How do you determine apple scab secondary infection periods?

72nd New England, NY and Canadian Fruit Pest Management Workshop 2010

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Apple Scab Infection Periods

- 2 types of infection
  - **Primary:** ascospores released from overwintered leaves from the previous year's infected leaves
  - **Secondary:** conidia released from current season lesions to cause additional infections

Determining Primary Infection Periods

- Ascospores are discharged when there is at least 0.01” of rain
  - Infection depends on temperatures and the length of time susceptible tissues remain wet (Revised Mills Table)
- 95% of ascospores are released during the day, however in high inoculum cases the risk of infection from the small percentage released at night may be significant and therefore wetness hours at night should be counted.
- 2 successive wet periods, the 1st started by rain and the 2nd started by rain or dew, should be considered a single, uninterrupted wet period if 24 hrs or less in between.
- Source: Coli, W.M. ed. 2004. 2003-2004 New England Apple Pest Management Guide. University of Connecticut, New Hampshire, Maine, Rhode Island, Massachusetts, and Vermont Cooperative Extension.

Determining Secondary Infection Periods

- Count the hours of leaf wetness from the first hour rain is recorded until the leaves are dry, regardless of the time of day rain began (Revised Mills Table)
  - Source: Coli, W.M. ed. 2004. 2003-2004 New England Apple Pest Management Guide. USDA Coop. Ext. Serv., University of Connecticut, New Hampshire, Maine, Rhode Island, Massachusetts, and Vermont Cooperative Extension. 159 pp.
- Both ascospores and conidia infect at similar rates when tested at equivalent temperatures and inoculum doses. Therefore, a single set of conditions can be used for determining minimum wetting requirements for both primary and secondary infections
- Conidia are not affected by light or darkness. Therefore, DO NOT ignore wetting hours during darkness if scab infections have already been observed in the orchard
  - Source: Cooley, D.R., L.M. Los, E. Teveris, G. Hamilton, A.T. Eaton, L.P. Berkett, T.L. Bradshaw, H.H. Faubert, G. Koehler, R. Moran. 2010. 2010 New England Tree Fruit Mgt. Guide, USDA Coop. Ext. Serv., Univ. of Conn., New Hamp., Maine, Rh. Is., Mass., and Ver. 237 pp.

2010 Apple Scab Infection Periods

April

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
				1	2	3
4	5	1 6	7	8	9	10
11	12	13	14	15	2 16	17
18	19	20	21	22	23	24
25	3 26	27	28	29	30	

May

Sunday	Monday	Tuesday	Wednesd	Thursday	Friday	Saturday
						4 1
2	5 3	4	5	6	6 7	8
9	10	11	12	13	14	15
16	17	18	7 19	20	21	22
23	8 24	25	26	27	28	29
30	31					

June

Sunday	Monday	Tuesday	Wednesd	Thursday	Friday	Saturday
		9 1	2	3	4	5
6	7	10 8	9	10	11	12
13	14	15	16	17	18	11 19
20	21	12 22	23	24	25	26
27	28	29	30			

July

Sunday	Monday	Tuesday	Wednesd	Thursday	Friday	Saturday
				1	2	3
4	5	6	13 7	8	9	10
11	12	13	14 14	15	16	17
18	15 19	20	21	22	23	24
25	26	27	28	29	30	31

August

Sunday	Monday	Tuesday	Wednesd	Thursday	Friday	Saturday
1	16 2	3	4	5	6	7
17 8	9	10	11	12	13	14
15	16	17	18 18	19	20	19 21
22	23	24	25	26	27	28
29	20 30	31				

September

Sunday	Monday	Tuesday	Wednesd	Thursday	Friday	Saturday
			1	2	3	4
21 5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	22 23	24	25
26	27	28	29	30		

	Primary Infection Period
	Secondary Infection Period

But….

1. Can dew initiate a secondary infection period? (Are conidia released with dew or just rain?)
2. Should we combine multiple dew events after a rain within 24 hours? (i.e. rain-dry-dew-dry-dew-dry-dew….)

2010 Apple Scab Secondary Infection Periods initiated by rain only

	Secondary Infection Period
	Secondary Infection Period initiated with dew but combined with rain event
	Secondary Infection Period initiated with dew and no rain event

Secondary Infection Periods initiated by rain or dew

May

Sunday	Monday	Tuesday	Wednesd	Thursday	Friday	Saturday
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	7 19	20	21	22
23	8 24	25	26	27	28	29
30	31					

June

Sunday	Monday	Tuesday	Wednesd	Thursday	Friday	Saturday
		9 1	2	3	4	5
6	7	10 8	9	10	11	12
13	14	15	16	17	18	11 19
20	21	12 22	23	24	25	26
27	28	29	30			

Infection Periods initiated by rain only

May

Sunday	Monday	Tuesday	Wednesd	Thursday	Friday	Saturday
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	7 19	20	21	22
23	24	25	8 26	27	28	29
30	31					

June

Sunday	Monday	Tuesday	Wednesd	Thursday	Friday	Saturday
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6	7	8	10 9	10	11	12
13	14	15	16	17	18	19
20	21	11 22	23	24	25	26
27	28	29	30			

2010 Apple Scab Infection Periods initiated by rain only

Secondary Infection Period

Secondary Infection Period initiated with dew but combined with rain event

Secondary Infection Period initiated with dew and no rain event

Infection Periods initiated by rain or dew

July

Sunday	Monday	Tuesday	Wednesd	Thursday	Friday	Saturday
				1	2	3
4	5	6	13 7	8	9	10
11	12	13	14 14	15	16	17
18	15 19	20	21	22	23	24
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August

Sunday	Monday	Tuesday	Wednesd	Thursday	Friday	Saturday
1	16 2	3	4	5	6	7
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29	20 30	31				

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Infection Periods initiated by rain only

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29	30	31				

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26	27	28	29	30		

2. Should we combine multiple dew events after a rain within 24 hours?

- Only one wet period caused by dew should be combined to the secondary infection period
  - Schwabe, W.F.S. 1980. Apple Scab Infection as influenced by “dew” following “rain” wetting periods. Phytophylactica 12:229-230.

2010 Apple Scab Infection Periods initiated by rain only and combining only one dew event after a rain

Secondary Infection Period

Secondary Infection Period initiated with more than 1 dew combined

Infection Periods initiated by rain only & multiple combined dew events

May

Sunday	Monday	Tuesday	Wednesd	Thursday	Friday	Saturday
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	7 19	20	21	22
23	24	25	8 26	27	28	29
30	31					

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Different Ways of Determining Secondary Infection Periods

Method of Determining Secondary Infection Periods	Total # Secondary Infection Periods
Ultra-Conservative: include infection periods initiated by dew and combine multiple dew events as long as within 24hrs of last leaf wetness	16
Rain Only: only count infection periods initiated by a rain event and combine multiple dew events as long as within 24hrs of last leaf wetness	11
Rain Only + 1 Dew: only count infection periods initiated by a rain event and combine only 1 dew event after a rain	17

What do you think?

- How are you determining secondary infection periods?
- Can heavy dew liberate and disseminate conidia to potentially cause new lesions on the same leaf or drip or move by air to other leaves or fruit in near proximity to the lesion?
- What is the difference between dew and light rain?

Sources

- Coli, W.M. ed. 2004. 2003-2004 New England Apple Pest Management Guide. USDA Coop. Ext. Serv., University of Connecticut, New Hampshire, Maine, Rhode Island, Massachusetts, and Vermont Cooperative Extension. 159 pp.
- Cooley, D.R., L.M. Los, E. Teveris, G. Hamilton, A.T. Eaton, L.P. Berkett, T.L. Bradshaw, H.H. Faubert, G. Koehler, R. Moran. 2010. 2010 New England Tree Fruit Mgt. Guide, USDA Coop. Ext. Serv., Univ. of Conn., New Hamp., Maine, Rh. Is., Mass., and Ver. 237 pp.
- MacHardy, W.E. 1996. Apple Scab Biology, Epidemiology and Management. The Amer. Phytopathol. Soc. Press, St. Paul, MN. 545 pp.
- Schwabe, W.F.S. 1980. Apple scab infection as influenced by “dew” following “rain” wetting periods. Phytophylactica 12:229-230.
- Sutton, T.B., Nelson, L.A. and Jones, A.L. 1976. Factors affecting dispersal of conidia of the apple scab fungus. Phytopathology 66(11): 1313-1317.