Characterization of microclimate conditions and effects upon apple scab (*Venturia inaequalis)* modeling at Cold Springs Orchard (CSO)

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Research Question

"Are Microclimate variations in New England orchards such as CSO sufficiently different to warrant site-specific treatment with fungicides?"

Background

- Apple scab (*Venturia inaequalis)* is the leading cause of crop loss in commercial cultivation of apples around the world. Preventative treatment of crops with foliar fungicides is one of few effective strategies meant to limit crop losses but is subject to varying environmental conditions.
- Considering that apples are one of the most heavily treated commercial crops, and the period over which primary infection occurs is relatively small (2-3 months), the time and cost associated with effective treatments are of valuable consideration by orchardists and cultivators such as those at CSO.
- Pictured below is a graphic of the lifecycle of *Venturia inaequalis*. Circled in blue is the stage of the lifecycle that this study examines.

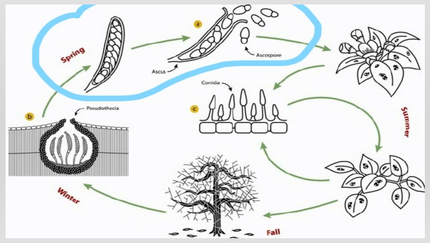


Figure 1. Life Cycle of *Venturia inaequalis*

Introduction

- There are existing forecast models such as the Revised Mills Criteria that seek to estimate the development of *V. inaequalis* ascospore maturation in an orchard setting.
- The Mills model is based upon the combination of leaf wetness conditions, relative humidity, and temperature over time to determine the minimum hours required for primary infection (Gadoury, 1989).
- This is the model that is utilized by the Network for Environment and Weather Applications (NEWA) that is developed and maintained through Cornell University.
- By better understanding the microclimate conditions across individual orchards, fungicide treatments can be utilized in a more targeted way, potentially limiting overall pesticide usage while maintaining effective treatment practices.

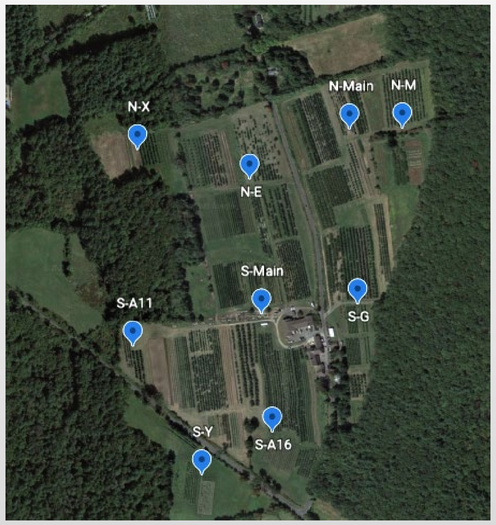
Temperature (°F)	Hours [1]	Lesions Appearance (days) [2]
34	41	-
36	35	-
37	30	-
39	28	-
41	21	-
43	18	17
45	15	17
46	13	17
48	12	17
50	11	16
52	9	15
54-56	8	14
57-59	7	12-13
61-75	6	9-10
77	8	-
79	11	-

Table 1. Mills temperature criteria

Methods

- The selected data ranges are between 4/26/20-5/25/20 and 3/26/21-6/2/21
- There are nine multi-sensor stations divided north and south around the orchard. Four stations in the north designated N-Main, N-M, N-E, and N-X; in the south the stations are designated S-Main, S-A11, S-A16, S-G, and S-Y.
- The relative humidity, temperature, and wetness sensors used for data capture are part of the HOBOware weather monitoring stations utilized across CSO
- Periods of darkness (6pm-7am) were excluded from mills durations based upon the revised mills criteria suggesting greatly reduced ascospore discharge during low-light conditions (Gadoury, Stensvand, & Seem, 1998)

Sensor placement across CSO



Limitations

- Data limited by full establishment of sensor network in mid-April 2020
- Operability of sensors was subject to intermittent technical errors
- The data obtained was restricted to the period between the stage of fruit development called 'green-tip' and the predicted date of 100% ascospore maturity based upon the NEWA maturation model

Findings

- The number of event periods across sites is similar across the orchard (apart from S-A11). Data from both Main sites suggests a greater number of periods overall for these stations.
- The average temperature during potential infection periods across sites were within one standard deviation (~2.58*) of the mean value (~54.6*), excluding S-A11
- Despite similar period counts, the difference in potential infection durations between the North and South sensor groups is significant (>20%) when corrected for the Revised Mills criteria (see Table 2.)

site	# of event periods	Avg Mills duration	Avg °F during period
N-E	6	5:28	54.29
N-M	8	5:09	53.01
N-X	7	5:24	54.34
N-Main	9	5:08	54.11
S-A11	1	0:00	60.91
S-A16	7	4:03	53.99
S-G	7	3:52	52.13
S-Main	9	2:48	56.00
S-Y	6	3:53	53.08
		mean (°F)	**54.60**
		SE	0.862360379

Table 2. Event data summary table

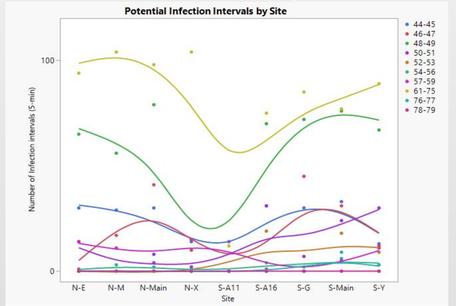


Figure 2. Number of infection intervals by site

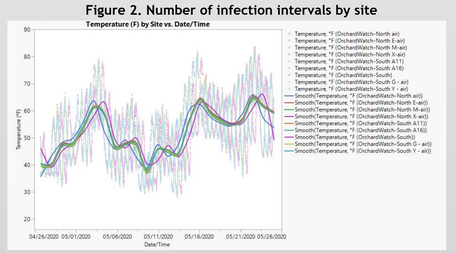


Figure 3. Temperature comparison by site (2020)

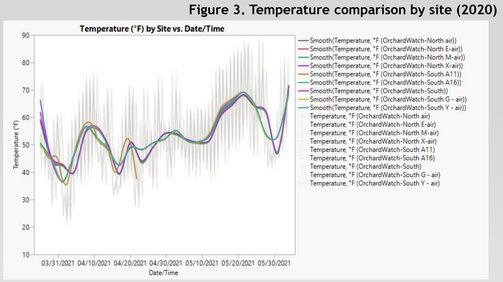


Figure 4. Temperature comparison by site (2021)

Acknowledgments

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References

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