

## **FINAL REPORT**

**Agro-Environmental Technology Grant  
Massachusetts Department of Agricultural Resources  
251 Causeway Street, Suite 500, Boston MA 02114**

### **‘AN ORCHARD SYSTEM FOR MONITORING AND MODELING APPLE SCAB, DISSEMINATING APPLE SCAB MODEL DATA REGIONALLY, AND MANAGING ORCHARD FUNGICIDE USE’**

Prepared by:

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*and cooperating apple growers:*

James O’Brien, Brooksby Orchard, Peabody MA  
Steve Ware, Bolton Orchard, Bolton MA  
Richard Bartlett, Bartlett Orchard, Pittsfield, MA  
Tom Clark, Clarkdale Fruit Farm, South Deerfield, MA  
Maurice and Phyllis Tougas, Tougas Family Farm, Northborough, MA  
William Broderick, Sunnycrest Orchard, Sterling, MA

### **Introduction**

A simple system for apple growers to monitor environmental weather data (temperature and leaf wetness particularly) to be used in models for predicting apple scab infection periods would make their fungicide application(s) more timely and accurate, thereby potentially reducing pesticide use, improving disease control, and saving money. Additionally, raw weather data and model output can now be easily shared regionally via the Internet to be used by neighboring growers. Such a system has recently become feasible with the availability of inexpensive electronic weather data monitors, personal computer (PC) based models, e-mail delivered weather data and models by commercial services(s), and grower familiarity with PC’s and the Internet.

### **Objectives**

1. Establish a series of onsite weather stations that collect data, which can be used in models to predict apple scab infection periods. Such models will help growers

- determine the need (or lack of) for fungicide sprays to control apple scab based on accurate environmental information previously unavailable to them.
2. Post weather and apple scab infection period information from these orchards on the Massachusetts Fruit Growers' Association web site (<http://www.massfruitgrowers.org>) for neighboring growers access and use in helping *them* make fungicide application decisions.
  3. Compare weather data collected by onsite weather stations in trial orchards to SkyBit E-Weather information, particularly when used in models to predict apple scab infection periods. Survey trial growers to ascertain their preference, and be able to make recommendations to other growers based on their preference.

### **Procedure**

In late April 2003, Spectrum Technologies weather stations (either 3610TWD 'Watchdog' Leaf Wetness/Temperature Logger or 3684PDSR 'Watchdog' Plant Disease Station) were installed in the cooperating grower orchards. Spectrum Technologies PC software (3656 SpecWare 6.0) for collecting and displaying weather data and analyzing apple scab infection periods (3656AS Apple Scab IPM) were installed on cooperating growers computers, and they were given coaching in it's use. Growers were instructed to collect weather data, run the apple scab model, and post the results to the Massachusetts Fruit Growers' Association (MFGA) web site (<http://www.massfruitgrowers.org/weather/readme.html>) at (minimum) weekly intervals via FTP (File Transfer Protocol). (APPENDIX A)

For the months of April, May, and June 2003, SkyBit Inc. E-Weather Combo (Forecast & Summary) and IPM Apple Disease were received by cooperating growers via daily e-mail(s). (APPENDIX B) Growers were instructed in interpreting the SkyBit E-Weather information, and casually comparing it to the weather data collected on-site. *It was assumed – and suggested that – growers would use the environmental information from both sources to help determine the need for and the timing of orchard fungicide sprays for apple scab.*

In general, installation and use of the Spectrum Technologies weather data loggers/stations went smoothly. On occasion, growers had trouble downloading and saving data to their personal computers -- in one instance data was lost and unrecoverable. In addition, growers found it easy to upload model data to the web site, however, timeliness and frequency of uploading could be improved.

During the growing season, contact was maintained with grower cooperators to make sure the weather stations were functioning properly and accurately, and that apple scab model data were being posted to the MFGA web site. In late September 2003, an on-line survey (APPENDIX C) was developed for cooperating growers to give feedback on their experience with the weather equipment, SkyBit E-Weather, and using the information to make spray decisions.

A press release on June 04, 2003 (APPENDIX D) resulted in article(s) appearing in at least two newspapers about this project. They included:

- ‘Grant application bears fruit: New Weather station will provide data for area growers.’ The Berkshire Eagle. June 26, 2003.
- ‘The fruit of his labors: Brooksby Farms teams up with UMass to improve apple growing.’ Gloucester Daily Times. August 27, 2003.

## **Results**

Cooperating growers used the Spectrum weather stations during the 2003 growing season to collect orchard weather data successfully, and then used the information in models to predict if apple scab infection periods occurred. Growers generally found the weather stations and computer software easy to use. (See survey, APPENDIX C)

They also monitored daily SkyBit E-Weather information to evaluate predicted spray conditions and the disease/insect models. Survey results suggest growers preferred the on-site weather stations to SkyBit E-Weather.

Survey results also suggest that growers may not have used the models to predict apple scab infection periods and help them make spray decisions as often as one would hope. One concern expressed by growers was the time it takes to evaluate the information (information overload?), particularly during the 2003 wet spring, early-summer scab spray season. In fact, it was so wet this season, that sprays to control apple scab had to be applied on a calendar (i.e. weekly) basis anyway. At least one grower, however, said he should have paid better attention to the model output, which predicted he should have actually applied fungicides more often than he did. *Although a start was made here, more education and effort needs to be made giving growers IPM tools that are both accurate and friendly, hence enhancing their adoption. Clearly there is still room for improvement in gathering and analyzing weather data to make orchard spray decisions.*

Apparently the model data uploaded to the MFGA web site was used minimally (if at all) by neighboring growers. Web site page requests to the web server weather directory, however, totaled approximately 2,800 for the three-month period April through June. (APPENDIX E)

All six cooperating growers now have functioning orchard weather monitoring stations installed in their orchards that can be used in upcoming growing seasons. They also have personal computer software to download and store the weather data collected by the stations, as well as disease and insect models. All growers expressed an interest in continuing to collect and use orchard environmental data in upcoming growing season(s).

An article about this project’s results will appear in an upcoming issue of ‘Fruit Notes.’ (<http://www.umass.edu/fruitadvisor/fruitnotes/FruitNotes.htm>) Included will be a discussion of the comparison between weather data (and models) collected on-site and that delivered by SkyBit E-Weather.

## Conclusion

Clearly, the objectives of this project were met. To summarize:

1. Six on-site weather stations were easily established in grower orchards. Growers used models – based on accurate orchard weather information – to help assess scab infection periods and time fungicide sprays. The only limitation(s) encountered were occasional weather station/computer software interface issues, and lack of time during a busy period for orchard activities to fully analyze all the information available for decision-making.
2. Weather and apple scab infection period information from these orchards were posted on the Massachusetts Fruit Growers' Association web site (<http://www.massfruitgrowers.org>) for neighboring growers access and use in helping *them* make fungicide application decisions. It's unclear, however, how much this information was used by neighboring growers. *A better approach would be to encourage growers to purchase their own weather stations.*
3. SkyBit E-Weather information was used by cooperating growers in decision-making, although the consensus appears to favor the use of on-site weather stations for this purpose. A thorough comparison of SkyBit E-Weather model output vs. on-site weather stations still needs to be done, however, grower preference clearly favors the on-site weather stations and model output derived therefrom.

Unfortunately, it is difficult to quantify the real impact – both monetary, and environmental – of deployment of these weather stations, and was perhaps beyond the scope of this project. *Clearly, however, a basic tenet of IPM is monitoring, and there is no doubt grower use of the technologies explored here has given them information to make spray decisions that they would otherwise not have, and therefore, ought to have both favorable economic and environmental impacts.*

## Final budget

<b>Item</b>	<b>DAR Amount</b>	<b>Matching</b>
Spectrum weather stations	\$2,880.50	\$1,560.00
SkyBit e-weather	-	\$1,470.00
Coordinator wages	\$1,000	\$1,000.00
Mileage	\$334.95	\$300.00
Office/communications	\$500.00	\$500.00
Advertising, web site	\$200.00	\$500.00
<b>TOTAL</b>	<b>\$4,915.45</b>	<b>\$5,330.00</b>

## APPENDIX A – Sample ‘Specware’ apple-scab output

Specware 6.02 CLARK Apple-Scab From 04/25/2003 To 07/01/2003

Date	Temperature		Wet Hrs	Degree Days	%Spore Mature	Infection Mills	Degree	
	High	Low					Wash St	Cornell
04/25	71.6	48.8	0.0	16	0	None	None	None
04/26	50.3	44.5	19.3	32	1	Light	Light	Infected
04/27	70.4	45.2	0.0	55	1	None	None	None
04/28	83.0	37.7	0.0	85	2	None	None	None
04/29	77.4	46.7	0.0	116	3	None	None	None
04/30	67.7	40.8	0.3	138	4	None	None	None
05/01	66.3	46.7	3.0	161	6	None	None	None
05/02	78.8	48.1	8.5	187	8	None	None	None
05/03	67.7	42.3	0.0	209	9	None	None	None
05/04	67.7	32.2	0.0	228	11	None	None	None
05/05	70.4	35.4	0.0	250	14	None	None	None
05/06	50.3	41.5	2.8	265	18	None	None	None
05/07	75.3	48.1	3.5	294	22	None	None	None
05/08	59.4	48.8	15.5	313	26	Medium	Light	Infected
05/09	70.4	45.9	8.3	338	30	Medium	Medium	Infected
05/10	76.0	38.5	0.0	362	34	None	None	None
05/11	70.4	41.5	7.0	385	39	None	None	None
05/12	54.5	44.5	11.3	402	42	None	None	Infected
05/13	59.4	43.7	7.5	420	45	None	None	Infected
05/14	66.3	48.1	0.0	444	50	None	None	None
05/15	69.7	42.3	0.8	469	54	None	None	None
05/16	62.2	40.0	0.0	488	58	None	None	None
05/17	69.7	39.3	0.0	508	62	None	None	None
05/18	76.0	32.2	0.0	531	66	None	None	None
05/19	85.2	37.7	0.0	560	71	None	None	None
05/20	83.0	41.5	0.0	592	76	None	None	None
05/21	62.2	48.8	10.5	614	80	Light	Light	Infected
05/22	62.8	49.6	2.5	636	83	None	None	None
05/23	54.5	48.8	13.5	655	85	Light	Light	Infected
05/24	52.4	46.7	17.0	672	88	Heavy	Heavy	Infected
05/25	65.6	48.1	6.5	696	91	Heavy	Heavy	Infected
05/26	55.9	49.6	14.8	717	93	Light	Light	Infected
05/27	71.8	49.6	0.0	743	95	None	None	None
05/28	66.3	54.5	11.8	769	97	None	None	None
05/29	72.5	49.6	8.8	798	98	Light	Light	Infected
05/30	79.5	52.4	0.0	831	99	None	None	None
05/31	68.4	48.8	8.0	857	99	None	None	Infected
06/01	62.2	52.4	10.5	883	99	Light	Light	Infected
06/02	73.2	42.3	0.0	910	99	None	None	None
06/03	76.0	40.0	0.0	937	99	None	None	None
06/04	70.4	49.6	0.0	966	99	None	None	None
06/05	64.2	53.8	6.3	992	99	None	None	None
06/06	79.5	52.4	0.0	1026	99	None	None	None
06/07	62.8	51.0	9.0	1052	99	None	Light	Infected
06/08	68.4	55.2	2.8	1082	99	None	None	None
06/09	72.5	55.9	9.5	1112	99	None	Light	Infected
06/10	80.2	53.8	0.0	1146	99	None	None	None
06/11	71.8	51.7	2.3	1177	99	None	None	None
06/12	80.2	63.5	8.5	1214	99	None	Light	Infected

06/13	64.2	55.9	21.5	1242	99	Heavy	Heavy	Infected
06/14	74.6	55.2	7.0	1273	99	Heavy	Heavy	Infected
06/15	81.6	53.1	0.0	1309	99	None	None	None
06/16	75.3	48.8	0.0	1338	99	None	None	None
06/17	74.6	48.8	0.0	1367	99	None	None	None
06/18	67.7	51.7	7.5	1394	99	None	None	Infected
06/19	80.2	55.2	11.3	1429	99	Medium	Medium	Infected
06/20	70.4	58.0	2.3	1462	99	None	None	None
06/21	77.4	55.9	6.5	1494	99	None	None	None
06/22	64.2	56.6	21.8	1521	99	Heavy	Heavy	Infected
06/23	90.3	57.3	7.5	1559	99	Heavy	Heavy	Infected
06/24	94.8	63.5	4.3	1604	99	None	None	None
06/25	94.1	57.3	0.0	1649	99	None	None	None
06/26	108.5	67.0	0.0	1701	99	None	None	None
06/27	94.8	63.5	0.0	1747	99	None	None	None
06/28	86.6	56.6	0.0	1786	99	None	None	None
06/29	83.0	55.2	0.0	1825	99	None	None	None
06/30	86.6	62.2	0.0	1865	99	None	None	None
07/01	85.2	53.1	0.0	1887	99	None	None	None
Overall			319.0			Heavy	Heavy	Infected

APPENDIX B – Sample ‘SkyBit E-weather’

**From:** The Agmaster <agmaster@drought.meso.com>  
**Date:** Sun Jul 13, 2003 5:25:27 AM US/Eastern  
**To:** clements@umext.umass.edu  
**Subject:** 'E-Weather Apple Disease MAHRC 030713'

E-WEATHER SERVICE  
 For: MA-BELCHERTOWN-HORTRESCENTER

AGWEATHER IPM APPLE DISEASE PRODUCT  
 Date: SUN Jul 13, 2003

Date	WEATHER					APPLE SCAB 030415				FIRE BLIGHT 030506				SOOTY BLOTCH 030521	
	TMX F	TMN F	PREC in	ARH %	LW hr	ASM %	AW hr	TW F	PW	ADH 65F	AW hr	TW F	PW	ALW hr	PW
BASED ON OBSERVATIONS															
0701	80	57	0.00	64	0	100	0	-	+	225	0	-	-	346	+
0702	83	57	0.00	63	0	100	0	-	+	225	0	-	-	346	+
0703	79	64	0.00	75	0	100	5	65	+	225	5	65	++	351	++
0704	89	64	0.00	71	9	100	9	69	++	225	9	69	++	355	++
0705	86	70	0.08	73	8	100	14	75	++	225	14	75	++	369	++
0706	87	70	0.00	66	10	100	18	75	++	225	18	75	++	373	++
0707	84	64	0.00	70	0	100	5	70	+	225	5	70	++	378	++
0708	85	70	0.00	75	10	100	10	72	++	225	10	72	++	383	++
0709	72	59	0.25	80	14	100	20	63	++	225	20	63	++	403	++
0710	75	57	0.00	71	9	100	23	64	++	225	23	64	++	412	++
0711	65	60	0.94	96	24	100	30	63	++	225	30	63	++	436	++
0712	80	61	0.00	73	10	100	34	63	++	225	34	63	++	440	++
BASED ON FORECASTS															
0713	77	61	0.00	65	0	100	0	-	+	225	0	-	-	440	++
0714	78	56	0.00	68	0	100	0	-	+	225	0	-	-	440	++
0715	82	62	----	69	0	100	3	64	+	225	3	64	++	443	++
0716	80	62	----	72	21	100	27	70	++	225	27	70	++	467	++
0717	81	60	----	70	10	100	31	70	++	225	31	70	++	474	++
0718	83	61	----	70	4	100	3	66	+	225	3	66	++	478	++
0719	82	64	----	72	5	100	5	67	+	225	5	67	++	483	++
0720	80	63	----	73	5	100	5	65	+	225	5	65	++	488	++
0721	80	62	----	72	4	100	4	65	+	225	4	65	++	492	++
0722	80	62	----	72	4	100	4	64	+	225	4	64	++	496	++

\*\*\*\*\* IMPORTANT: Check the dates at the top of each column. \*\*\*\*\*  
 Green Tip Date - is used for Apple Scab  
 Blossom Date - is used for Fire Blight  
 Petal Fall Date - is used for Sooty Blotch

ASM = Apple Scab Maturity Percentage  
 ADH = Accumulated degree-hours from blossom date up to a max of 225.  
 ALW = Accumulated leaf wetness hours from petal fall date.  
 AW = Accumulated wetness hours for the most severe event.  
 TW = Average temperature during the most severe event.  
 PW = Pest Wait/Watch/Warning: - = not active

+ = active but no infection  
++ = possible infection & damage

\*\*\*\*\* ATTENTION: Please report your biofix dates (1-800-454-2266) \*\*\*\*\*

Please call 1-800-454-2266 to report your biofix dates for Green Tip, Blossum, and Petal Fall. Your product will NOT be correct unless these dates are reported accurately. Thank you.

=====  
To request product re-delivery, or to report biofix dates, call 1-877-273-7363  
Copyright(c) 2003 SkyBit, Inc. Phone: 1-800-454-2266



APPENDIX C – ‘Weather-grower’ survey

**Confidential Weather-Grower Survey (October 2003)**

<http://www.massfruitgrowers.org/2003/weathersurvey.html>

[Number of respondents = 6 (100%)]

Dear 'Weather Grower,'

Please take a few moments to fill out this brief survey. Your comments are particularly useful. There is an option to include your name at the end, otherwise the survey is confidential.

Thank you very much for your cooperation. Any questions? [clements@umext.umass.edu](mailto:clements@umext.umass.edu)

1.) How easy (or difficult) was the weather station hardware to use?

It was easy to use [5]

Intermediate (had a few problems) [1]

Difficult (had major problems/issues keeping the unit running)

Comments: [Data not always recorded if wire not precisely in place.](#)

2.) Did you have trouble downloading data (interfacing with your computer)?

No, it was easy [6]

Intermediate (had a few problems)

Difficult (had major problems/frustrations downloading the data, including losing data)

Comments:

3.) Concerning the computer software in general, was that easy to use?

Easy [4]

Intermediate (had a few problems understanding what was going on) [1]

Difficult (had major problems/issues with the software, including losing data) [1]

Comments: [Easy to follow once Jon set up; Lost data, rain units off.](#)

4.) Uploading data to the website?

It was easy to do. [3]

I had occasional problems, and it was somewhat inconvenient. [3]

Difficult. (Had major problems/issues uploading data or was not able to do it)

Comments: [Time consuming.](#)

5.) Do you know of any other growers in your area that looked at your model data on the web site?

Yes. [1]

No. [5]

Comments:

6.) The apple scab model -- did it aid you in deciding when to spray for scab.

Yes, I used it to help make spray decisions and it either saved me unnecessary sprays or helped me from getting a scab infection. [1]

I looked at it, and it may have helped confirm the need (or not need) to spray. [5]

I really did not use it to make spray/no spray decisions.

Comments:

7.) Did you have an UNACCEPTABLE amount of scab in your orchard this year?

Yes.

No. [1]

Comments: [However, more than ever before.](#)

8.) Concerning SkyBit, did you find it useful?

Yes, it was very useful in helping me schedule orchard activities. [2]

Intermediate -- I skimmed it daily. [4]

No, it was information overload.

Comments:

9.) Given the choice between SkyBit or the Spectrum weather station/software models, which would you prefer to have? (Assuming the same cost or no cost)

Spectrum weather station. [5]

SkyBit. [1]

Comments:

10. Would you recommend the Spectrum weather station and/or Skybit to other apple growers?

Spectrum weather station only. [3]

SkyBit only.

Spectrum weather station and SkyBit. [2]

Neither.

Comments:

11.) Would you be interested in cooperating in a similar project next year, particularly uploading model data to the Mass Fruit Growers' web site?

Yes. [6]

No .

Maybe.

Comments:

12. Name: (optional)

13. Final comments: [Fun to follow and a great tool to help in a tough scab year.](#)

Thank you!



**MASSACHUSETTS FRUIT GROWERS'  
ASSOCIATION AWARDED MASSACHUSETTS  
DEPARTMENT OF FOOD AND AGRICULTURE  
AGRO-ENVIRONMENTAL TECHNOLOGY  
GRANT TO MONITOR ORCHARD WEATHER  
AND DISEASE CONDITIONS**

**FOR IMMEDIATE RELEASE  
JUNE 4, 2003**

**CONTACT: Jon Clements, UMass Extension Tree Fruit Specialist, 413-323-4208**

The Massachusetts Fruit Growers' Association (MFGA), in cooperation with University of Massachusetts Extension has been awarded \$5,000 to monitor orchard weather and apple disease conditions this spring and early summer by the Massachusetts Department of Food and Agriculture (DFA) Agro-Environmental Technology Grant program.

Extension Tree-fruit Specialist Jon Clements, project coordinator, says "The installation of orchard weather monitoring stations orchards throughout Massachusetts gives growers accurate and site-specific weather data that will allow them to model apple disease periods and better protect their orchard from apple scab infection."

Specifically, thanks to the 2003 DFA Agro-Environmental Technology Grant Program (<http://www.state.ma.us/dfa/programs/agroenviro/>) and in-kind donations of cooperating apple growers, 'Watchdog' Plant Disease Stations manufactured by Spectrum Technologies, Plainfield IL were installed this spring in six commercial apple orchards throughout Massachusetts, including: Bolton, Deerfield, Northboro, Peabody, Pittsfield, and Sterling. At a minimum, the Stations monitor orchard temperature and leaf wetness, and some also collect rain and humidity data. The UMass Cold Spring Orchard Research and Education Center in Belchertown is also home to an existing weather station.

Dubbed the 'MFGA Orchard Weather Network,' the cooperating orchards are continuously monitoring environmental data that is used in a personal computer disease 'model' to predict if an apple scab infection period occurred in their orchard. Apple scab is an important disease of susceptible varieties like McIntosh and Cortland that becomes very active in the spring with warmer temperatures and periods of rain combined with leaf wetting. Accurate monitoring of orchard temperature and leaf wetness are important components of an integrated pest management (IPM) program to keep apple scab below threshold levels with well-timed fungicide sprays. As part of the MFGA Orchard Weather Network, cooperators are also uploading their weather data and apple scab infection periods to the MFGA web site (<http://www.massfruitgrowers.org/weather/readme.html>) so that nearby growers have access to the information.

Also, from April through June, cooperating growers are receiving daily e-mails from ‘SkyBit’ E-Weather Service (<http://www.skybit.com>) with detailed weather forecasts and insect and disease model predictions. Clements says “Using both the on-site weather monitoring equipment, and the SkyBit forecasts, these growers have a very good picture of orchard weather conditions that will help them make information-based management decisions on how to best control insects and diseases – that’s part of what IPM is all about.”

For more information, contact: Jon Clements, University of Massachusetts Extension (413-323-4208, [clements@umext.umass.edu](mailto:clements@umext.umass.edu)).

## APPENDIX E – MFGA weather directory web site statistics

Reporting on 90.87 days, from Apr 01, 2003 12:29am to Jun 30, 2003 09:28pm. Calculated Nov 24, 2003 11:54am.						
Displaying items 1-10 of 10 by name with directory of '/weather/'.						
% of Hits ?	Hits ?	% of Bytes ?	KBytes ?	Hits Over Time ?	Request ?	
14.52%	405	14.62%	658.2K		<a href="#">/weather/</a> *	
18.00%	502	22.28%	1,003.0K		<a href="#">/weather/belchertown/</a> *	
12.30%	343	13.60%	612.3K		<a href="#">/weather/bolton/</a> *	
9.07%	253	8.76%	394.5K		<a href="#">/weather/deerfield/</a> *	
11.37%	317	10.28%	463.0K		<a href="#">/weather/northborough/</a> *	
10.54%	294	7.67%	345.3K		<a href="#">/weather/peabody/</a> *	
1.18%	33	1.06%	47.9K		<a href="#">/weather/philipston/</a> *	
11.22%	313	12.24%	551.2K		<a href="#">/weather/pittsfield/</a> *	
0.04%	1	0.02%	1.1K		<a href="#">/weather/sdeerfield/</a> *	
11.76%	328	9.42%	424.1K		<a href="#">/weather/sterling/</a> *	