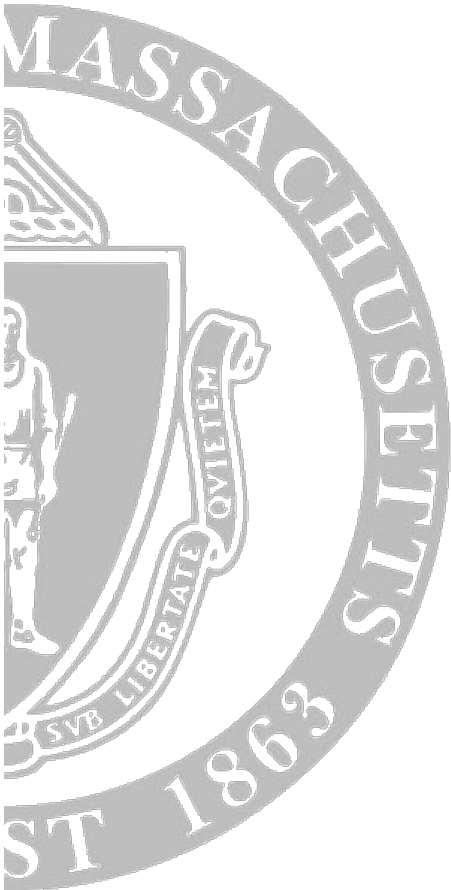


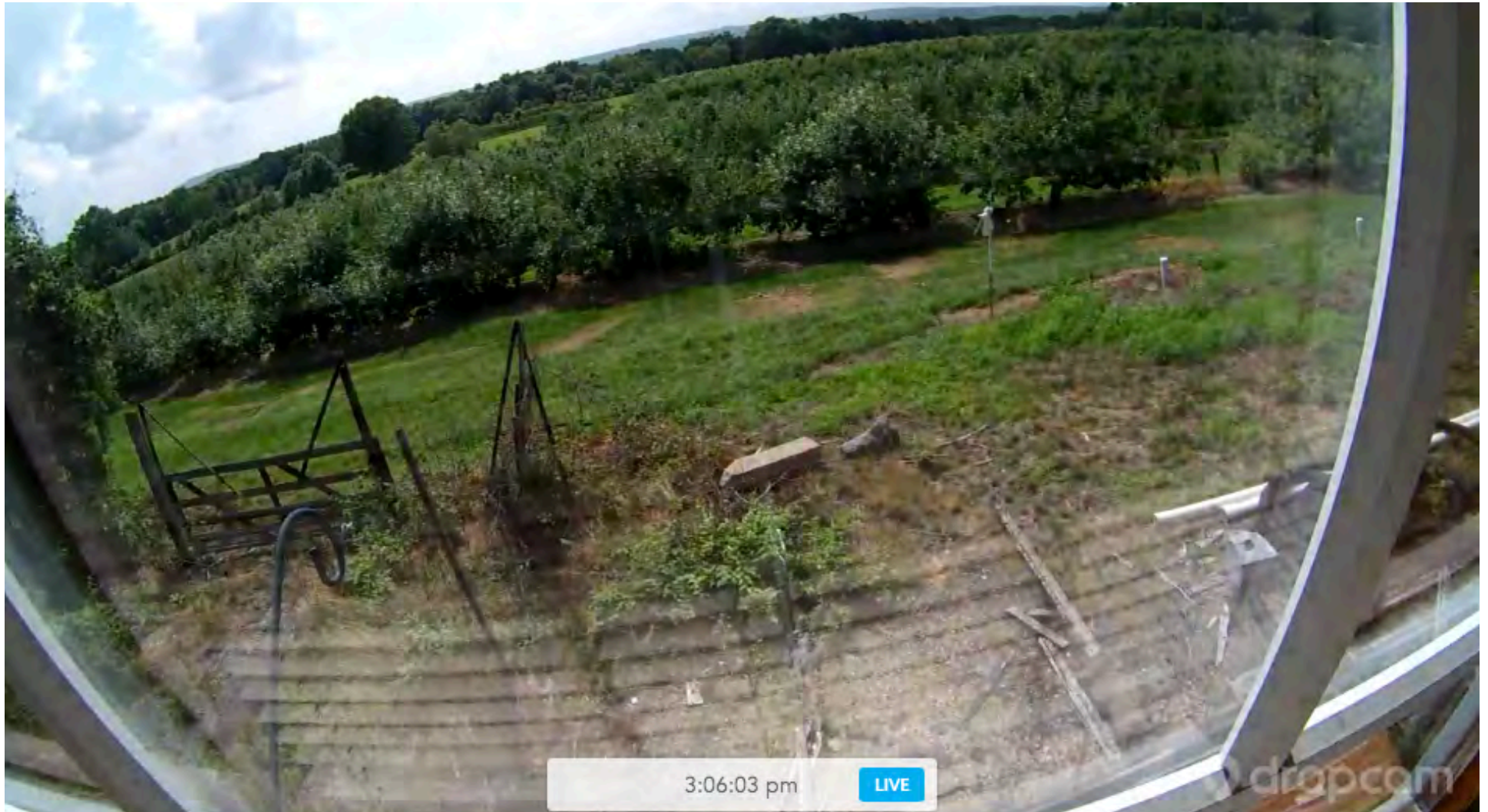
Decision support systems for apple scab

*Models, outputs and
implementation*

Jon Clements
Daniel Cooley



UMass Cold Spring Orchard, Belchertown, MA



Decision support systems and inputs

Decision Support System	Input	Forecast	Interacts with fungicide treatment
NEWA	Weather stations; on-site; private and public	Limited	No
SkyBit	Interpolated meso-scale est.; off-site	Yes	No
AgRadar	SkyBit data; off-site	Yes	Yes
RIMpro	Weather stations; on-site	Yes	Yes

NEWA

- Temperature, leaf wetness, rainfall
- Infection events
- Ascospore maturity
- Wetness event details
- <http://newa.cornell.edu>



NEWA

NEWA Apple Disease Models

Select a disease:

Weather Station:

Date of Interest:

Map
Results
More info

Apple Scab Summary for Belchertown

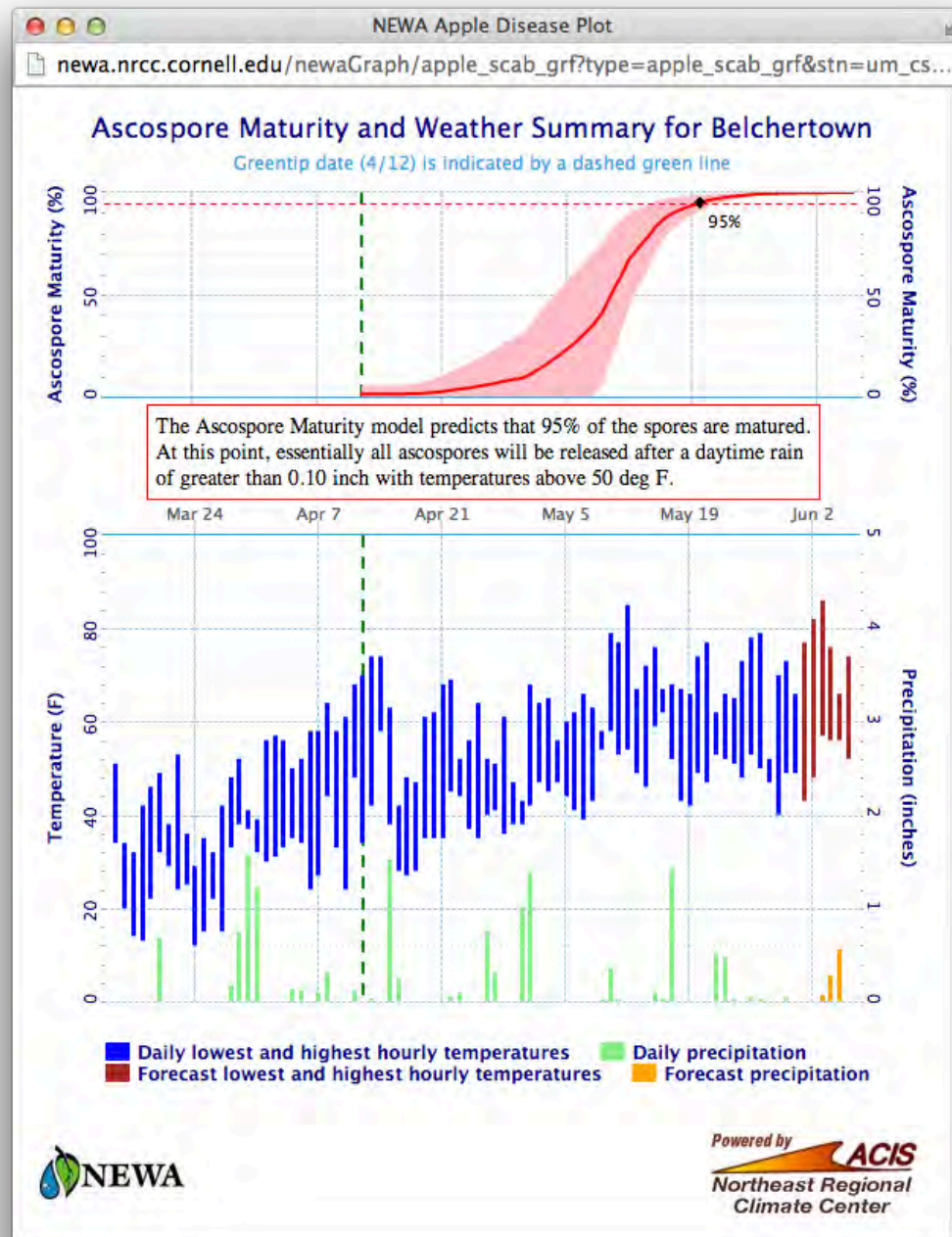
	Past	Past	Current	5-Day Forecast			Forecast Details	
	May 28	May 29	May 30	May 31	Jun 1	Jun 2	Jun 3	Jun 4
Ascospore Maturity	99%	100%	100%	100%	100%	100%	100%	100%
<u>Infection Events</u>	-	-	No					
Days to Symptoms	-	-	NA					
Wetness Events								
Rain Amount	0.02	0.00	0.07	0.12	0.00	0.00	0.07	0.30
Rain Prob (%) Night Day ?			- -	- -	- -	- -	- -	- -
Dew ?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Leaf Wetness (hours)	9	9	7	20	1	0	6	9

NA - not applicable

Download Time: 5/30/2014 23:00

Apple Scab Infection Events (March 1 - July 30)

Start Date & Time	End Date & Time	Wet Hours	Temp Avg. (F)	Rain (in.)	Days to Symptoms	Combined Event
July 27 9:01 AM	July 29 3:00 AM	15	67	0.95	9-10	Yes
July 23 8:01 PM	July 24 8:00 AM	12	67	0.96	9-10	
July 13 8:01 PM	July 16 12:00 PM	45	70	1.77	9-10	Yes
July 9 10:01 PM	July 10 8:00 AM	10	62	0.33	9-10	
July 7 8:01 PM	July 8 8:00 AM	12	69	0.07	9-10	
July 2 5:01 PM	July 5 4:00 AM	45	66	2.22	9-10	Yes
June 26 12:01 AM	June 26 8:00 AM	8	68	0.32	9-10	
June 13 10:01 AM	June 14 9:00 AM	21	62	0.48	9-10	Yes
June 3 9:01 PM	June 5 2:00 PM	19	60	0.69	12-13	Yes
May 30 5:01 PM	May 31 8:00 AM	15	52	0.07	15	
May 27 6:01 PM	May 28 9:00 AM	14	49	0.06	17	Yes
May 22 10:01 AM	May 26 10:00 AM	41	54	1.15	14	Yes
May 15 10:01 PM	May 17 9:00 AM	28	62	1.61	9-10	Yes
May 9 6:01 AM	May 11 5:00 AM	38	58	0.45	12-13	Yes
April 29 9:01 PM	May 2 5:00 AM	42	44	2.44	17	Yes
April 26 2:01 AM	April 27 2:00 PM	28	42	1.09	17	Yes
April 22 8:01 PM	April 23 2:00 PM	16	48	0.17	17	Yes
April 15 7:01 AM	April 16 1:00 AM	18	53	1.63	15	
April 11 4:01 PM	April 13 11:00 AM	20	46	0.20	17	Yes
April 7 8:01 PM	April 10 3:00 AM	55	46	0.44	17	
March 28 11:01 AM	March 31 2:00 PM	69	39	3.64	-	Yes
Dry conditions last 34 hours at download		Download Time: 7/30/2014 13:00				



- E-Weather TM
- Max, min temp; inches precip.; leaf wetness; rh
- AgWeather IPM Apple Disease Product (output described below)
- <http://www.skybit.com>

Apple Scab Disease Information	
ASM	Ascospore Maturity expressed as a percentage.
AW	Accumulated Wetness hours for a continuous wetness event. In the case of multiple events in a day, this value represents the most severe event.
TW	Average Temperatures during those wetness hours.
PW	Pest Wait/Watch/Warning status given as not active (-), active but not infectious (+), and infectious with possible damage(++).

E-WEATHER SERVICE
For: MA-BELCHERTOWN-HORTRESCENTER

						APPLE SCAB			
WEATHER						140414			
	TMX	TMN	PREC	ARH	LW	ASM	AW	TW	PW
Date	F	F	in	%	hr	%	hr	F	
=====	=====	=====	=====	=====	=====	=====	=====	=====	=====
BASED ON OBSERVATIONS									
0401	54	32	0.00	58	0	-	-	-	-
0402	56	31	0.00	66	0	-	-	-	-
0403	54	32	0.00	51	0	-	-	-	-
0404	48	36	0.19	62	6	-	-	-	-
0405	49	36	0.10	67	12	-	-	-	-
0406	55	31	0.00	46	0	-	-	-	-
0407	56	32	0.14	55	5	-	-	-	-
0408	61	43	0.39	78	15	-	-	-	-
0409	55	35	0.00	47	0	-	-	-	-
0410	58	28	0.00	44	0	-	-	-	-
0411	65	47	0.18	61	9	-	-	-	-
0412	67	41	0.02	55	9	-	-	-	-
0413	67	43	0.06	65	5	-	-	-	-
0414	72	54	0.00	67	0	0	0	-	-
0415	62	34	1.40	89	20	0	20	54	++
0416	42	28	0.14	53	7	0	27	48	++
0417	45	26	0.00	55	0	0	0	-	+
0418	47	26	0.00	66	0	0	0	-	+
0419	61	33	0.00	52	0	0	0	-	+
0420	57	31	0.00	45	0	0	0	-	+
0421	68	31	0.00	45	0	0	0	-	+
0422	69	44	0.03	61	5	0	5	54	+
0423	52	44	0.22	70	15	0	20	50	++
0424	57	39	0.00	33	0	1	0	-	+
0425	62	35	0.00	38	0	1	0	-	+
0426	49	42	0.97	84	24	1	24	45	++
0427	51	41	0.06	71	16	1	34	44	++
0428	59	37	0.00	58	0	1	0	-	+
0429	46	40	0.03	72	4	1	2	43	+
0430	44	39	1.41	87	24	1	26	42	++

E-WEATHER SERVICE
For: MA-BELCHERTOWN-HORTRESCENTER

APPLE SCAB										
140414										
WEATHER										
	TMX	TMN	PREC	ARH	LW		ASM	AW	TW	PW
Date	F	F	in	%	hr		%	hr	F	
=====										
BASED ON OBSERVATIONS										
0501	65	44	1.01	88	24		2	50	47	+
0502	63	47	0.00	56	8		2	58	48	++
0503	64	44	0.00	58	0		3	0	-	+
0504	58	48	0.00	58	0		3	0	-	+
0505	61	47	0.00	56	0		4	0	-	+
0506	61	41	0.00	50	0		5	0	-	+
0507	65	36	0.00	45	0		6	0	-	+
0508	64	42	0.00	67	0		8	0	-	+
0509	58	53	0.11	87	23		10	23	56	++
0510	78	58	0.55	78	20		14	8	65	++
0511	77	54	0.00	39	5		19	13	63	++
0512	83	50	0.00	47	0		26	0	-	+
0513	60	48	0.00	59	0		31	0	-	+
0514	70	47	0.00	62	0		38	0	-	+
0515	73	59	0.12	80	10		47	5	68	+
0516	66	63	0.41	88	24		56	29	65	++
0517	69	50	1.47	63	10		63	39	64	++
0518	66	45	0.00	48	0		69	0	-	+
0519	65	45	0.00	45	0		74	0	-	+
0520	73	49	0.00	48	0		80	0	-	+
0521	73	46	0.00	57	0		84	0	-	+
0522	60	53	0.52	86	15		87	15	57	++
0523	62	53	0.63	86	22		90	30	57	++
0524	64	52	0.00	79	12		92	18	55	++
0525	71	50	0.01	74	12		94	13	56	++
0526	79	53	0.01	64	4		96	4	58	+
0527	74	50	0.45	72	11		97	11	60	++
0528	52	45	0.09	86	15		98	26	54	++
0529	66	40	0.01	65	4		98	1	59	+
0530	69	47	0.14	73	8		99	8	56	++
0531	65	48	0.01	70	11		99	18	55	++

E-WEATHER SERVICE
For: MA-BELCHERTOWN-HORTRESCENTER

APPLE SCAB 140414									
WEATHER									
	TMX	TMN	PREC	ARH	LW	ASM	AW	TW	PW
Date	F	F	in	%	hr	%	hr	F	
-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
BASED ON OBSERVATIONS									
0601	74	45	0.00	54	0	99	0	-	+
0602	80	50	0.01	55	1	99	1	50	+
0603	82	55	0.11	67	5	100	5	63	+
0604	70	59	0.04	78	11	100	16	62	++
0605	66	58	0.42	85	23	100	23	61	++
0606	72	56	0.00	65	0	100	0	-	+
0607	80	54	0.00	62	0	100	0	-	+
BASED ON FORECASTS									
0608	82	57	0.00	61	0	100	0	-	+
0609	71	61	0.03	74	9	100	9	68	++
0610	76	59	-----	77	9	100	9	64	++
0611	74	59	-----	74	7	100	7	64	++
0612	73	57	-----	78	8	100	3	67	+
0613	77	61	-----	83	24	100	27	69	++
0614	79	62	-----	78	24	100	51	70	++
0615	76	59	-----	72	10	100	61	69	++
0616	76	57	-----	71	4	100	4	60	+
0617	76	55	-----	69	4	100	4	58	+

E-WEATHER SERVICE
For: MA-BELCHERTOWN-HORTRESCENTER

WEATHER						APPLE SCAB			
140414									
Date	TMX	TMN	PREC	ARH	LW	ASM	AW	TW	PW
	F	F	in	%	hr	%	hr	F	
BASED ON OBSERVATIONS									
0401	54	32	0.00	58	0	-	-	-	-
0402	56	31	0.00	66	0	-	-	-	-
0403	54	32	0.00	51	0	-	-	-	-
0404	48	36	0.19	62	6	-	-	-	-
0405	49	36	0.10	67	12	-	-	-	-
0406	55	31	0.00	46	0	-	-	-	-
0407	56	32	0.14	55	5	-	-	-	-
0408	61	43	0.39	78	15	-	-	-	-
0409	55	35	0.00	47	0	-	-	-	-
0410	58	28	0.00	44	0	-	-	-	-
0411	65	47	0.18	61	9	-	-	-	-
0412	67	41	0.02	55	9	-	-	-	-
0413	67	43	0.06	65	5	-	-	-	-
0414	72	54	0.00	67	0	0	0	-	-
0415	62	34	1.40	89	20	0	20	54	++
0416	42	28	0.14	53	7	0	27	48	++
0417	45	26	0.00	55	0	0	0	-	+
0418	47	26	0.00	66	0	0	0	-	+
0419	61	33	0.00	52	0	0	0	-	+
0420	57	31	0.00	45	0	0	0	-	+
0421	68	31	0.00	45	0	0	0	-	+
0422	69	44	0.03	61	5	0	5	54	+
0423	52	44	0.22	70	15	0	20	50	++
0424	57	39	0.00	33	0	1	0	-	+
0425	62	35	0.00	38	0	1	0	-	+
0426	49	42	0.97	84	24	1	24	45	++
0427	51	41	0.06	71	16	1	34	44	++
0428	59	37	0.00	58	0	1	0	-	+
0429	46	40	0.03	72	4	1	2	43	+
0430	44	39	1.41	87	24	1	26	42	++

E-WEATHER
For: MA-BI

E-WEATHER SERVICE
For: MA-BELCHERTOWN-HORTRESCENTER

WEATHER						APPLE SCAB			
140414									
Date	TMX	TMN	PREC	ARH	LW	ASM	AW	TW	PW
	F	F	in	%	hr	%	hr	F	
BASED ON OBSERVATIONS									
0501	65								
0502	63								
0503	64								
0504	58								
0505	61								
0506	61								
0507	65								
0508	64								
0509	58								
0510	78								
0511	77								
0512	83								
0513	60								
0514	70								
0515	73								
0516	66								
0517	69								
0518	66								
0519	65								
0520	73								
0521	73								
0522	60								
0523	62								
0524	64								
0525	71								
0526	79								
0527	74								
0528	52								
0529	66								
0530	69								
0531	65								
BASED ON FORECASTS									
0601	74	45	0.00	54	0	99	0	-	+
0602	80	50	0.01	55	1	99	1	50	+
0603	82	55	0.11	67	5	100	5	63	+
0604	70	59	0.04	78	11	100	16	62	++
0605	66	58	0.42	85	23	100	23	61	++
0606	72	56	0.00	65	0	100	0	-	+
0607	80	54	0.00	62	0	100	0	-	+
0608	82	57	0.00	61	0	100	0	-	+
0609	71	61	0.03	74	9	100	9	68	++
0610	76	59	-----	77	9	100	9	64	++
0611	74	59	-----	74	7	100	7	64	++
0612	73	57	-----	78	8	100	3	67	+
0613	77	61	-----	83	24	100	27	69	++
0614	79	62	-----	78	24	100	51	70	++
0615	76	59	-----	72	10	100	61	69	++
0616	76	57	-----	71	4	100	4	60	+
0617	76	55	-----	69	4	100	4	58	+

E-WEATHER SERVICE
For: MA-BELCHERTOWN-HORTRESCENTER

APPLE SCAB									
140414									
WEATHER									
	TMX	TMN	PREC	ARH	LW	ASM	AW	TW	PW
Date	F	F	in	%	hr	%	hr	F	
----	----	----	-----	----	--	-----	--	----	--
BASED ON OBSERVATIONS									
0401	54	32	0.00	58	0	-	-	-	-
0402	56	31	0.00	66	0	-	-	-	-
0403	54	32	0.00	51	0	-	-	-	-
0404	48	36	0.19	62	6	-	-	-	-
0405	49	36	0.10	67	12	-	-	-	-
0406	55	31	0.00	46	0	-	-	-	-
0407	56	32	0.14	55	5	-	-	-	-
0408	61	43	0.39	78	15	-	-	-	-
0409	55	35	0.00	47	0	-	-	-	-
0410	58	28	0.00	44	0	-	-	-	-
0411	65	47	0.18	61	9	-	-	-	-
0412	67	41	0.02	55	9	-	-	-	-
0413	67	43	0.06	65	5	-	-	-	-
0414	72	54	0.00	67	0	0	0	-	-
0415	62	34	1.40	89	20	0	20	54	++
0416	42	28	0.14	53	7	0	27	48	++
0417	45	26	0.00	55	0	0	0	-	+
0418	47	26	0.00	66	0	0	0	-	+
0419	61	33	0.00	52	0	0	0	-	+
0420	57	31	0.00	45	0	0	0	-	+
0421	68	31	0.00	45	0	0	0	-	+
0422	69	44	0.03	61	5	0	5	54	+
0423	52	44	0.22	70	15	0	20	50	++
0424	57	39	0.00	33	0	1	0	-	+
0425	62	35	0.00	38	0	1	0	-	+
0426	49	42	0.97	84	24	1	24	45	++
0427	51	41	0.06	71	16	1	34	44	++
0428	59	37	0.00	58	0	1	0	-	+
0429	46	40	0.03	72	4	1	2	43	+
0430	44	39	1.41	87	24	1	26	42	++

E-WEATHER SERVICE
For: MA-BELCHERTOWN-HORTRESCENTER

APPLE SCAB 140414									
WEATHER									
	TMX	TMN	PREC	ARH	LW	ASM	AW	TW	PW
Date	F	F	in	%	hr	%	hr	F	
BASED ON OBSERVATIONS									
0501	65	44	1.01	88	24	2	50	47	++
0502	63	47	0.00	56	8	2	58	48	++
0503	64	44	0.00	58	0	3	0	-	+
0504	58	48	0.00	58	0	3	0	-	+
0505	61	47	0.00	56	0	4	0	-	+
0506	61	41	0.00	50	0	5	0	-	+
0507	65	36	0.00	45	0	6	0	-	+
0508	64	42	0.00	67	0	8	0	-	+
0509	58	53	0.11	87	23	10	23	56	++
0510	78	58	0.55	78	20	14	8	65	++
0511	77	54	0.00	39	5	19	13	63	++
0512	83	50	0.00	47	0	26	0	-	+
0513	60	48	0.00	59	0	31	0	-	+
0514	70	47	0.00	62	0	38	0	-	+
0515	73	59	0.12	80	10	47	5	68	+
0516	66	63	0.41	88	24	56	29	65	++
0517	69	50	1.47	63	10	63	39	64	++
0518	66	45	0.00	48	0	69	0	-	+
0519	65	45	0.00	45	0	74	0	-	+
0520	73	49	0.00	48	0	80	0	-	+
0521	73	46	0.00	57	0	84	0	-	+
0522	60	53	0.52	86	15	87	15	57	++
0523	62	53	0.63	86	22	90	30	57	++
0524	64	52	0.00	79	12	92	18	55	++
0525	71	50	0.01	74	12	94	13	56	++
0526	79	53	0.01	64	4	96	4	58	+
0527	74	50	0.45	72	11	97	11	60	++
0528	52	45	0.09	86	15	98	26	54	++
0529	66	40	0.01	65	4	98	1	59	+
0530	69	47	0.14	73	8	99	8	56	++
0531	65	48	0.01	70	11	99	18	55	++

E-WEATHER SERVICE
For: MA-BELCHERTOWN-HORTRESCENTER

APPLE SCAB 140414									
WEATHER									
	TMX	TMN	PREC	ARH	LW	ASM	AW	TW	PW
Date	F	F	in	%	hr	%	hr	F	
BASED ON OBSERVATIONS									
0601	74	45	0.00	54	0	99	0	-	+
0602	80	50	0.01	55	1	99	1	50	+
0603	82	55	0.11	67	5	100	5	63	+
0604	70	59	0.04	78	11	100	16	62	++
0605	66	58	0.42	85	23	100	23	61	++
0606	72	56	0.00	65	0	100	0	-	+
0607	80	54	0.00	62	0	100	0	-	+
BASED ON FORECASTS									
0608	82	57	0.00	61	0	100	0	-	+
0609	71	61	0.03	74	9	100	9	68	++
0610	76	59	-----	77	9	100	9	64	++
0611	74	59	-----	74	7	100	7	64	++
0612	73	57	-----	78	8	100	3	67	+
0613	77	61	-----	83	24	100	27	69	++
0614	79	62	-----	78	24	100	51	70	++
0615	76	59	-----	72	10	100	61	69	++
0616	76	57	-----	71	4	100	4	60	+
0617	76	55	-----	69	4	100	4	58	+

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AgRadar



- Formerly Orchard Radar
- Data source is SkyBit E-Weather™ product
- Disease and insect models (and horticulture!)
- <http://extension.umaine.edu/ipm/programs/apple/pestcasts/>

SCAB BIOLOGY

DAILY PRIMARY SCAB Infection Chart

Comprehensive estimate of relative primary scab infection risk. Absolute risk depends on infection pressure, cultivar, site, pruning etc.

[Daily primary scab infections in TABLE format](#)

CUMULATIVE PRIMARY SCAB potential and release

[Scab ascospore maturity chart](#) – Less useful than comprehensive ratings shown above.

[Scab ascospore maturity table](#)

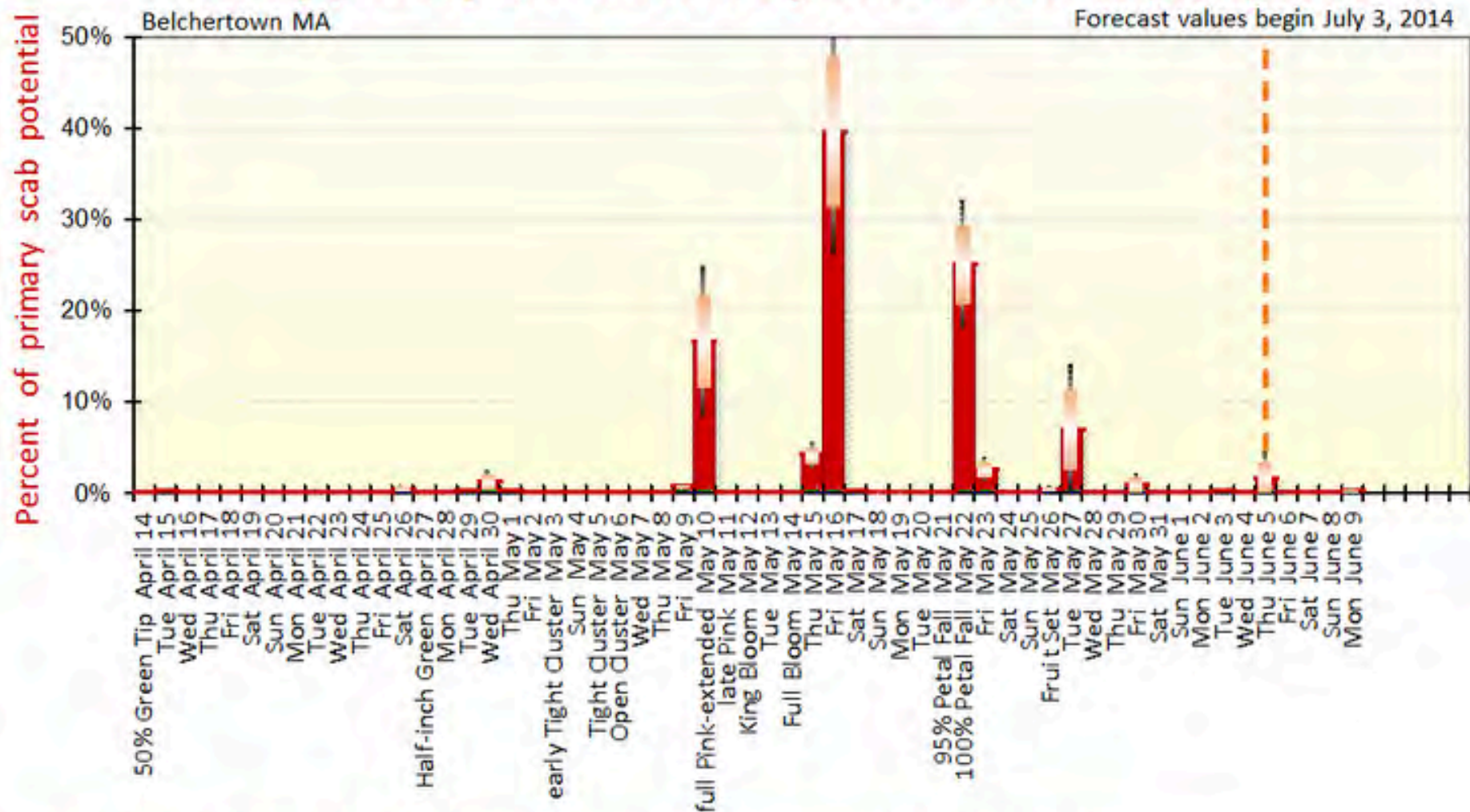
Primary scab infection periods: DETAILS

Timing and severity for each rain event during primary scab season.

Primary & secondary scab infection periods: Summary

Same as above but covers wetting periods throughout the growing season in less detail.

Daily primary scab infection potential as % of yearly total



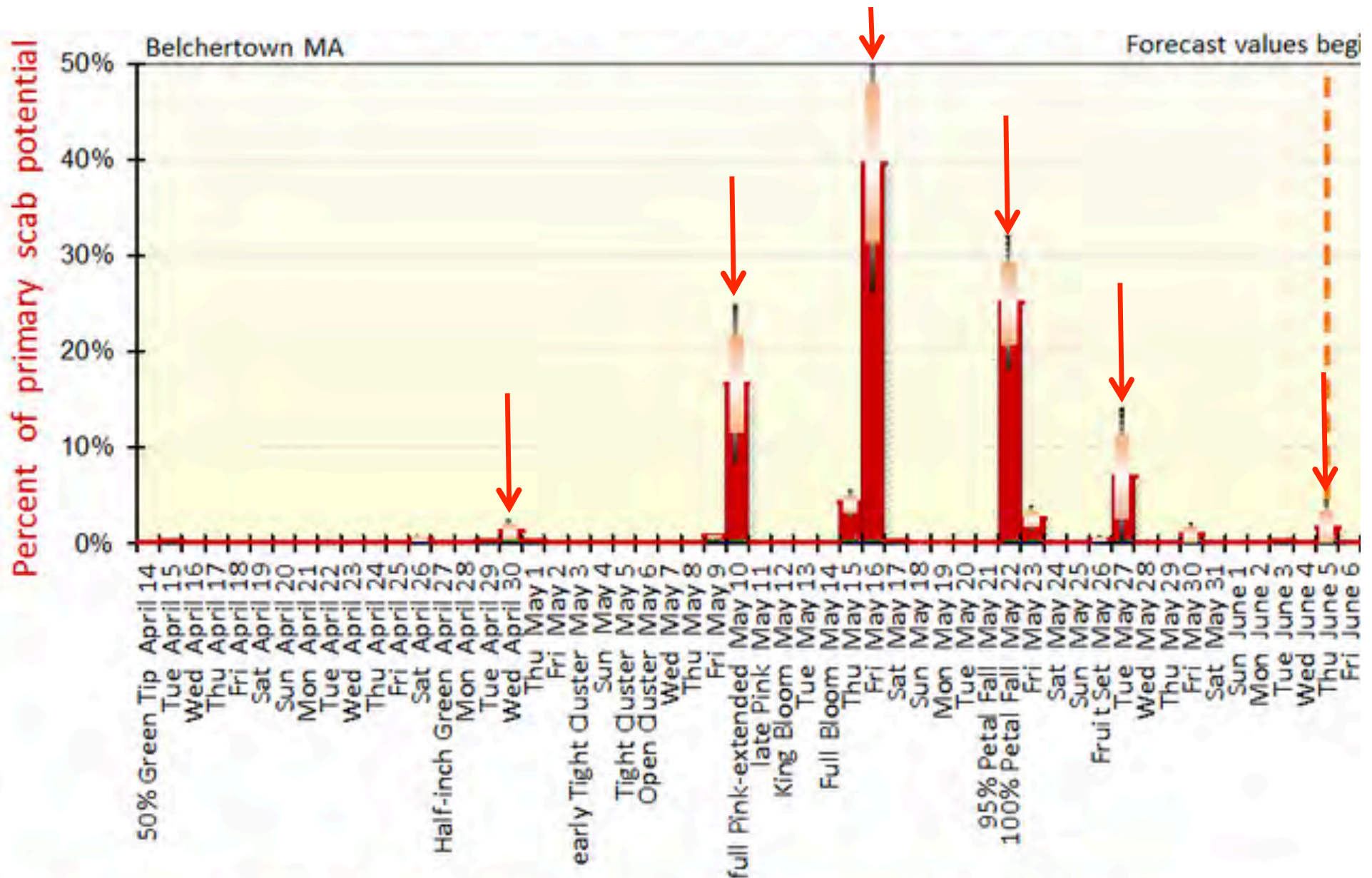
Top of wide red bar shows best estimate of primary scab ascospore infection potential.

White-to-light red shaded narrow boxes overlaid on red bars show range expected to contain the true value most of the time (68% confidence interval). Vertical black bars show wider range of 90% confidence interval.

Vertical green line = today's date. Vertical dotted green line = end of forecast range.

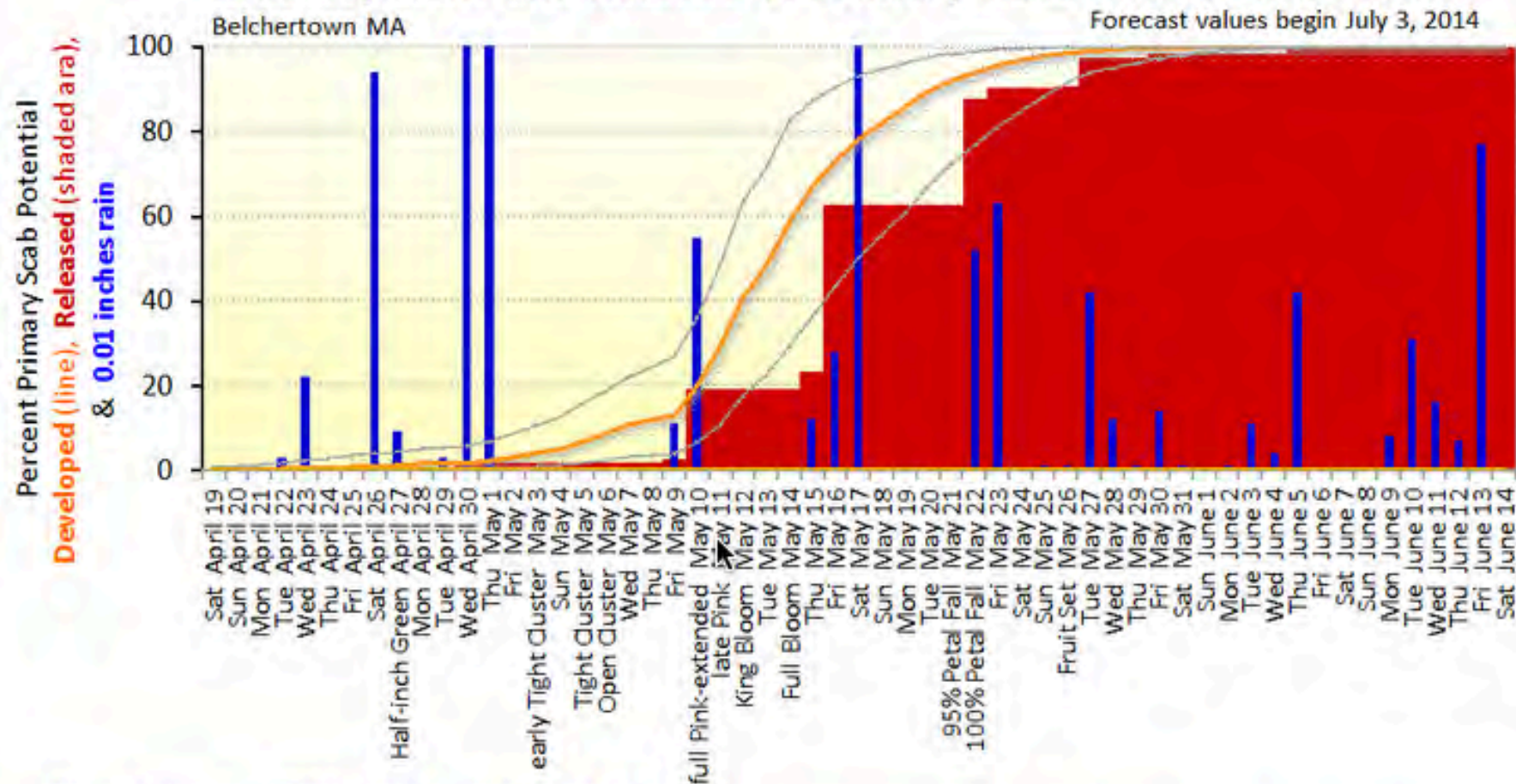
Vertical orange dotted line = date of final significant primary scab infection period (estimated 99+% cumulative spore release, and 95% chance of at least 95% cumulative spore release).

Infection potential rating is for scab ascospores (i.e. primary scab) only. Uncontrolled infections can produce secondary scab spores that magnify infection risk beyond what is indicated by this chart 9-17 days (depending on temperatures) after the infection period.



- Set threshold at $\geq 1\%$ of “scab potential” get **6** infections
- Last ascospores released June 5

Development and Release of Primary Scab Infection Potential



Blue columns show 100ths of inch rain for each date.

Rising thick orange line = cumulative primary scab infection potential developed by that date.

Rising thin gray lines with triangle markers = 90% high and low error bar values for estimate of cumulative infection potential developed, but not necessarily released, by each date.

Solid red area under orange line shows estimated cumulative percent primary scab infection potential released by end of that date. The red area is below the maroon line unless a warm soaking daytime rain allows full expression of infection potential.

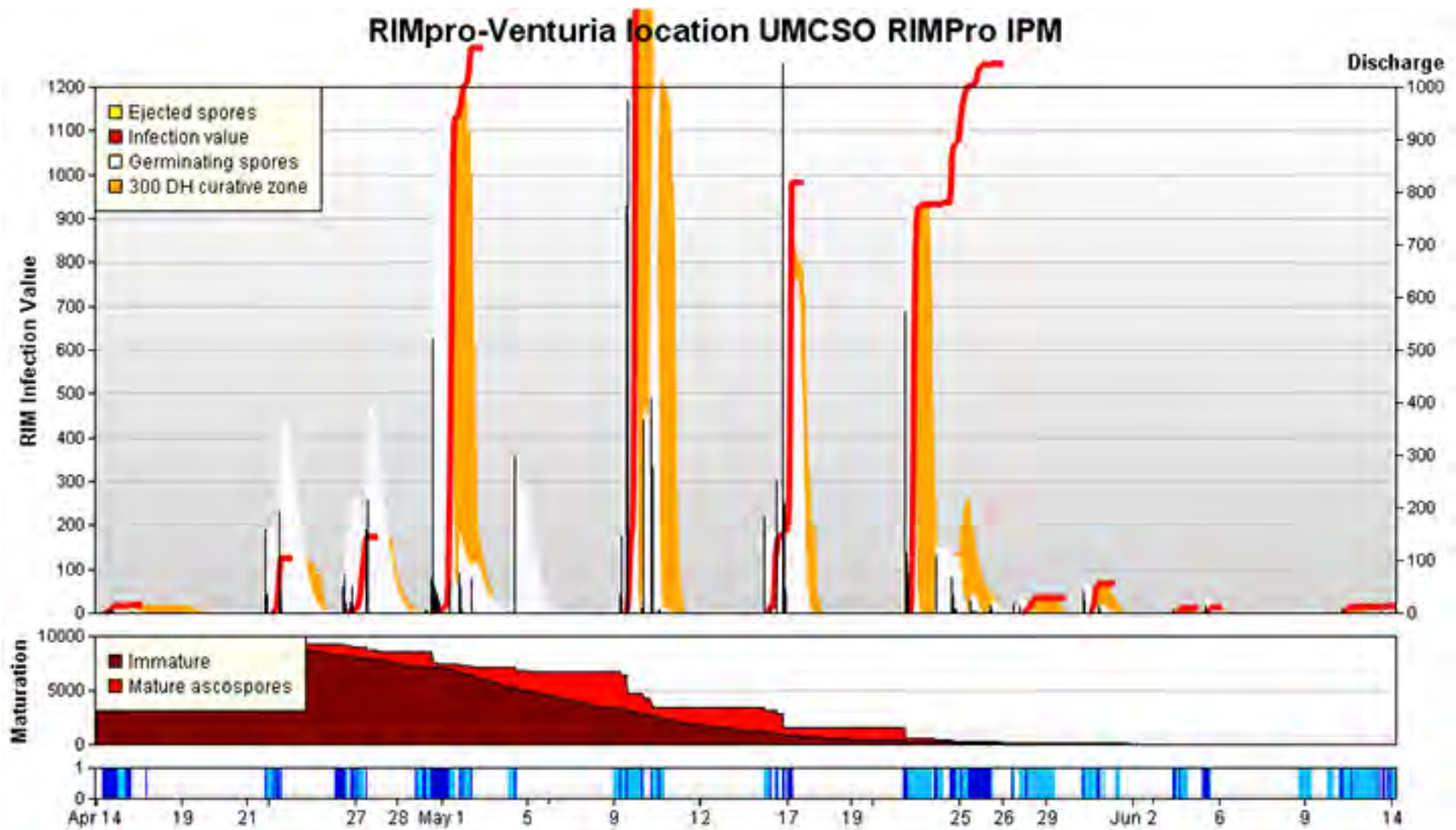
Vertical green line = today's date and beginning of forecast values. Vertical dotted green line = end of forecast range.

Note: This is a relative, not absolute, measure of scab infection severity. The number of scab ascospores per square meter of orchard is not included in these ratings. A high scab block can have 300,000 times more spores than a very low scab block. In high scab blocks even a small portion of the year's scab potential can cause significant infection! This chart represents risk from primary spore releases only. Secondary spore production from earlier uncontrolled infections can magnify infection potential.

RIMpro

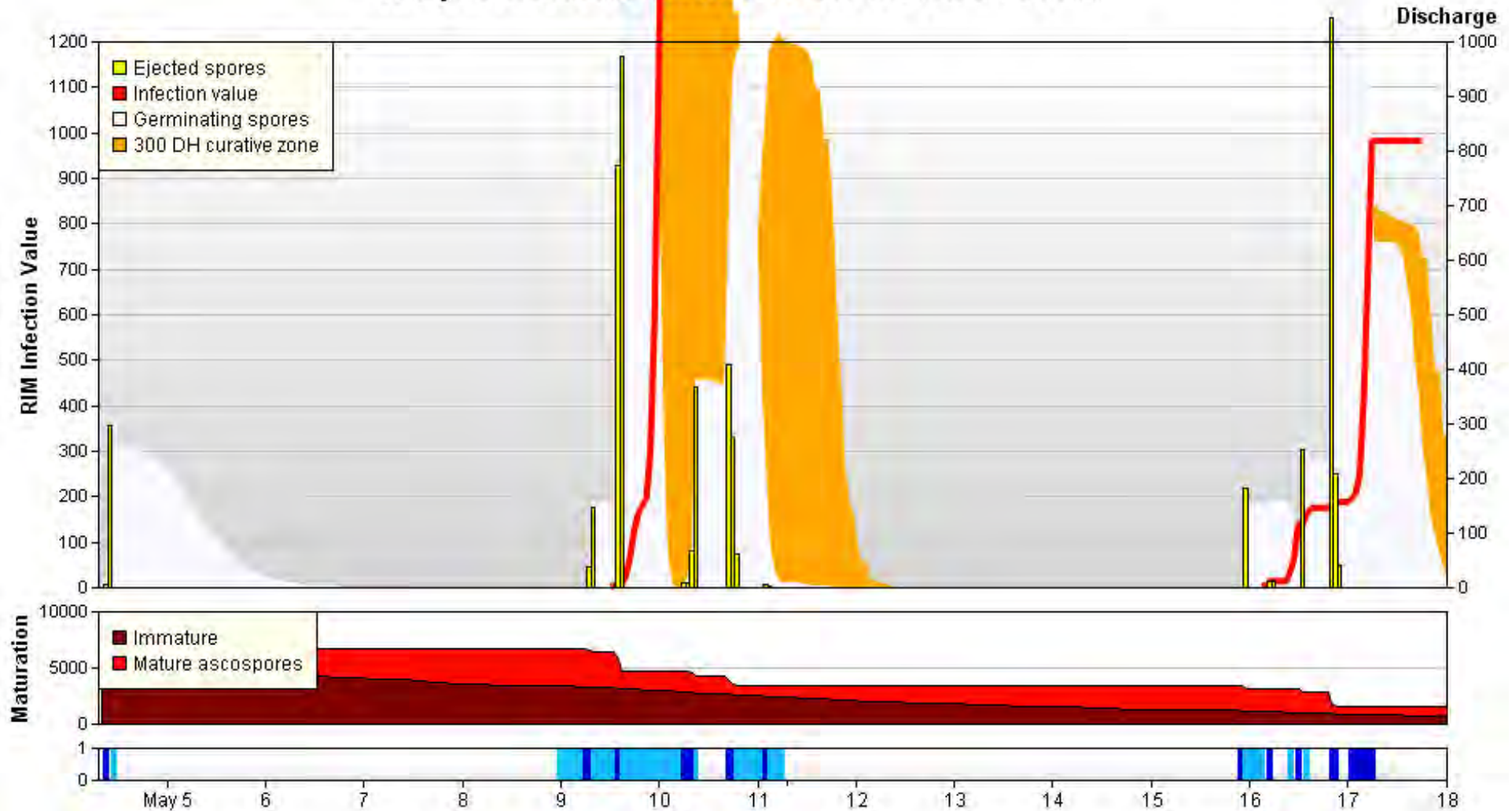
- Marc Trapman – Netherlands
- Relative Infection Measure Program
- Uses on-site weather station data
- Detailed picture of scab infection process
- <http://www.rimpro.eu>



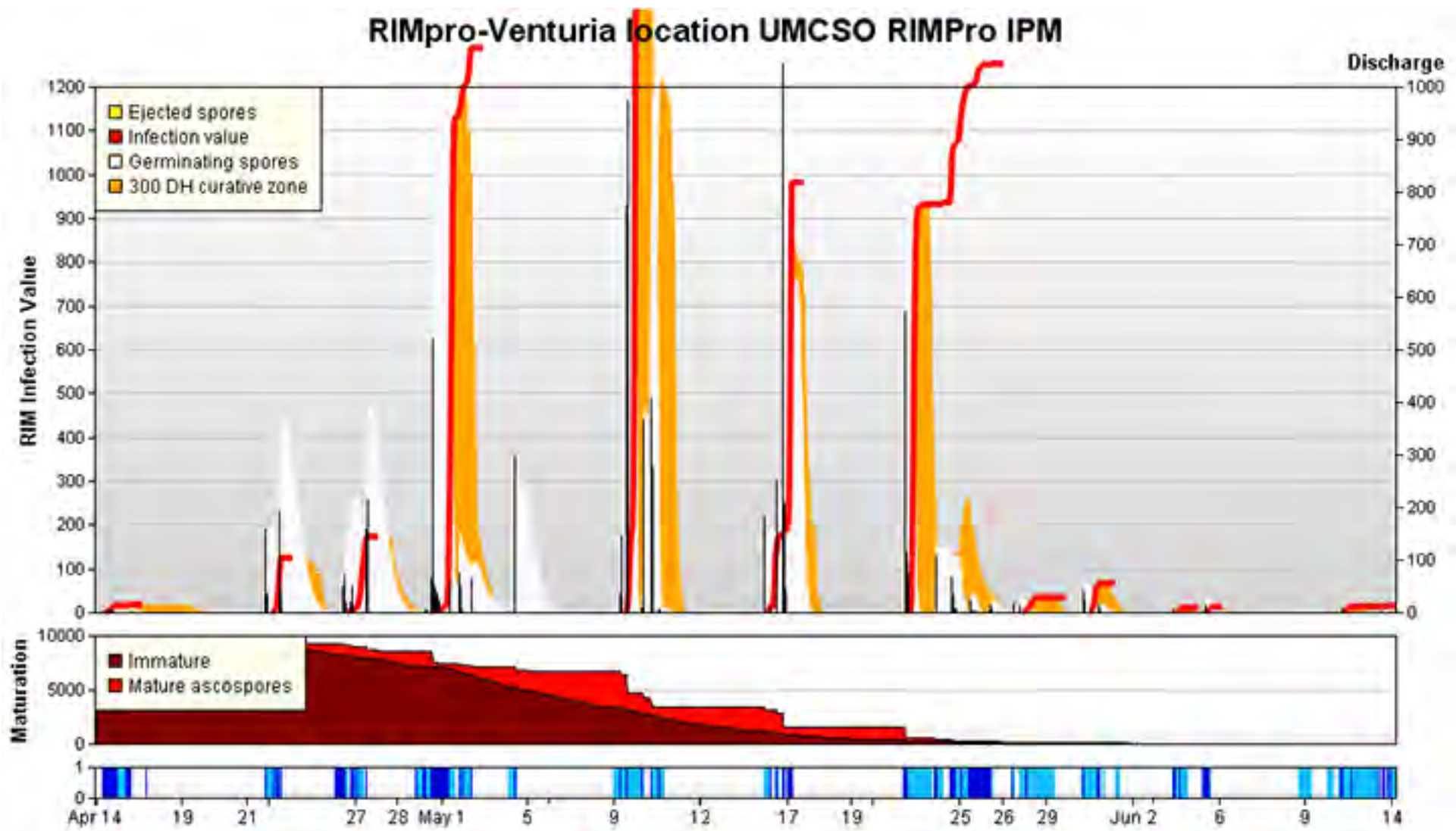


- RIM scale is arbitrary – values over 300 “a big deal”
- Some spores ejected, some not; some germinate, some don’t; some infect, some don’t

RIMpro-Venturia location UMCSO RIMPro IPM



- 3 infection periods here
- Spore release > germinating spores > infection value
- Curative zone = germ. spores still susceptible to fungicide



- Set RIM = 100 as threshold get **6** infection periods
- Last ascospores released June 3

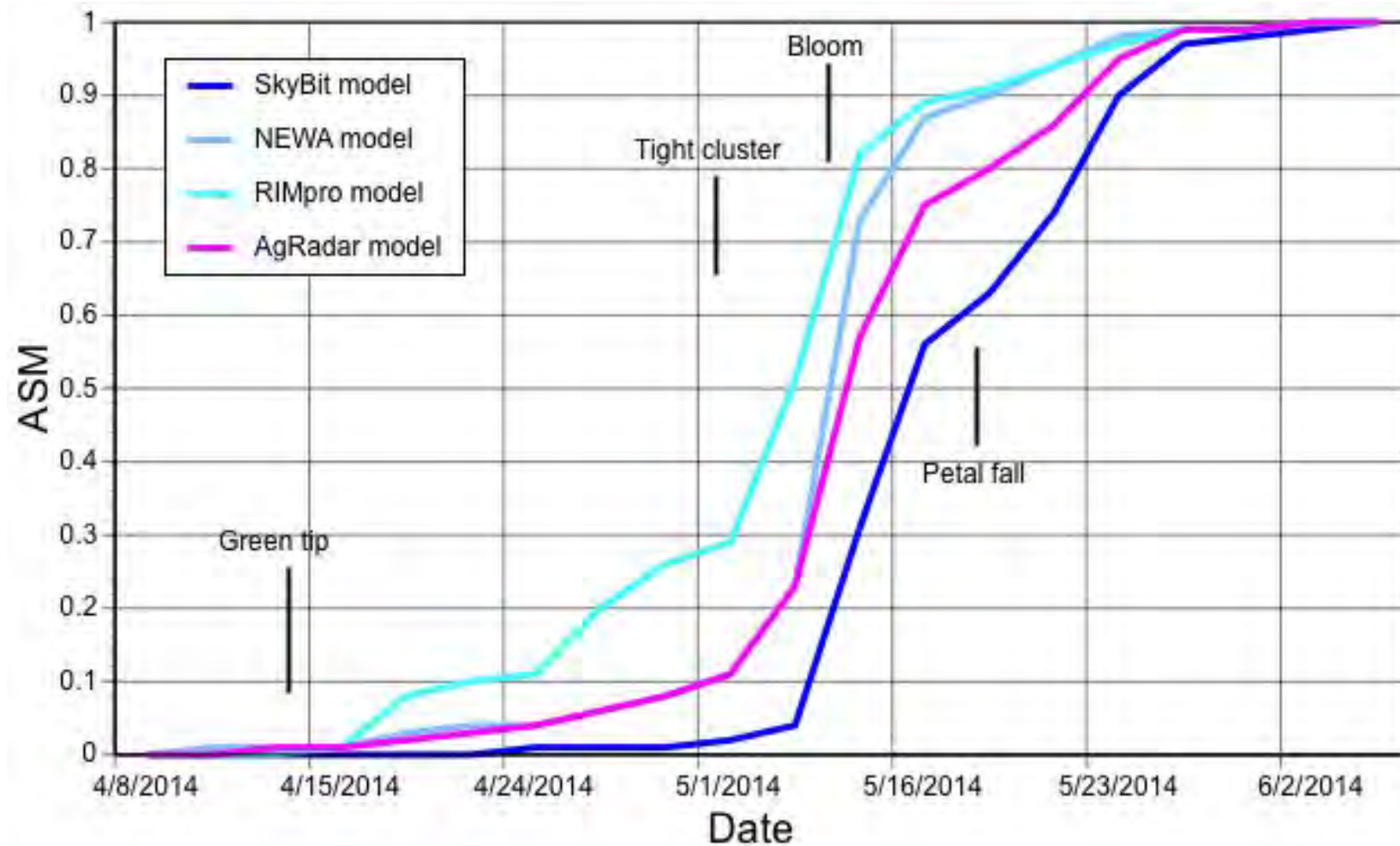
Comparison in terms of primary scab

Decision Support System	Number of Primary Infection Periods	Last Ascospore Release Date
NEWA	9	May 28
SkyBit	10	June 4
AgRadar	6	June 5
RIMpro	6	June 3

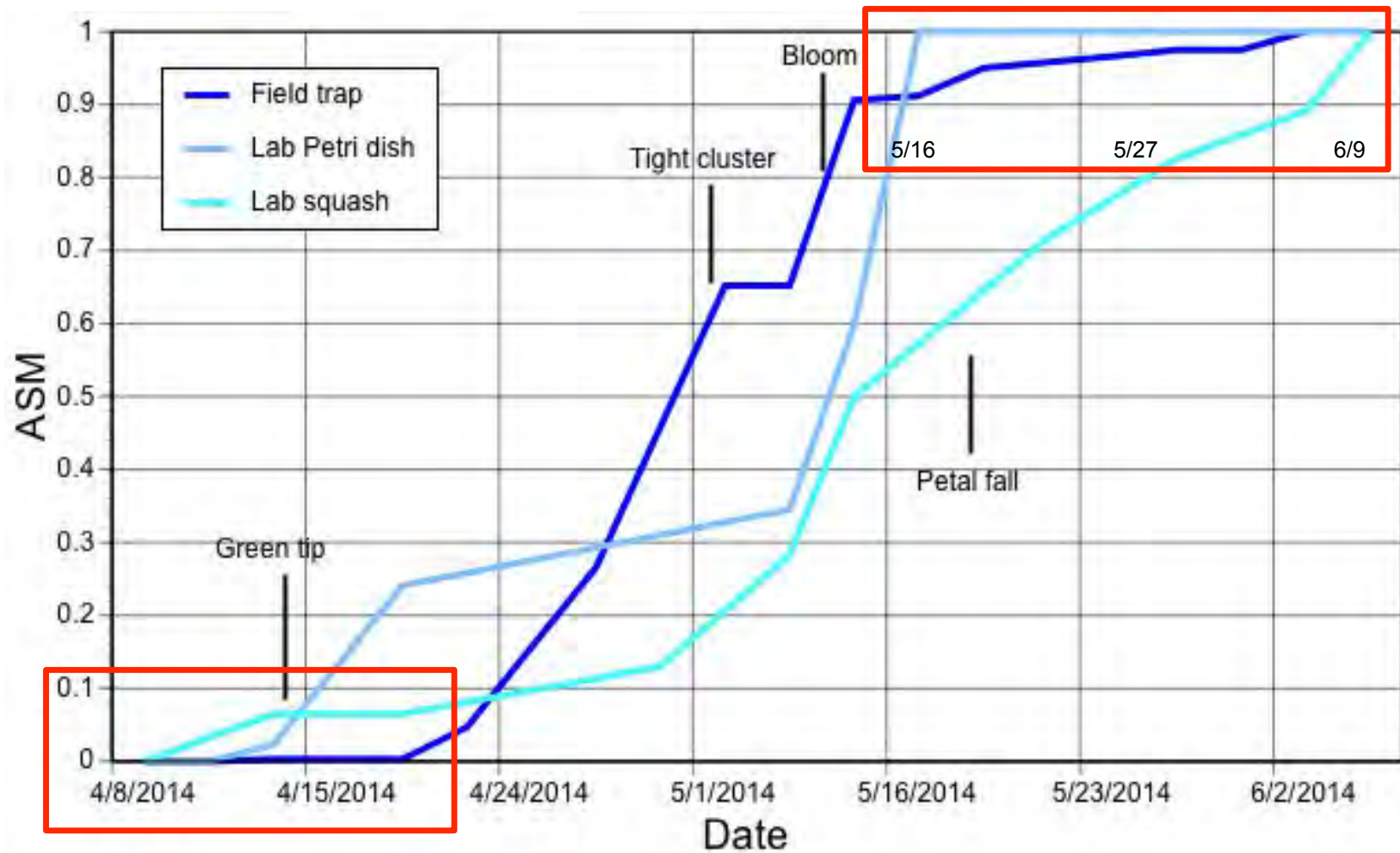
Comparison in terms of primary infection periods

Dates	NEWA	SkyBit	AgRadar	RIMpro
Apr 15-16	√	√		
Apr 22-24	√	√		√
Apr 26-27	√	√		√
Apr 29-May 2	√	√	√	√
May 9-11	√	√	√	√
May 15-17	√	√	√	√
May 22-25	√	√	√	√
May 27-28	√	√	√	
May 30-31	√	√		
June 4-5		√	√	
Total	9	10	6	6

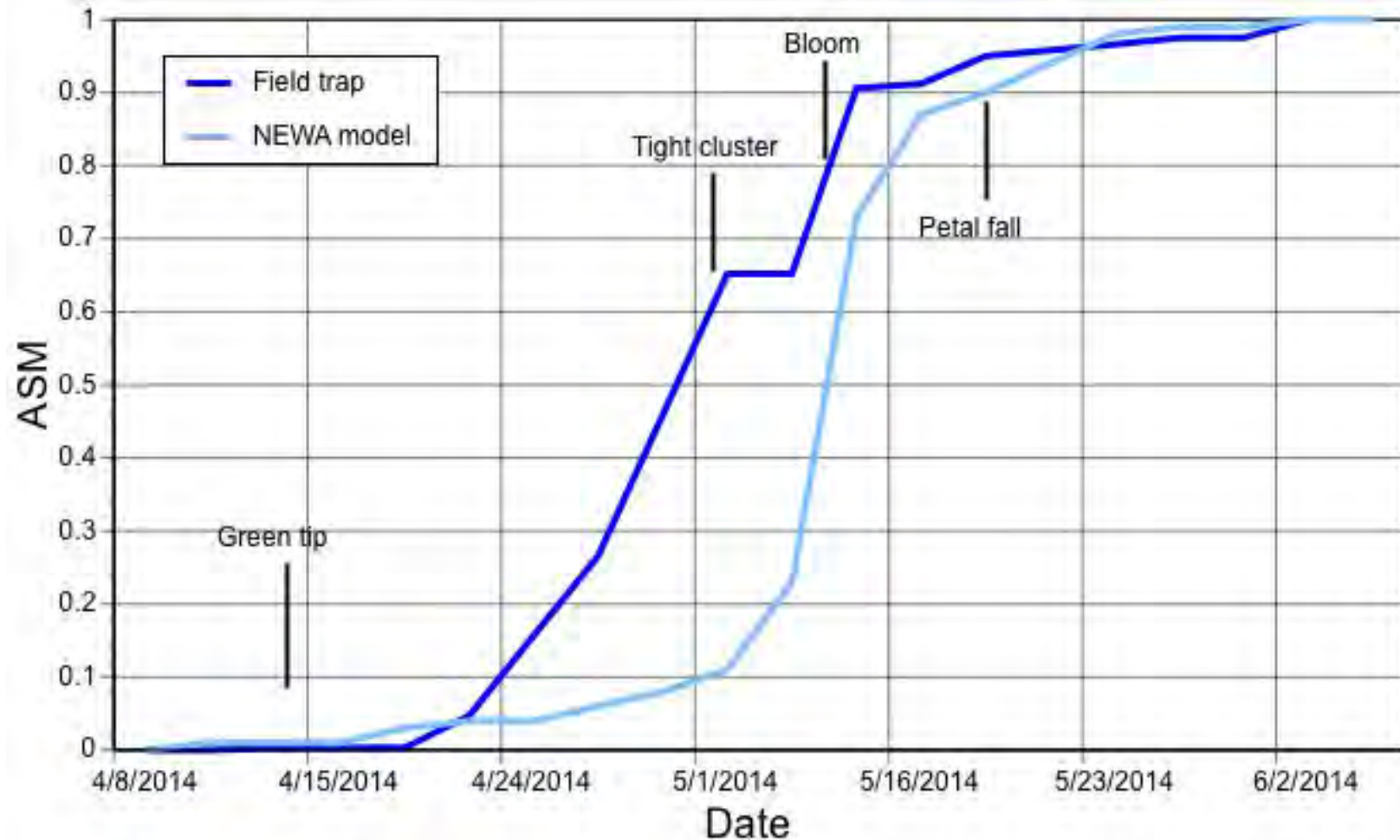
Ascospore maturity: DSS models



Ascospore maturity: trapping and lab assays



Ascospore maturity: observed and models



Does this matter in terms of fungicide applications?

- In order to determine need to apply a fungicide, need to know whether fungicide residue is effective
- Gap in knowledge of fungicide depletion
- AgRadar and RIMpro have depletion rules; NEWA and SkyBit do not
- Arbitrary rule:
- One week OR 1 inch rain OR one growth stage change
- Then need to reapply for next infection

Comparison in terms of recommended sprays

Infection Dates	Growth	NEWA	SkyBit	RIMpro	Cal.	AgRadar
Apr 15-16	green tip	√	√		√	√
Apr 22-24		√	√	√	√	
Apr 26-27	½" green					
Apr 29-May 2		√	√	√	√	√
May 9-11	pink	√	√	√	√	√
May 15-17	bloom	√	√	√	√	√
May 22-25	petal fall	√	√	√	√	√
May 27-28	fruit set					
May 30-31	fruit set	√		√	√	√
June 4-5	early fruit		√			
Total		7	7	6	7	6

Field trial

- Fungicide trial, McIntosh block, 3-tree reps, 6 reps, 6 treatments sprayed according to DSS
- NEWA, SkyBit, RIMpro IPM, calendar control, unsprayed control
- Applied the same fungicides to NEWA, SkyBit, RIMpro IPM and calendar – DSS determined timing

Comparison in terms of actual sprays

Dates	G.S.	Fungicide	NEWA	SkyBit	RIMpro	Cal.
Apr 22	gr. t.	copper hydroxide	√	√	√	√
Apr 28	½" g.	captan + mancozeb + kresoxim-methyl	√	√	√	√
May 1	t.c.	cyprodinil + mancozeb		√	√	
May 7	pink	difenoconazole/cyprodinil + mancozeb	√			√
May 9	pink	difenoconazole/cyprodinil + mancozeb		√	√	
May 14	bl.	kresoxim-methyl + mancozeb	√	√	√	√
May 21	p. f.	difenoconazole/cyprodinil + mancozeb	√	√	√	√
Jun 2	fr.	captan + mancozeb				√
Jun 3	fr.	captan + mancozeb	√	√	√	
Jun 13	fr.	fluxapyroxad/pyraclostrobin + captan	√	√	√	√
Total			7	8	8	7

Field trial

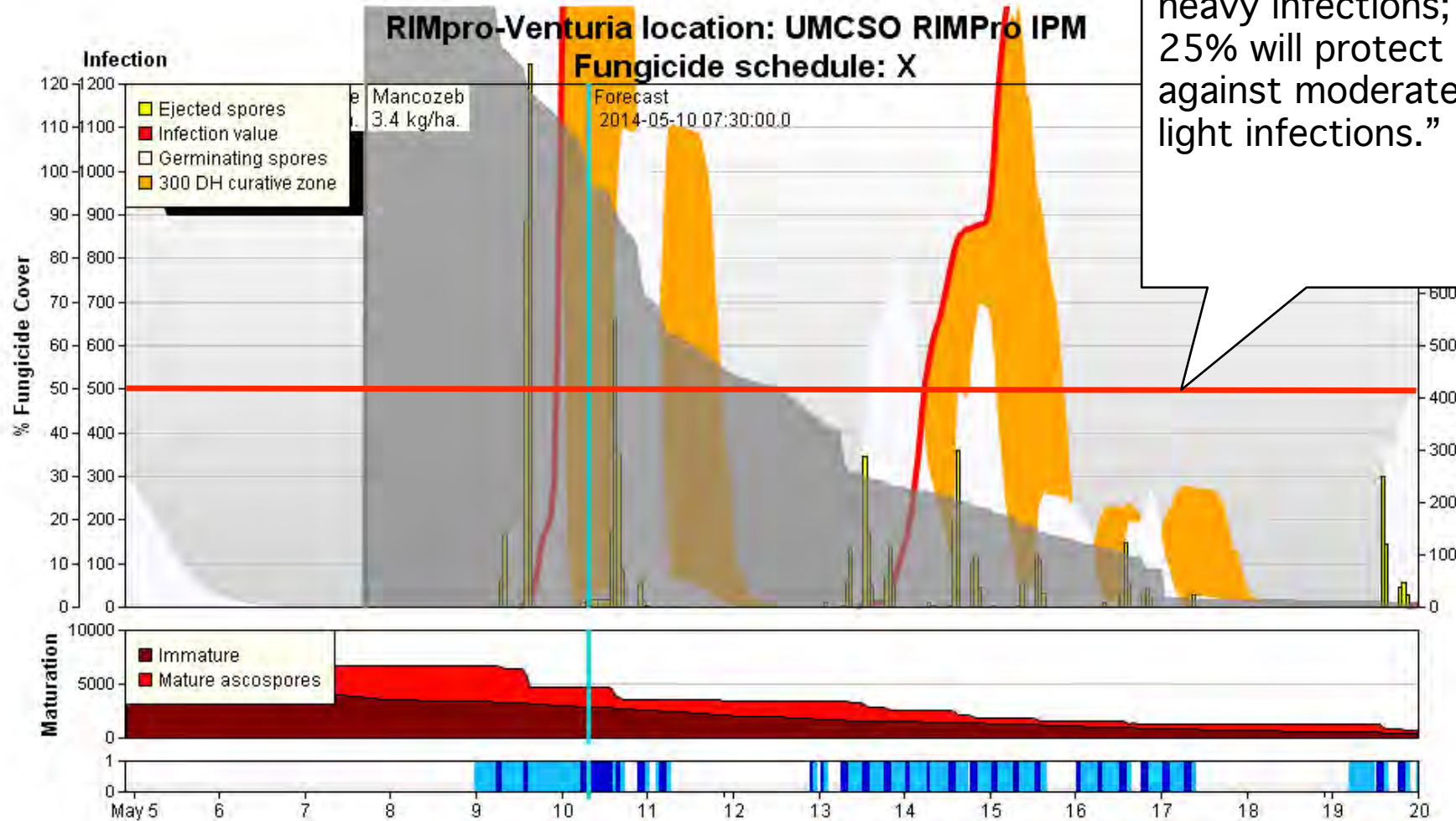
DSS	Leaf scab incidence*	Leaf scab severity**	Fruit scab rating***
NEWA	51.5% b	0.63 b	0.3 b
SkyBit	49.2% b	0.70 b	0.5 b
RIMpro IPM	50.9% b	0.65 b	0.3 b
Calendar	52.5% b	0.66 b	0.4 b
Control	100.0% a	7.15 a	2.1 a

* Differences significant at $p=0.05$ by Tukey's HSD

** Infected leaves per terminal

***0 = no scab; $1 \leq 10\%$; $2 \leq 50\%$; $3 > 50\%$

RIMpro estimates fungicide protection



AgRadar estimates of fungicide depletion

- Protectant fungicides – combination of time, rain and tree growth
- Basically 7 days OR 2 inches of rain adjusted for temperature (e.g. warm temps. decrease time)
- Systemic fungicides similar with 48 to 72 hr. post-infection activity

Full-dose 'Protectant' fungicide (captan, mancozeb, SDHI, Syllit) SPRAY DATE 6am application time assumed	Inches Rain	END of Protectant fungicide residue protection & limiting factor	DEADLINE for next Pre-Infection Application This is the start time for the next infection period that has rain after fungicide depletion time.	Deadline for post-infection fungicide to reach back to start time of subsequent infection period (1 col. to left), or back to depletion time of previous fungicide spray (2 cols. to left), whichever is later. Assumes no scab resistance.
Sat, April 19	0	April 24, 3PM rapid growth	Sat, April 26, 1am	Tue, Apr 29, 1AM
Sun, April 20	0	April 25, 3PM rapid growth	Sat, April 26, 1am	Tue, Apr 29, 1AM
Mon, April 21	0	April 26, 5PM rapid growth	Sat, April 26, 1am	Tue, Apr 29, 5PM If application is after deadline, lesions may start showing May 14.
Tue, April 22	0.03	April 29, 6AM 7 days normal growth	Sat, April 26, 1am	Fri, May 2, 6AM
Wed, April 23	0.22	April 30, 5PM rain removal	Tue, April 29, 11pm	Sat, May 3, 5PM
Thu, April 24	0	April 30, 6PM rain removal	Tue, April 29, 11pm	Sat, May 3, 6PM
Fri, April 25	0	May 1, 6AM rain removal	Tue, April 29, 11pm	Sun, May 4, 6AM

Full-dose STROBILURIN fungicide (Flint, Sovran, Pristine) SPRAY DATE 6am application time assumed	Inches Rain	END of STROBILURIN FUNGICIDE PROTECTION & limiting factor	DEADLINE for next Pre-Infection Application This is the start time for the next infection period that has rain after fungicide depletion time.	Deadline for post-infection fungicide to reach back to start time of subsequent infection period (1 col. to left), or back to depletion time of previous fungicide spray (2 cols. to left), whichever is later. Assumes no scab resistance.
Sat, April 19	0	Apr 23, 10 AM rapid growth	Tue, April 22, 8pm	Sat, Apr 26, 10AM
Sun, April 20	0	Apr 24, 6 PM rapid growth	Sat, April 26, 1am	Tue, Apr 29, 1AM
Mon, April 21	0	Apr 25, 3 PM rapid growth	Sat, April 26, 1am	Tue, Apr 29, 1AM
Tue, April 22	0.03	Apr 28, 6 AM 6 days normal growth	Sat, April 26, 1am	Thu, May 1, 6AM
Wed, April 23	0.22	Apr 29, 6 AM 6 days normal growth	Sat, April 26, 1am	Fri, May 2, 6AM
Thu, April 24	0	May 1, 6 AM slow growth at 7 day limit	Tue, April 29, 11pm	Sun, May 4, 6AM
Fri, April 25	0	May 2, 4 AM slow growth at 7 day limit	Fri, May 9, 2am	Mon, May 12, 2AM

Conclusions

- The four DSSs reported different numbers of primary infection periods, ranging from 6 to 10.
- Dates of final primary infection periods also differed, a 10 day range.
- Recommended fungicide applications that would have been applied did not differ greatly, at either 6 or 7.
- A field test of 3 DSSs plus a calendar schedule applied either 7 or 8 sprays; no difference in scab incidence or severity.

Observations

- DSSs included varying levels of fungicide information, particularly with regard to depletion – NEWA and SkyBit had none; AgRadar and RIMpro included models.
- It is not clear in the models that if secondary scab appears, the primary models are no longer useful.
- Using any of the models requires familiarity with apple scab epidemiology and takes time to learn the interface.

Thanks!

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