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Tree Fruit Diseases

Comparison of Capture of Ascospores of *Venturia pirina* with Degree Days (0°C), Temperature of Rains and Dry Periods in Ukiah, California 2007

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Abstract: Ascospores of *Venturia pirina* were trapped during rain periods using rotor rod samplers as part of a disease management program in Ukiah, California pear orchards. It was possible to judge the effect of degree days (0°C), wetness temperature and dryness on apparent pseudothecial productivity as measured by ascospore capture. Rains beginning at night or early AM were judged to have spore discharge started at 7AM the next morning. Rains occurring before 5% and after 95% of the seasonal spore total had been captured were categorized separately, since a shortage of ascospores in the pseudothecia would lower productivity as measured by spore capture data. Regression analysis showed a strong relationship between spores captured vs. spores matured as predicted by degree days ($R^2 = 0.46$, $P = 0.02$). Apparent lags in captures predicted by degree days followed dry periods (<30% minimum daily relative humidity for three consecutive days) or coincided with higher rainfall events (>2 cm). There were captures with rain periods of 6 hour wetness at least 7°C (45°F). Capture often rose with increasing temperature, but the analysis had little statistical significance compared with earlier reported years with colder rain events.

Introduction

Beginning at the period of early bud swell on February 20, 2007, there were 19 rainfall events (totaling 34.4 cm) on 26 days in the next 72 day period in Ukiah pear orchards. This compared with 30 rainfall events (totaling 46.7cm) on 37 days in a 52 day period in the previous year 2006 (Table 1). The rainfall events were not all equally productive in *Venturia pirina* ascospore capture. It was possible to judge the effect of degree days elapsed prior to the events, rainfall amounts and temperature of wetness on apparent pseudothecial activity. Ascospore capture was compared with similar studies reported for the high rainfall previous year 2006, and after another high rainfall year 1998 (7, 11).

Methods

Ascospores were trapped during rain periods using rotor rod samplers (Model 20, Sampling Technologies Inc., Minnetonka, MN 55305) as part of a disease management program in 2007. The three samplers were located 45 cm above the ground in commercial Bartlett pear orchards,

and were baited with a 1 m diameter pile of random leaf litter 10 cm deep beneath the samplers in late winter. Remote sensing equipment (Adcon Telemetry, Inc., Boca Raton, FL) located in pear orchards in Ukiah, CA was used to determine the average temperature of wetness events. Accumulated degree day readings were maintained at Hopland, CA, using a digital biophenometer (Model TA51, Omnidata International, Logan, UT 84321) which made temperature readings at 10 minute intervals and converted the data to a degree day readout. Data of the percent of spores trapped for the season were compared with similar plots for percent of mature asci vs. degree days above 0^{o}C (6). Percent capture for the season was also compared by regression analysis using Sigmastat statistical software (Jandel Scientific, San Rafael, CA), with degree days since the beginning of the previous Mills Table rainfall event (3) and with the temperature of the wetness event's warmest 6 hour period. (Commencing 7 AM-7 PM, these periods were usually about 8-9 AM to 2-3 PM.). Percent capture for the season was also compared with the temperature of Mills Table wetness of the rainfall infection period. In considering the results, the concept of the effect of prior dry periods on ascospore capture was given initial exploration by examining ascospore capture following periods of three consecutive days with minimum relative humidity below 30% (4, 8).

Results and Discussion

Capture of ascospores proceeded with 5 rainfall events in 6 days (26 degree days) in which only 4% of spores were trapped. This was followed by 13 rainfall events, February 27 - May 1, in which the next 89% of spores were trapped, and 1 rainfall event, May 2, in which the last 7% of spores were trapped (Figure 1). Two additional rain events above 0.075cm (0.03") occurred May 3 and May 4, but were not monitored for spore release. The approximate 26 degree day lag in capture is less than observed last year in 2006, but is closer than other years to values reported for maturation of ascospores of pear scab, *Venturia pirina* (Figure 2)(6). Other spore trapping efforts in California have also suggested a maturation lag for pear scab in some seasons (2, 9 and 11).

Release of ascospores appeared to have reached a low plateau after 650 degree days since initial captures at early budswell, as predicted by the Spotts and Cervantes model (Figure 2). This is in agreement with results of some other years studied, but contrasts with 2006 and another wet year 1993 which reached this low plateau of discharge early in the season (9, 11).

Dry periods have been reported in the Po Valley of Italy and in Norway to result in diminished spore discharge in the case of apple scab (4, 8). Regression analysis of spores captured vs. spores matured in 2007 was very significant ($R^2 = 0.46$, $P = 0.02$ for event captures and $R^2 = 0.98$, $P = 0.0001$ for accumulated total captures (Figures 3, 4). Even so, lags in capture occurred March 26 AM and April 7, which **closely** followed significant dry periods at least 3 consecutive days below 30% minimum daily relative humidity (Figures 1, 2 and 5). These under-productive events are labeled in the figures correlating spore capture with temperature and wetness, so that their effect on the resulting regression analyses may be postulated (Figures 6, 7). Similarly, under-productive higher rainfall events February 25 and April 21 are present (Figure 5).

With the many rains occurring in 2007, it was possible to judge the effect of temperature of wetness on apparent pseudothecial productivity as measured by ascospore capture. There were significant increases in spore capture with rain periods whose warmest 6 hours rose above 7^{o}C in 1998 (10). Statistical support for this effect was lacking in 2006 and in this study (Figure 6) (11). A statistical basis was suggested in comparisons of spore capture with the temperature of

the infection period (R^2=0.05, P=0.34), as warmer temperatures measured in the entire period of wetness resulted in increasing capture (Figure 7). The effect was less significant than measured in 2006, however. Lower temperatures of wetness have been shown to delay the release of apple scab ascospores (5, 7). There was stronger suggestion (R^2=0.15, P = 0.10) than in 2006, that increased rainfall amounts were resulting in lower spore capture (Figure 8) (11). There was little indication that an increased interval between rainfall events resulted in lower spore capture, compared with 2006 (Figure 9). However, comparing only those events separated by up to 50 degree days (as was the case in all of 2006) seems to offer a similar result as in 2006 (11). Rainfall temperature, the degree day interval between rains up to 50 degree days, the amount of rainfall in an event and drying periods between them thus may help explain lags and deviations in discharge from the predictions of maturation models based on degree days alone.

Summary

The highest correlations were of spore capture vs. the number of degree days since the beginning of spore capture in 2007. Twenty six percent of the season total of spores was captured before green tissue was present in 2007 vs. none before in 2006 (Figures 1, 2,) (11). Prolonged drying periods between rain events and higher event rainfall amounts seemed to result in captures below that predicted by degree days alone (Figures 1, 2). In 2007, a year of warmer rains, there was not a significant, measurable effect of temperature influence on spore discharge as was seen in cooler seasons (Figures 6, 7) (10).

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Table 1. Rainfall Amounts, cm Ukiah, California 2006-2007

Spores	All Days		Rain Days		Total, cm		Rain/Day	
Captured	*(2006)*	2007	*(2006)*	2007	*(2006)*	2007	*(2006)*	2007
0-5%	(15)	4	(12)	4	(20.7)	3.6	(1.7)	0.9
5-95%	(22)	58	(17)	18	(16.5)	16.2	(1.0)	0.9
95-100%	(15)	12	(8)	4	(9.5)	0.7	(1.2)	0.2
Total	(52)	72	(37)	26	(46.7)	34.4	(1.3)	0.5

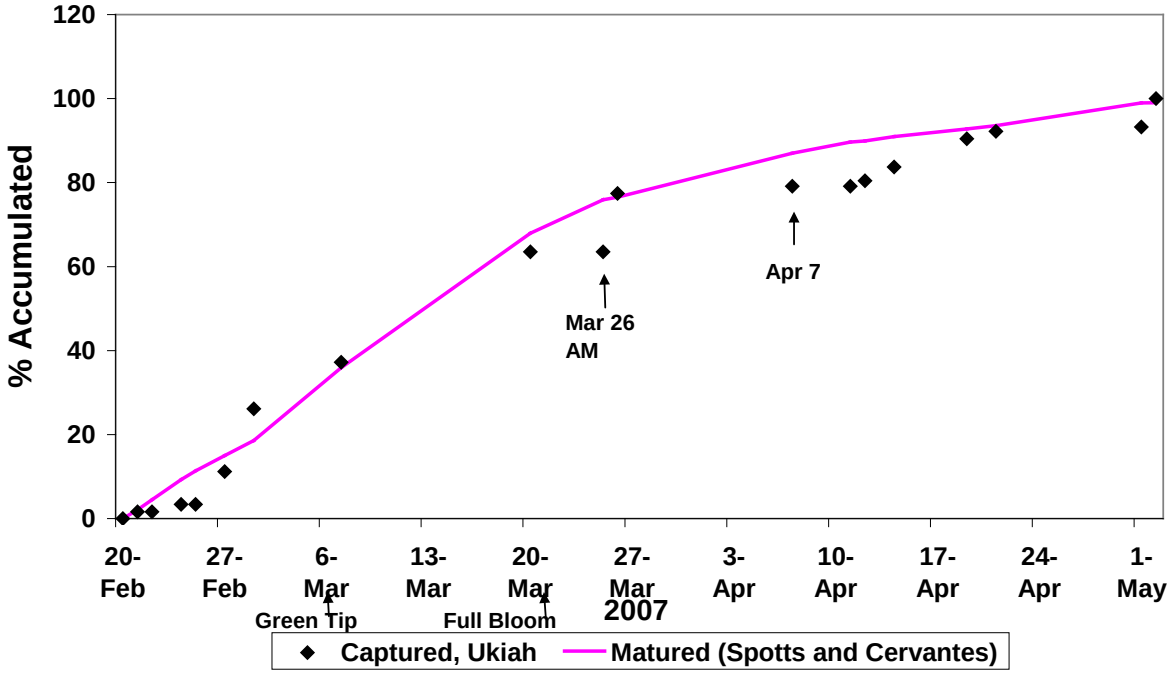

Figure 1. Ascospores captured and ascospores matured vs. date.

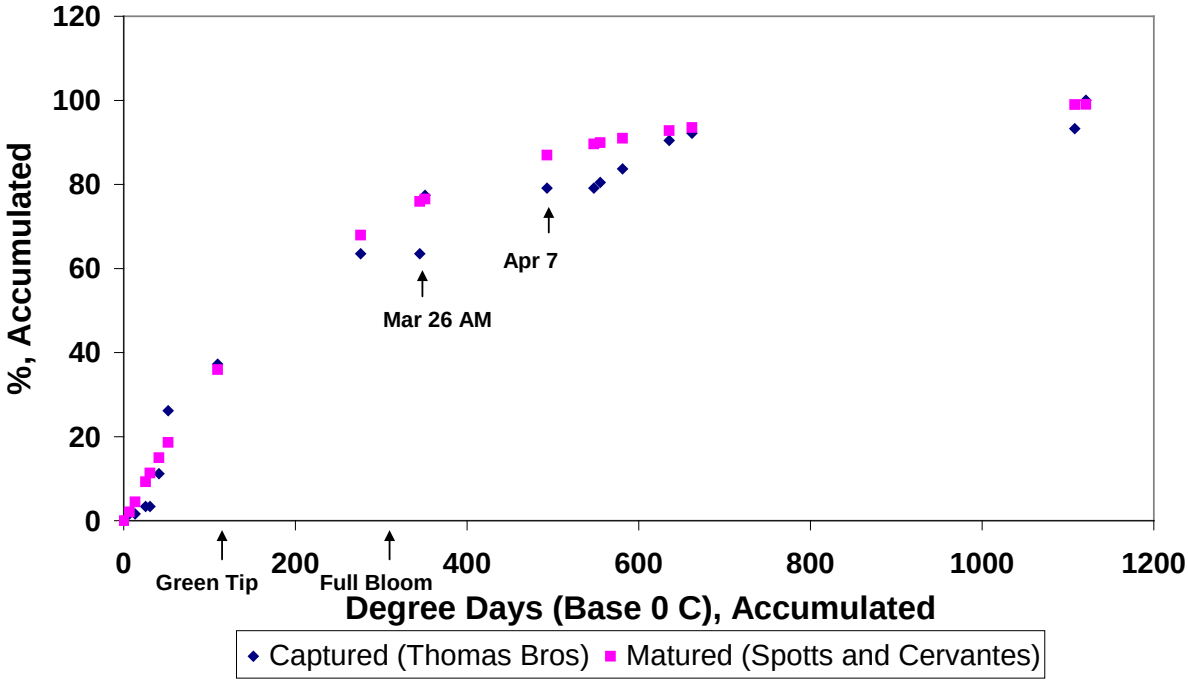

Figure 2. Ascospores captured and ascospores matured vs. degree days, 2007.

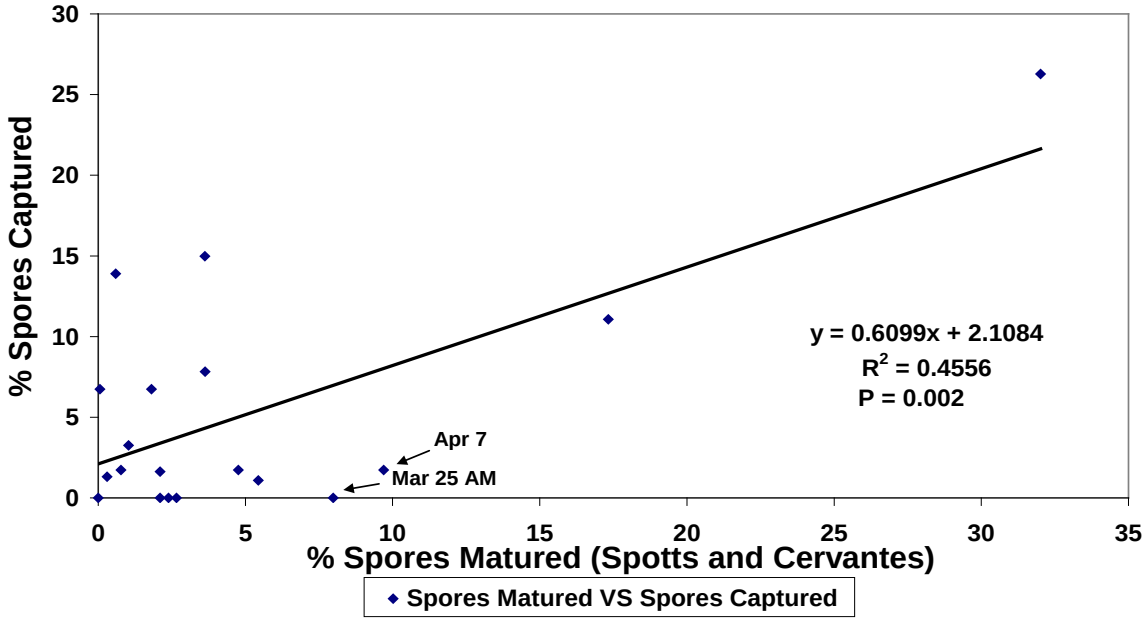

Figure 3. Ascospores captured vs. ascospores matured, by event, 2007.

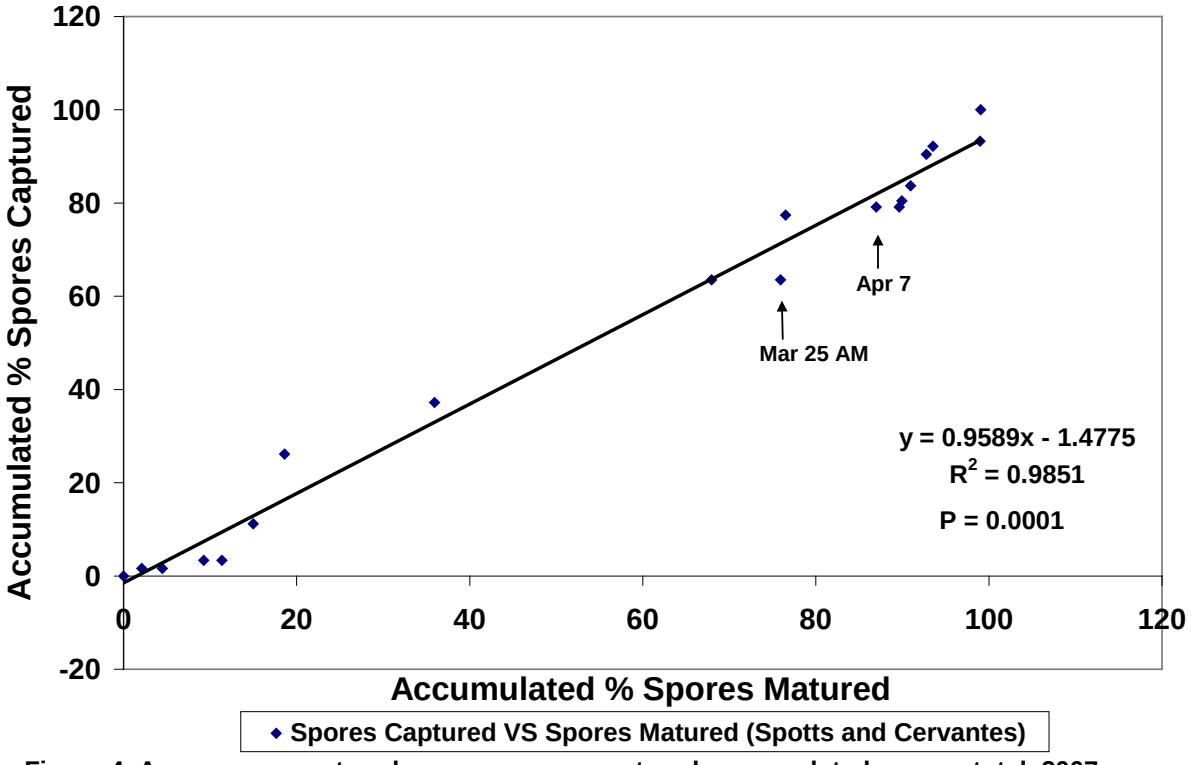

Figure 4. Ascospores captured vs. ascospores matured, accumulated season total, 2007.

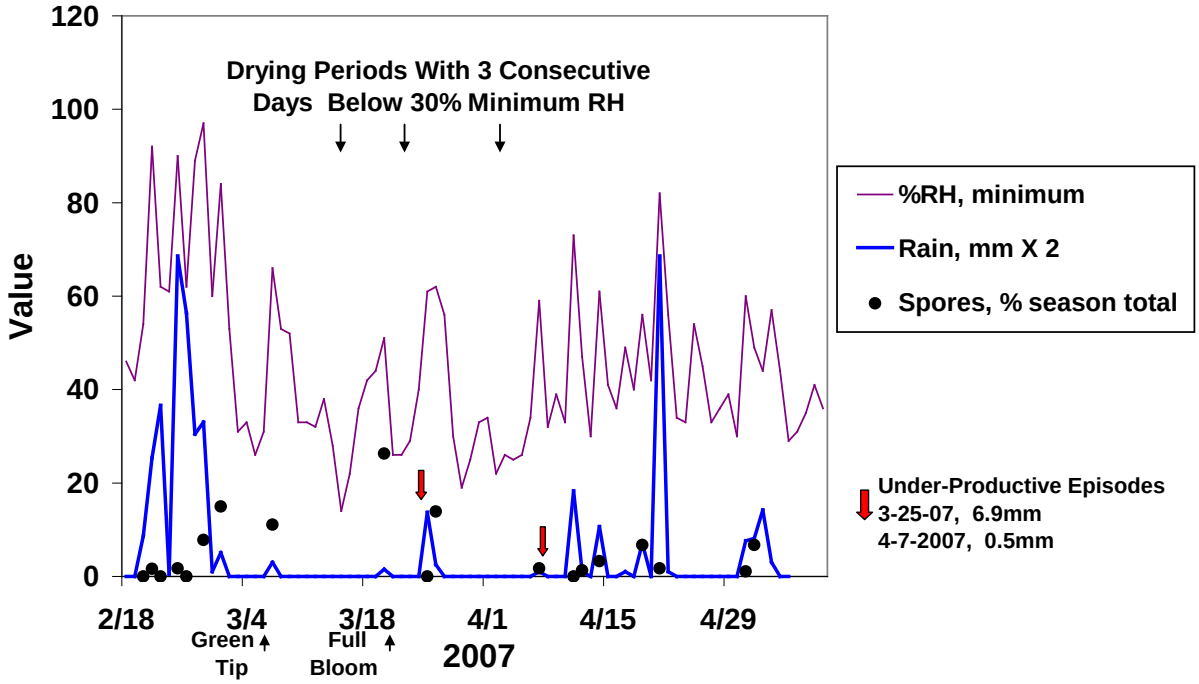

Figure 5. Spore capture showing reduced productivity when rains closely follow dry periods.

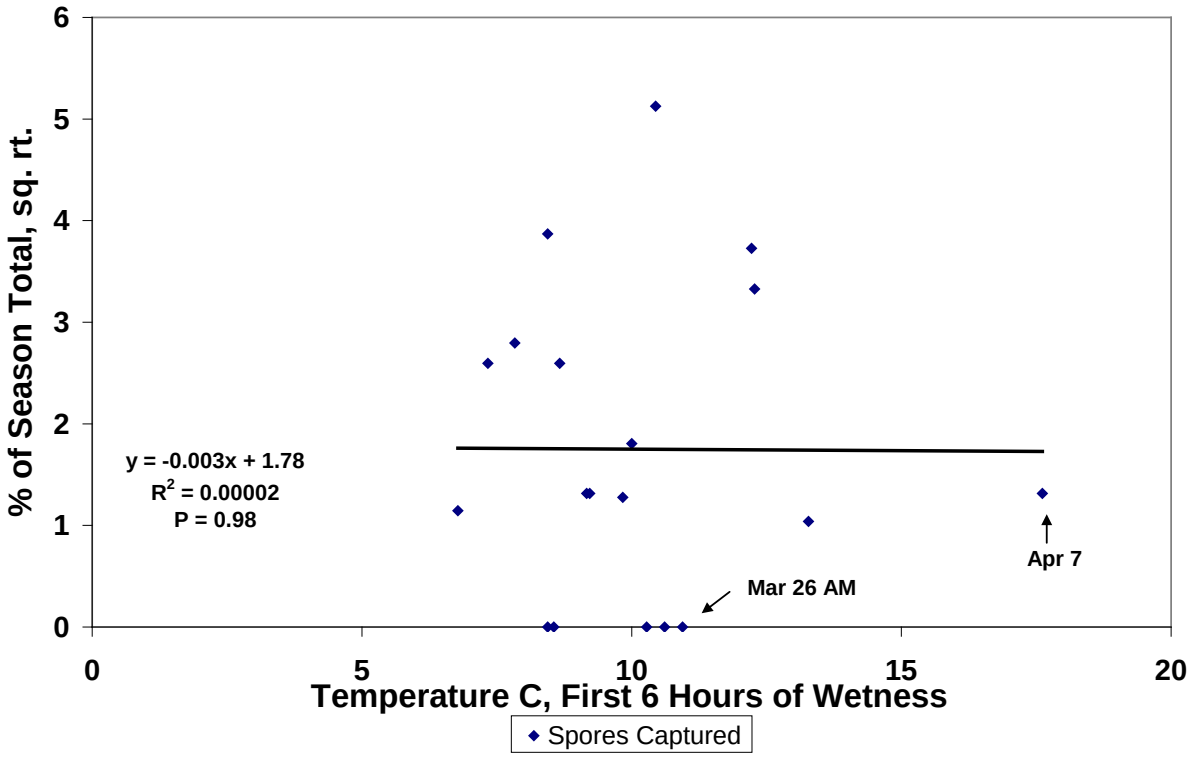

Figure 6. Ascospores captured vs. temperature of warmest 6 hour period of wetness, 2007.

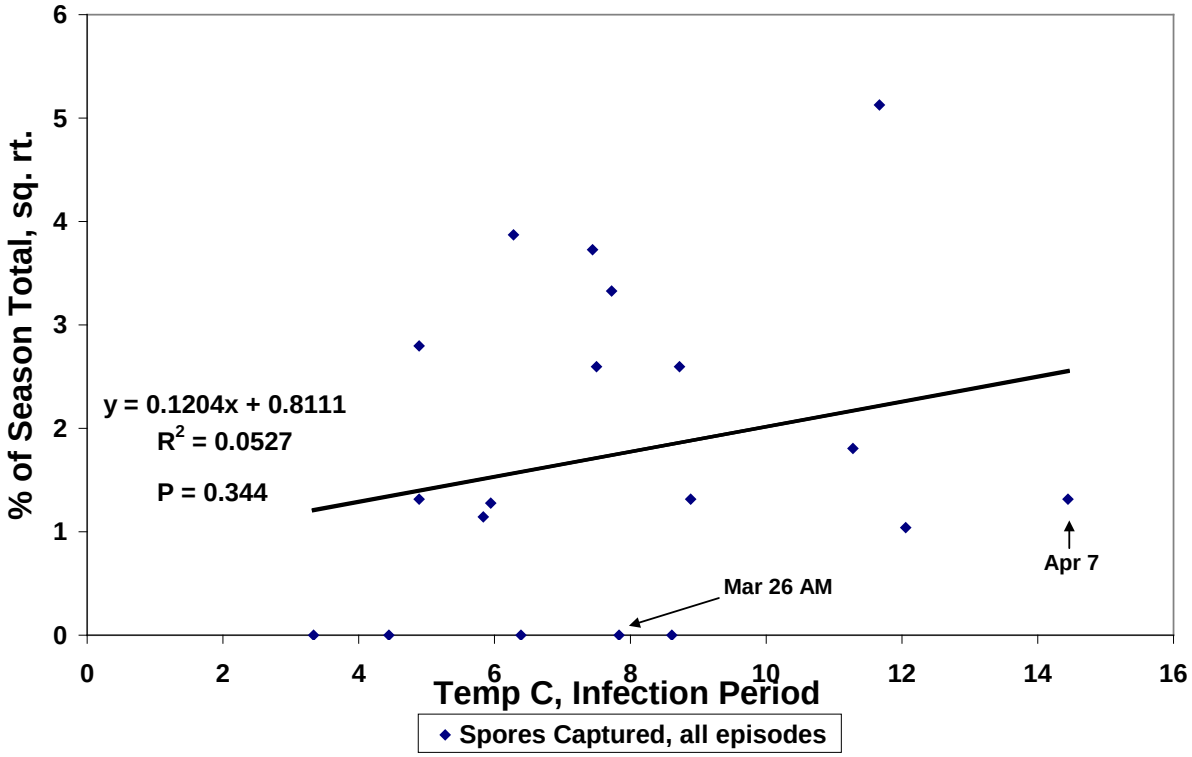

Figure 7. Ascospores captured vs. temperature of infection period, 2007.

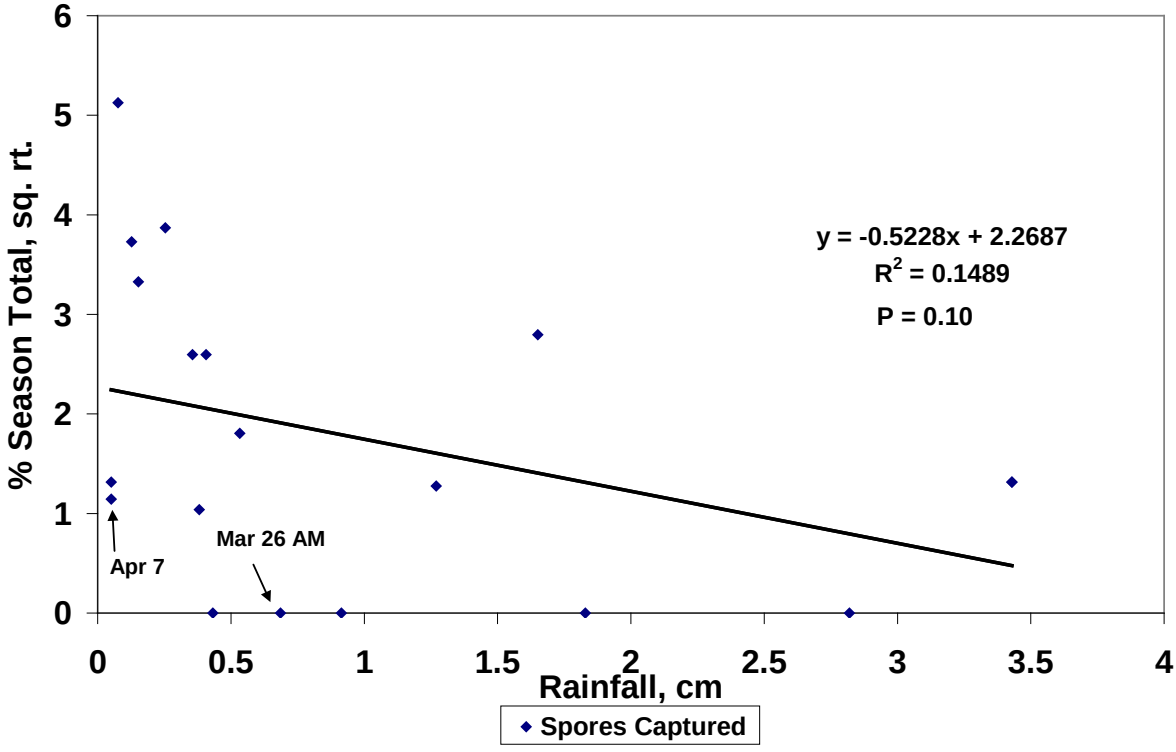

Figure 8. Ascospores captured vs. rainfall amount, 2007.

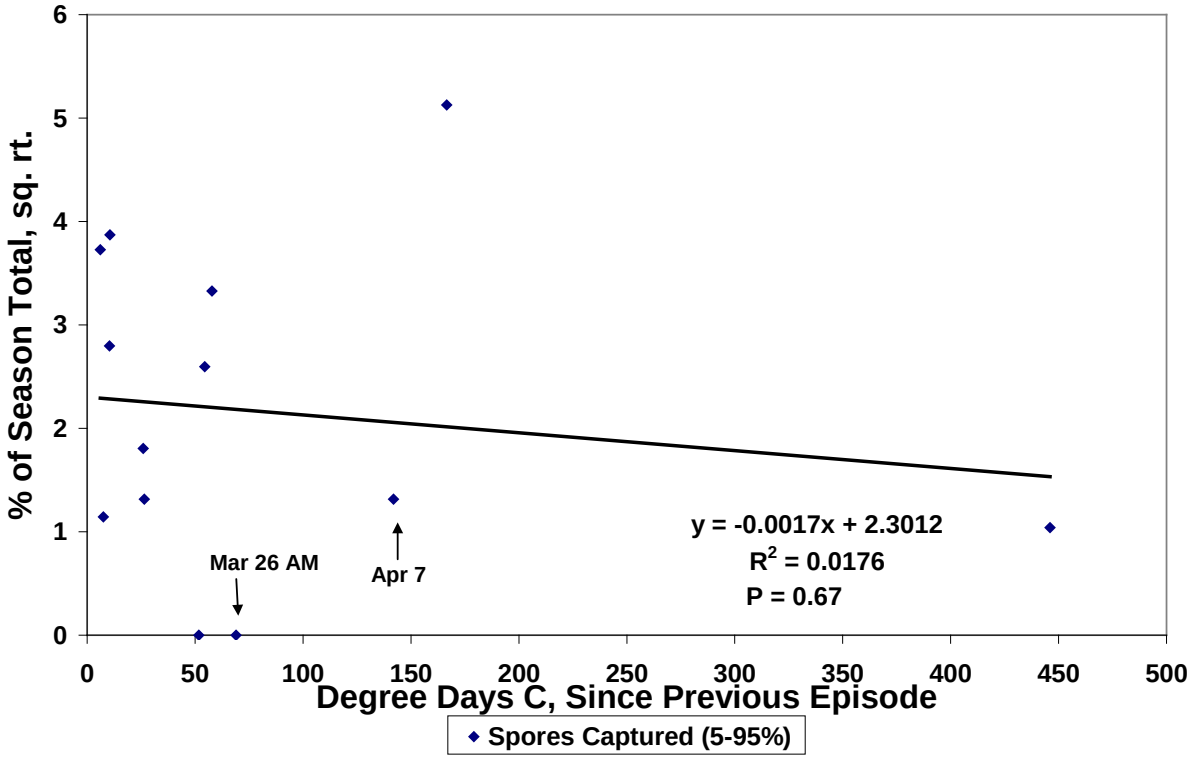

Figure 9. Spores captured vs. degree days since start of previous Mills Table episode, 2007.