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Further work on the Epidemiology of Pepper Spot

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ABSTRACT

Critical weather conditions for pepper spot development on Hass fruit were investigated to enable more effective timing of spray applications. Fruit were capped with lightweight plastic caps at the beginning of the season and exposed to natural infection for 10-14 day periods. Hourly weather data was recorded with an on site data-logger and daily weather data was obtained from the ARC-ITSC Burgershall Research Station. Fruit were assessed for disease at harvest and data correlated with weather data. Inoculation studies were conducted to determine the susceptibility of different developmental stages of Hass fruit.

Hourly data showed that temperature was the most important factor in disease development. Below 18°C little disease occurred irrespective of leaf wetness. Above 18°C there was an increase in disease with temperature and the hours during the exposure period in which the canopy was wet.

Mean daily temperature and mean rainfall recorded at the Burgershall Research Station over two seasons showed that the mean minimum daily temperature and rainfall for the period were the best predictors of disease, with temperature the most important. If temperature is above 18°C and rainfall for a 10-14 day period is above 20 mm, severe disease can be expected.

No pepper spot developed on any of the artificially inoculated fruit. The reason for this is yet unknown and further investigations are needed.

INTRODUCTION

Pepper spot on Hass, its symptoms and extent, has been previously described (Schoeman & Manicom 1998). A large spot field anthracnose (raised black spots in the size range 2-5 mm) has also become common, particularly on Ryan and Pinkerton, but also found on Hass. This may or may not be related to pepper spot. Growers are currently combating these problems with an increased number of copper or benomyl sprays. Initial observations from field trials of a number of chemicals is that the strobulurin group of fungicides will be more effective but there is some way to go before these can be used.

The purpose of this year's trials was to refine our understanding of the conditions favourable for pepper spot in order to better time spray applications. A capping trial with shorter time intervals and the inclusion of weather data from an on site logger was performed, as well as inoculation studies.

MATERIALS AND METHODS

Determination of infection periods

Fifteen hundred fruit were capped with lightweight plastic caps in mid-November (1999) at a site where disease was previously severe. Fruit was exposed for periods of ten days to two weeks before having the caps replaced through the season. The shorter time interval was used during periods which had previously been identified as critical (Dec, Jan and early Feb) (Table 1).

At harvest, fruits were assessed for disease and the data correlated with on site, hourly measurements of leaf wetness, temperature and humidity, and with daily data from the ARC-ITSC Burgershall Research Station, about 10 km distant. Malfunctions with the data logger meant the loss of on site data from the 15th February until the 12th of March, 2000. Results from the previous year were also combined with this years' data and investigated by a variety of techniques for significant effects on disease incidence.

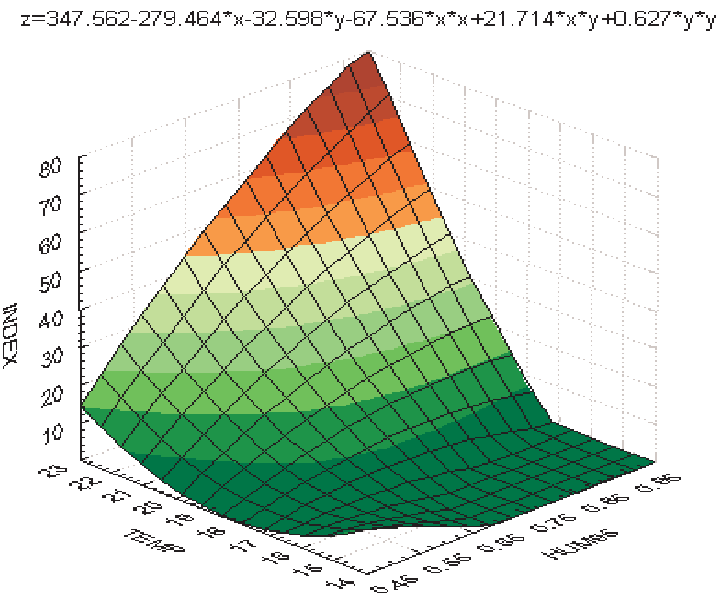

Figure 1 Relationship of mean hourly temperature and proportion of time hourly humidity was above 96% (wet canopy) with pepper spot incidence for exposure periods. Data from on site data-logger, sensors within the canopy.

Determination of fruit susceptibility

The susceptibility of Hass fruit at different developmental stages was studied using artificially inoculated fruit that were not exposed to natural infection. Five hundred Hass fruits were capped in mid November. Fifty fruits were inoculated monthly by applying a conidial suspension of *Colletotrichum* with a handspray from the beginning of December to April. Immediately after infection the fruits were enclosed in plastic bags for three days to promote infection, after which the bags were removed and the fruit left covered only with the plastic caps. Fruits were evaluated for pepper spot incidence at harvest.

RESULTS AND DISCUSSION

Infection periods

Fruit were harvested in May and evaluated for pepper spot on a scale of 0 - 4, with 0 = clean fruit, 1 = light infection, 2 = medium infection and 3 = severely infected fruit. Results were expressed as a disease index from 0 – 100 using the method of Wheeler (1969).

In line with expectations, fruit capped for the whole period had a 2,1% infection rate and those left open were 93,1% infected.

Data from the data logger was first investigated, as this being on site was expected to provide more precision than the data from the Burgershall Research Station 10 km away. The data logger read temperature, humidity and leaf wetness every hour. This hourly data was averaged for each period during which the fruit was exposed. Various combinations of temperature, temperature bands, leaf wetness, humidity, humidity bands etc. were investigated. Humidity above 96% and leaf wetness were highly and significantly correlated (Pearson = 0.95) and the former was then used as a measure of leaf wetness.

Temperature had a significant effect. As can be seen from Figure 1,

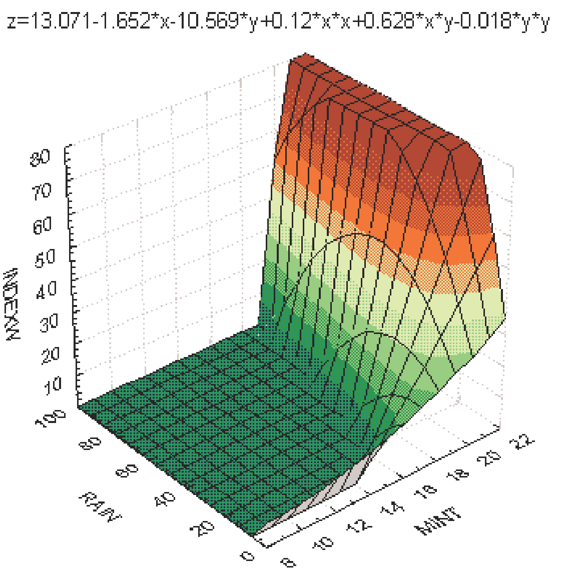

Figure 2 Relationship between pepper spot incidence and mean rainfall and mean minimum temperature for exposure periods. Combined data from Burgershall Weather Station for two sites in 1998/99 and one site in 1999/00.

Table 1 Exposure periods and disease index from November 1999 to May 2000.

Period	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Disease Index
Open																		93.06
19 Nov – 3 Dec																		6.25
3 – 13 Dec																		11.11
13 – 23 Dec																		10.61
23 Dec- 4 Jan																		51.67
4 – 14 Jan																		35.71
14 – 24 Jan																		42.11
24 Jan – 3 Feb																		66.67
3 – 14 Feb																		46.67
14 - 28 Feb																		18.33
28 Feb – 13 Mrt																		20.37
13 – 27 Mrt																		27.78
27 Mrt –10 April																		2.78
10- 17 April																		0.00
17 – 25 April																		4.76
25 April – 9 May																		4.76
9 – 23 May																		2.22
Capped																		2.15

Table 2 Number of days during which rain occurred and mean minimum temperature exceeded 18°C for seasons 98/99 and 99/00. Data ex Burgershall weather station.

Period	98/99	99/00	Mean
Nov 1-15	3	0	1.5
Nov 16-30	7	7	7
Dec 1-15	6	5	5,5
Dec 16-31	10	5	7,5
Jan1-15	7	10	8,5
Jan 16-31	4	3	3,5
Feb 1-15	8	11	9,5
Feb 16-28	4	6	5,0
Mar 1-15	3	11	7,0
Mar 16-31	3	8	5,5
Apr 1-15	0	0	0,0
Apr 15-30	1	0	0,5
May 1-15	0	0	0,0
May 16-31	0	0	0,0

below about 18°C there was little disease irrespective of leaf wetness. Above this temperature, disease increased with mean temperature and the proportion of time during the exposure period in which the canopy was wet.

The equation of Fitzell *et al* (1984) was applied to the data set from the logger but correlations with disease incidence were poor in terms of number of infection periods and/or percentage of spores predicted to germinate. This merely points out the dangers of uncritically transferring a model developed for one system to another. It did, however, show that infection periods (defined in their model as temperature/wet period combinations in which 40% of spores can be expected to germinate) occurred throughout the season into early April. These were overnight conditions when there were 12-14 hours of leaf wetness with temperatures in excess of 18°C. These infection periods were common in late December, January and through to late March. February data was obscured by rain causing a continuous infection period for the first half of the month and loss of data thereafter. Rain always considerably extended the infection periods which is why the rain/temperature effect is so dramatic on disease incidence (Figure 2).

The coarser data from the Burgershall Research Station site for the two experimental sites of 1998/99 and the site of 1999/00 were combined. Comparison of the on site readings and those from the weather station for equivalent periods showed the on site temperatures to be consistently approximately two degrees lower, and the humidity 3 – 10 percentage points higher, sensors having been placed within the canopy. Regression investigations showed that, for the weather station data, mean daily minimum temperature and mean rainfall for the exposure periods were the best predictors of disease, although the adjusted R^2 was only 0.31. Most important is minimum temperature. If this is above 18°C and mean rainfall for a 10-14 day period is above 20 mm, severe disease can be expected (Figure 2). The number of days in which these conditions existed over the past two seasons is given in Table 2.

In the 1998/99 season the highest infection was recorded in the period 26 January – 9 February, with a smaller peak in the period 29 December – 12 January (Schoeman & Manicom, 2000). This season (1999/2000) a similar trend was observed with the highest infection in the period 24 January – 3 February and a smaller peak from 23 December – 4 January. These two peak periods correspond with the period in which weather conditions were found to be most favourable for disease development. This period (late December through to February) is the most important for pepper spot development and fungicide applications should be made in these months to protect the fruit. The fungicides recommended for Cercospora spot control are also effective against pepper spot but the number of applications and timing needs to be adjusted to cover these periods.

Fruit susceptibility

In the artificial inoculation trial no pepper spot developed on any of the fruit inoculated. Why this should be is as yet unknown. It also means that we have no idea of the incubation period for the disease. Table 2 shows that there were sufficient infection periods in the last half of November to have expected more disease than occurred (6,25%). Fruit averaged 50 x 30 mm at this time which leads us to speculate that young fruit are more resistant to infection. Further, symptoms are not really noted in the field until January which points to infection only beginning from mid-December onward. This needs further investigation.

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