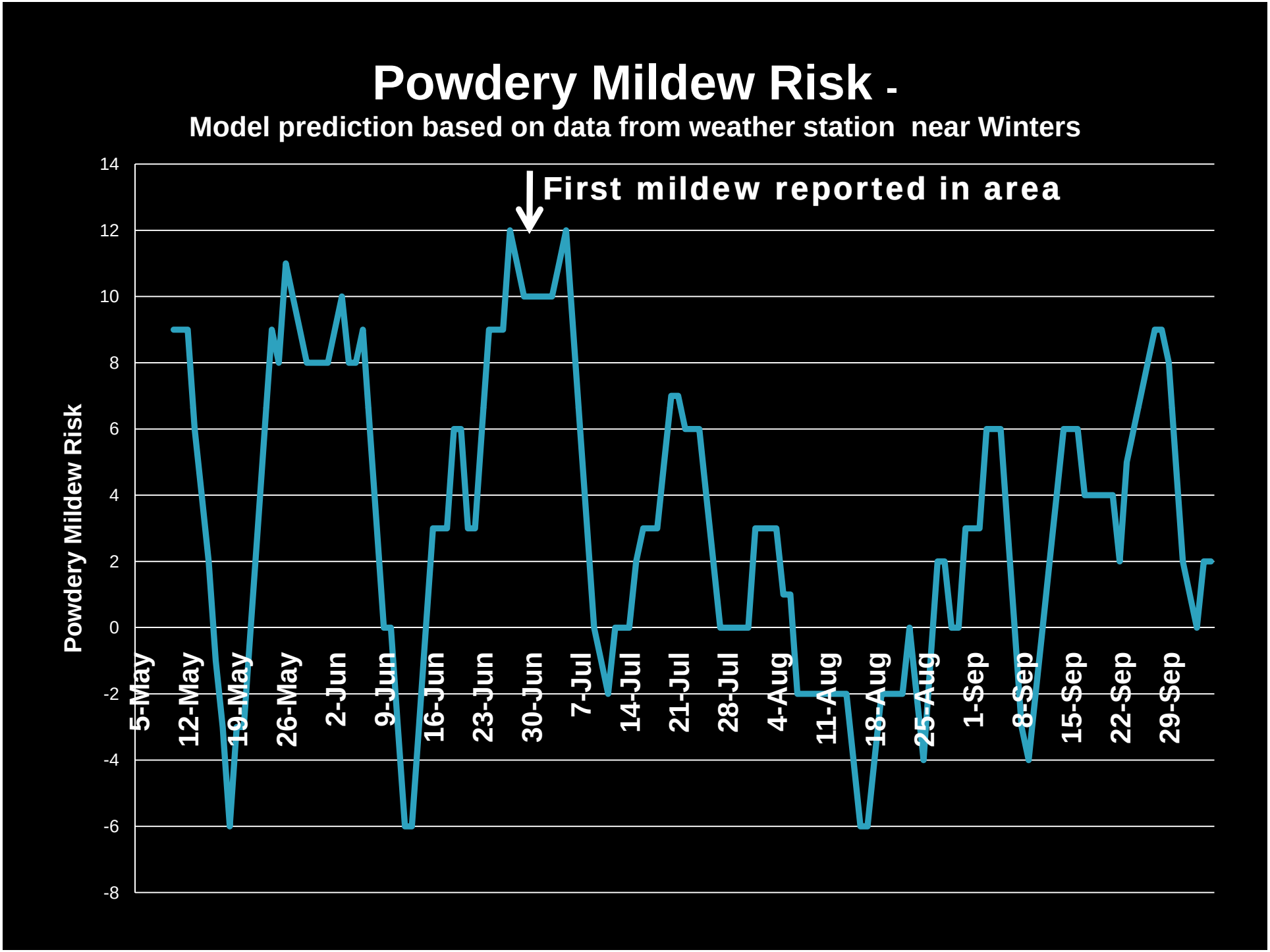
Yellow spots (or not)

Powdery white sporulation (or not)

Turning necrotic in age

Powdery Mildew Risk -

Model prediction based on data from weather station near Winters



Registered materials

Group Code	Chemical group name	Common names	Fungicide Resistance Risk
11	Quinone outside inhibitors (QoI)	azoxystrobin trifloxystrobin pyraclostrobin	high
3	Demethylation inhibitors (DMI)	myclobutanil difenoconazole	medium
M	M2 – inorganic	sulfur	low
	Not categorized	potassium bicarbonate biofungicides	resistance not known – presume risk is low

2009 CTRI trials evaluating spray program timings and materials

- Three trials in commercial fields (Dixon, Tracy and Los Banos areas), a third trial at West Side Research and Extension Center near Five Points
- All trials transplanted mid-May, harvested mid-Sept
- All trials (except Davis-Dixon area trial) were in variety SUN6368
- Powdery mildew developed at all but one trial location (Los Banos-area)

2009 CTRI trials evaluating spray program timings and materials

- Quadris 6 oz alternated with Rally 4 oz – 7 day interval (late June through late August)
- Quadris alt. Rally – as above but 14 day interval
- Quadris alt. Rally – 7 day - late start at ~6 weeks before harvest (August)
- Quadris alt. Rally – 7 day – early start but ending about 6 weeks before harvest (July)
- Sulfur dust – 7 day – for 6 to 10 weeks midseason (July-August)
- Non-treated control – no mildew fungicides

Field Trial Methods

- Fungicides applied with CO_2 backpack sprayer and a hand-held boom (32 to 40 psi)
- Sulfur dust applied with hand-crank operated duster
- Plots consisted of a single bed by 50 to 75 feet (plot length varied by trial) – with one buffer row between treated rows – plots replicated four times
- Plots evaluated for:
  - Percent of foliage affected by mildew
  - Percent necrosis at end of season
  - Fruit yield and maturity
  - Fruit quality (sunburn, color, soluble solids, pH)

TRACY-AREA TRIAL

SPRAY PROGRAMS				POWDERY MILDEW DISEASE SEVERITY			
				20-Aug		2-Sep	
Fungicides	Spray interval	Spray dates	Applications	Mildew severity[z]		Necrosis severity[z]	
Sulfur dust	7	7/7 to 8/17	5	1.0	c	1.8	c
Quadris alt. Rally	7	6/26 to 8/24	8	1.8	b	3.5	b
Quadris alt. Rally: late start	7	8/5 to 8/17	2	2.5	a	3.8	b
Quadris alt. Rally	14	7/7 to 8/20	4	1.5	bc	4.3	ab
Quadris alt. Rally: early start	7	7/7 to 8/5	5	2.0	ab	4.5	ab
Nontreated control	-		0	2.5	a	5.3	a
			LSD 5%	0.7		1.1	
			% CV	25		19	
			P value	0.003		0.0001	
	Group comparisons						
	Fungicides vs.			1.8		3.6	
	Non-treated control			2.5		5.3	
			P value	0.01		0.001	

z Disease severity rating scale: 0 = no disease 1 = 2.5% of foliage affected 2 = 10% 3 = 21% 4 = 35% 5 = 50% 6 = 65% 7 = 79% 8 = 90% 9 = 97.5% 10 = 100%

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TRACY-AREA TRIAL

FRUIT YIELD AND QUALITY

Fungicides	Spray interval	Spray dates	Applications	Marketable yield (tons)	Sunburn (%)	PTAB color	Soluble solids (°Bx)		pH
Sulfur dust	7	7/7 to 8/17	5	61.7	2.7	24.0	4.90	a	4.37
Quadris alt. Rally	7	6/26 to 8/24	8	61.0	3.4	24.3	4.73	ab	4.36
Quadris alt. Rally: late start	7	8/5 to 8/17	2	62.0	4.0	24.8	4.53	bc	4.38
Quadris alt. Rally	14	7/7 to 8/20	4	64.7	3.4	24.5	4.58	bc	4.41
Quadris alt. Rally: early start	7	7/7 to 8/5	5	63.0	2.9	24.3	4.55	bc	4.41
Nontreated control		none	0	60.7	3.7	24.8	4.43	c	4.44
			LSD 5%	NS	NS	NS	0.27		NS
			% CV	9	30	4	4		0.9
			P value				0.03		
	Group comparisons								
	Fungicides vs.			62.5	3.3	24.4	4.66		4.39
	Non-treated control			60.7	3.7	24.8	4.43		4.44
			P value	NS	NS	NS	0.03		0.03

TRACY-AREA TRIAL

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			LSD 5%	NS	NS	NS	0.27		NS
			% CV	9	30	4	4		0.9
			P value				0.03		
	Group comparisons								
	Fungicides vs.			62.5	3.3	24.4	4.66		4.39
	Non-treated control			60.7	3.7	24.8	4.43		4.44
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Nontreated control		none	0	60.7	3.7	24.8	4.43	c	4.44
			LSD 5%	NS	NS	NS	0.27		NS
			% CV	9	30	4	4		0.9
			P value				0.03		
	Group comparisons								
	Fungicides vs.			62.5	3.3	24.4	4.66		4.39
	Non-treated control			60.7	3.7	24.8	4.43		4.44
			P value	NS	NS	NS	0.03		0.03


Two weeks prior to harvest
Sulfur dust treatment
Non-treated control

Tracy-area trial

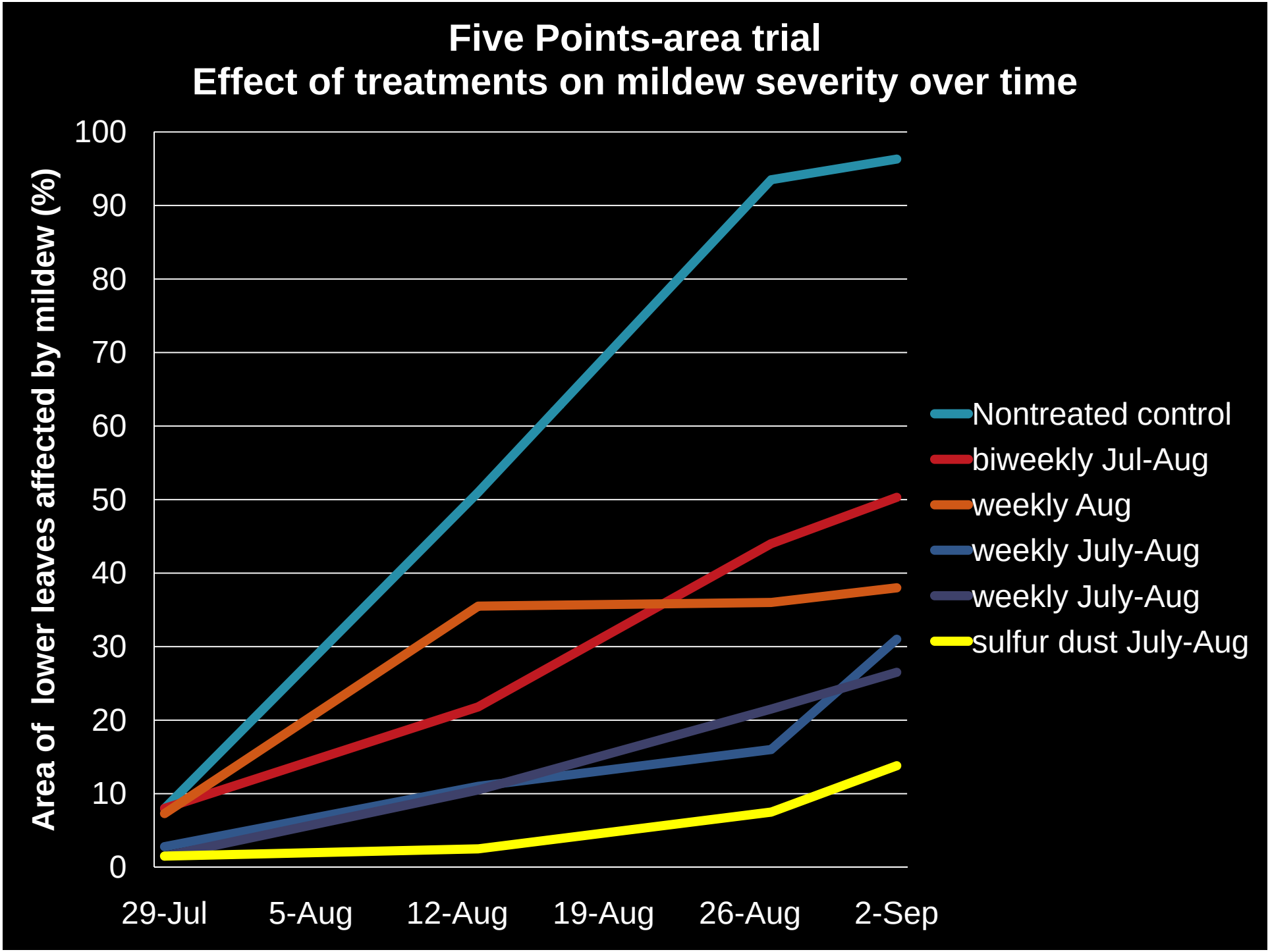
- Powdery mildew came into field relatively late (mid-August)
- Powdery mildew and leaf necrosis were reduced and fruit solids were increased in the top two treatments (5 sulfur dust applications or 8 fungicide applications)
- Marketable yield did not differ significantly among treatments
- Fruit solids higher and pH level lower in fungicide treatments than in non-treated control

DAVIS/DIXON-AREA TRIAL			FRUIT YIELD AND QUALITY					
Fungicides	Spray interval	Applications	Marketable yield (tons)	Sunburn (%)		Color	Soluble solids (°Bx)	pH
Quadris alt. Rally	7	10	48.0	6	ab	24.5	5.48	4.20
Quadris alt. Rally	14	5	43.4	6	ab	25.5	5.10	4.20
Quadris alt. Rally: late start	7	5	41.3	6	ab	24.5	5.50	4.20
Quadris alt. Rally: early start	7	7	44.5	6	ab	24.0	5.35	4.19
Sulfur dust (weekly)	7	10	45.3	3	bc	24.8	5.30	4.22
non-treated control	-	0	43.0	7	a	24.5	5.08	4.20
Quadris alt. Rally: late start + Surround	7	5	47.0	4	bc	24.8	5.08	4.20
		LSD 5%	NS	2.6		NS	NS	NS
		% CV	9	33		4	4	0.5
		P value		0.04			0.06	
Group comparisons								
Fungicides vs.			44.9	5.1		24.7	5.3	4.2
Non-treated control			43.0	7.4		24.5	5.1	4.2
Probability			NS	0.03		NS	0.09	NS

DAVIS/DIXON-AREA TRIAL			FRUIT YIELD AND QUALITY					
Fungicides	Spray interval	Applications	Marketable yield (tons)	Sunburn (%)		Color	Soluble solids (°Bx)	pH
Quadris alt. Rally	7	10	48.0	6	ab	24.5	5.48	4.20
Quadris alt. Rally	14	5	43.4	6	ab	25.5	5.10	4.20
Quadris alt. Rally: late start	7	5	41.3	6	ab	24.5	5.50	4.20
Quadris alt. Rally: early start	7	7	44.5	6	ab	24.0	5.35	4.19
Sulfur dust (weekly)	7	10	45.3	3	bc	24.8	5.30	4.22
non-treated control	-	0	43.0	7	a	24.5	5.08	4.20
Quadris alt. Rally: late start + Surround	7	5	47.0	4	bc	24.8	5.08	4.20
		LSD 5%	NS	2.6		NS	NS	NS
		% CV	9	33		4	4	0.5
		P value		0.04			0.06	
Group comparisons								
Fungicides vs.			44.9	5.1		24.7	5.3	4.2
Non-treated control			43.0	7.4		24.5	5.1	4.2
Probability			NS	0.03		NS	0.09	NS

Davis/Dixon-area trial

- Infection level light until 2 weeks before harvest
- Powdery mildew and leaf necrosis highest in non-treated control, lowest in sulfur treatment (10 weekly dust applications)
- Marketable yield not significantly different among treatments
- Level of sunburn damage lower with sulfur dust or Surround treatments (5 late fungicide applications plus Surround)


Five Points-area trial
Effect of treatments on mildew severity over time
Area of lower leaves affected by mildew (%)
100
90
80
70
60
50
40
30
20
10
0
29-Jul
5-Aug
12-Aug
19-Aug
26-Aug
2-Sep
Nontreated control
biweekly Jul-Aug
weekly Aug
weekly July-Aug
weekly July-Aug
sulfur dust July-Aug

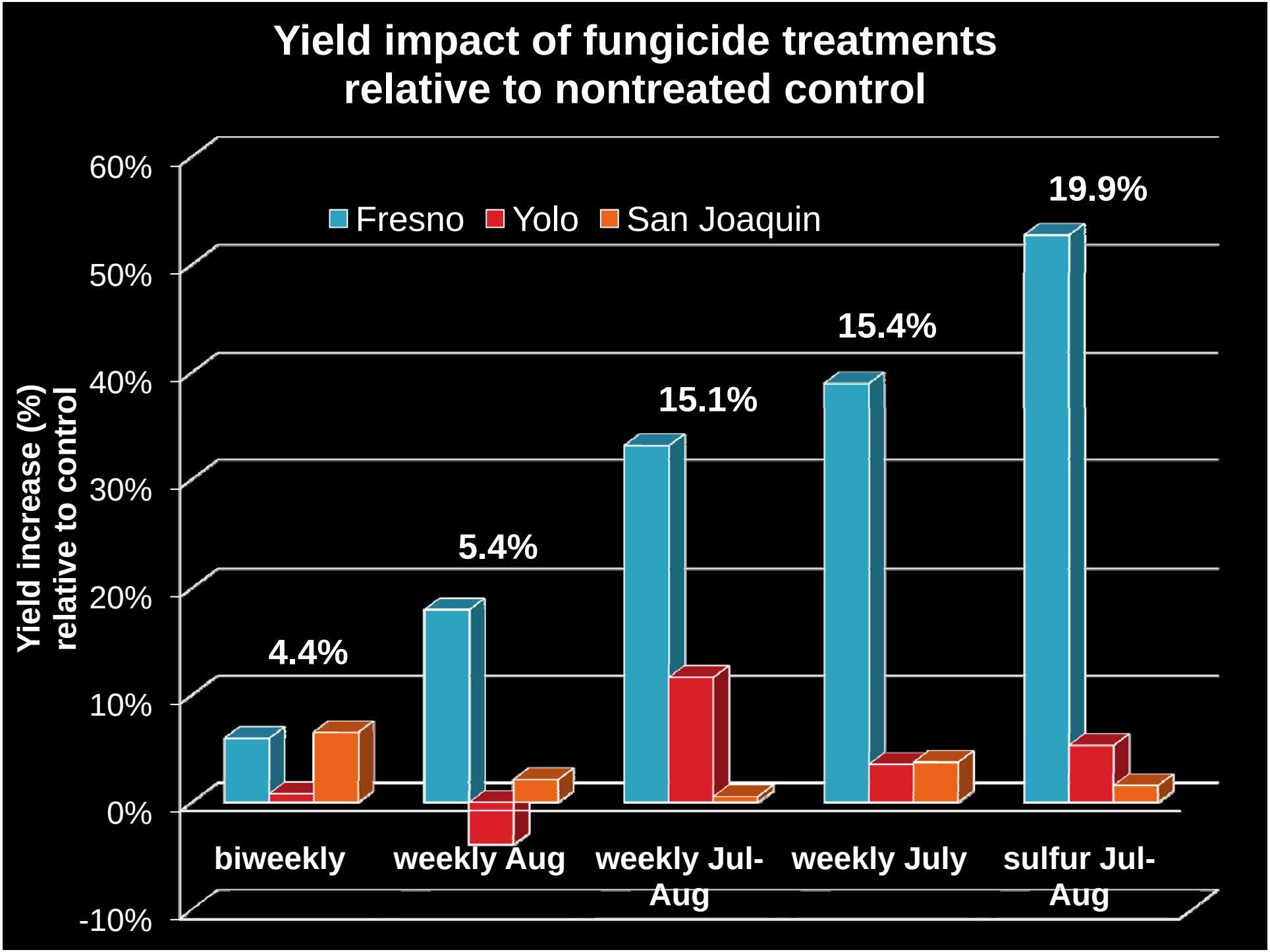
FIVE POINTS-AREA TRIAL

FRUIT YIELD AND QUALITY

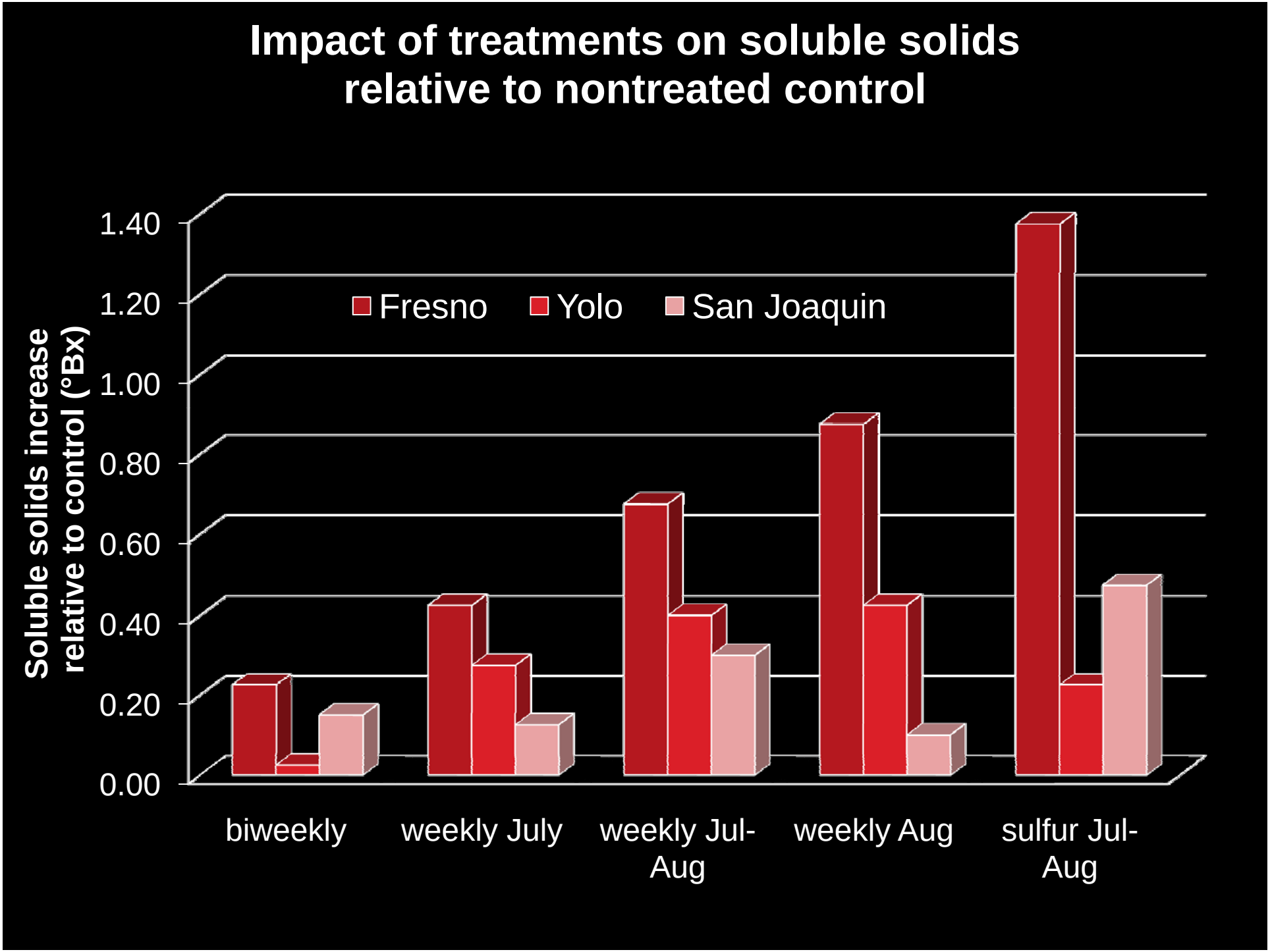
Fungicides	Spray interval	Spray dates	Applications	Marketable yield (tons)		Sunburn (%)	PTAB color	Soluble solids (°Bx)		pH
Sulfur dust	7	7/2 to 8/13	7	34.0	a	17.3	25.3	5.38	a	4.51
Quadris alt. Rally: early start	7	7/2 to 8/6	6	31.0	ab	21.8	29.5	4.43	c	4.47
Quadris alt. Rally	7	6/26 to 8/27	10	29.7	abc	25.2	27.8	4.68	bc	4.51
Quadris alt. Rally: late start	7	7/30 to 8/27	5	26.3	bcd	21.7	30.3	4.88	b	4.46
Quadris alt. Rally	14	7/2 to 8/5	5	23.6	cd	18.7	27.5	4.23	cd	4.51
Nontreated control		none	0	22.3	d	25.2	28.0	4.00	d	4.57
			LSD 5%	6.2		NS	2.5	0.34		0.08
			% CV	14.9		27.59	5.93	4.95		1.13

Five Points-area trial

- High disease pressure, mildew starting earlier (late July) than at two northern trials
- Mildew severity and necrosis much higher in non-treated control; lowest mildew and necrosis in the following treatments:
  - 10 weekly fungicide applications (26-Jun to 27-Jul)
  - 5 weekly fungicide applications late (30-Jul to 27-Aug)
  - 7 weekly sulfur dust applications (2-Jul to 13-Aug)
- Yield reduced 35% in non-treated control as compared with sulfur treated plots
- Fruit solid levels of 4.00 in non-treated control versus 5.39 °Bx in sulfur treatment


Yield impact of fungicide treatments relative to nontreated control
Yield increase (%) relative to control
60%
50%
40%
30%
20%
10%
0%
-10%
Fresno
Yolo
San Joaquin
4.4%
5.4%
15.1%
15.4%
19.9%
biweekly
weekly Aug
weekly Jul-Aug
weekly July
sulfur Jul-Aug

Impact of treatments on soluble solids relative to nontreated control



Summary

- Mildew occurred at 3 out of 4 trial locations
- Impacts at 3 locations with mildew pressure:
  - Reduced yield: 1location (Fresno)
  - Increased sunburnt fruit: 1 location (Yolo)
  - Increased PTAB color: 1 location (Fresno)
  - Reduced soluble solids: all 3 locations (but weak in Yolo)
  - Increased pH at 2 locations (Fresno, San Joaquin)
- Sulfur dust effective when applied early and regularly (best material at all 3 locations)
- Most effective program timings are starting earlier and with close intervals – but what is economically justified?

Tomato Powdery Mildew Fungicides

- Best registered materials are sulfur, Quadris Top (= Quadris plus Inspire), and Quadris

- Promising new materials in two new chemical classes (not yet registered for tomato):
  - metrafenone (benzophenone class)
  - fluopyram and penthiopyrad (SDHI class)

When to spray/dust? Factors to consider:

- Planting date/ plant age/canopy density
- Weather
- Variability in processing varieties
- Spores in the air? Mildew in the vicinity?
- Plant stress? History of field location (root disease, Vert wilt, other soil issues)?
- Grower tolerance for mildew

Variety tolerance, Fresno Co. trial

Entries	Leaf surface with evidence of powdery mildew (%)[y]						Necrosis rating[x]			
	3 Aug		19 Aug		28 Aug		20 Aug		1 Sep	
H 9780 (STD)	4.0	abc	42.0	ab	31.0	e	3.1	abcd	3.3	abc
HMX 7885	4.0	abc	23.0	c	31.0	e	1.8	d	2.5	c
CXD 255	4.0	bc	34.0	abc	41.0	de	1.5	d	3.0	abc
H 4007	6.0	abc	35.0	abc	42.0	de	3.3	abcd	4.0	abc
PX 650	7.0	abc	30.0	bc	45.0	cde	2.3	bcd	4.0	abc
H 8504	6.0	abc	37.0	abc	45.0	cde	3.3	abcd	4.0	abc
HMX 7883	5.0	abc	28.0	bc	49.0	bcde	3.0	abcd	4.3	abc
HMX 6903	2.0	c	27.0	bc	50.0	bcde	2.0	cd	3.3	abc
PX 002	5.0	abc	34.0	abc	52.0	bcde	2.8	bcd	3.3	abc
HM 6898	6.0	abc	50.0	a	62.0	abcd	4.0	abcd	6.5	a
AB 2 (STD)	11.0	a[w]	53.0	a	68.0	abcd	3.3	abcd	5.0	abc
N 6390	5.0	abc	40.0	ab	69.0	abc	3.3	abcd	3.5	abc
H 8004 (STD)	10.0	ab	48.0	a	73.0	ab	4.8	ab	5.8	ab
H 2601 (STD)	6.0	abc	51.0	a	75.0	ab	4.0	abcd	4.5	abc
SUN 6366 (STD)	9.0	ab	42.0	ab	78.0	ab	5.8	a	6.3	ab
SUN 6368 (STD)	7.0	abc	48.0	a	88.0	a	4.5	abc	6.0	ab

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PX 002	5.0	abc	34.0	abc	52.0	bcde	2.8	bcd	3.3	abc
HM 6898	6.0	abc	50.0	a	62.0	abcd	4.0	abcd	6.5	a
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SUN 6368 (STD)	7.0	abc	48.0	a	88.0	a	4.5	abc	6.0	ab

When to spray/dust? Factors to consider:

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- Weather
- Variability in processing varieties
- Spores in the air? Mildew in the vicinity?
- Plant stress? History of field location (root disease, Vert wilt, other soil issues)?
- Grower tolerance for mildew

Powdery mildew chemical control

- Early treatment – fungicides are mostly preventative
- Good coverage, penetrate canopy – PM fungicides are not systemic
- Utilize good rotations and tank mixes – fungicide resistance is a real risk, let's maintain efficacy of the few materials we have