THE EFFECT OF CLIMATE CHANGE ON PATTERNS OF PLANT DISEASE IN NEW ZEALAND

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Most fungal pathogens and bacterial pathogens require free water to infect their hosts, so rainfall and duration of surface wetness are major determinants of disease epidemics. Warmer temperatures shorten the generation time of fungal and bacterial pathogens and, therefore, generally increase the rate at which epidemics develop, provided water is not limiting.

Of the two scenarios postulated by the Climate Change Impacts Working Group, the second (mean temperatures 3°C higher than at present with wetter conditions in the north and east) is the more significant from the plant disease viewpoint. This presentation looks at just two examples of the expected changes in plant disease patterns as a result of climate change: apple black spot at Kumeu, north of Auckland, and kiwifruit blossom blight at Te Puke, in the Bay of Plenty.

Apple black spot is a fungal disease which causes unacceptable fruit blemishes. The fungus requires rain for spore dispersal, and surface wetness for infection. Primary infections occur during spring. An infection index in the range 0 (nil) to 3 (severe) can be calculated from mean temperature during wet periods (Mills, 1944). In Table 1 apple black spot indices are listed for 1986 and 1988, based on hourly climate data at Kumeu. The first column of indices for each year has been calculated from unmodified data for the 3 months September-November, with the second column showing the effect of a 3°C increase in temperature.

In 1986, a relatively wet season, there were 11 infection periods during the 3 months. The 3°C temperature rise increased the severity of 3 of those periods, and added another 3 infection periods. In 1988, a relatively dry season, there were 7 infection periods. The temperature rise increased the severity of 1 of them, and added an eighth period.

Kiwifruit blossom blight is a bacterial disease which damages buds and flowers, thus decreasing yield. At Te Puke a strong correlation exists between mean disease incidence over the district, and heat unit accumulation on moderately high (> 10mm) rainfall days over a fixed period from 21 October to 17 November (Young et al., 1988). In Table 2 the calculation of predicted disease incidence is given for 1986 and 1987. Again the first column of incidence for each year is based on unmodified climate data, with the second column showing the effect of higher temperatures.

In 1986, a year of low disease, there were only 3 days in the period under consideration with more than 10 mm rain. The effect of raising daily mean temperature by 3°C is to increase predicted disease incidence from 1.4% to 5.3%. In 1987, a year of moderately severe disease, there were 5 such rain days. The effect of the high temperature scenario is to raise predicted disease incidence from 6.1% for unmodified data to 19.2%, a level which would have serious economic implications for the grower.

These examples put numerical values on the increase in two plant diseases under the more favourable infection conditions predicted by the climate change scenario. Increased wetness alone leads to more infection periods, as illustrated by the comparison of past wet and dry years, and a 3°C temperature rise increases both the number and severity of infection periods. In the case of apple black spot, the expectation is that the disease will still be controlled by spraying, albeit at an increased cost in chemicals. For kiwifruit blossom blight, spray programmes are still being evaluated, and prospects for control under increased infection pressure are less certain.

Table 1: Apple black spot infection periods calculated for Kumeu for 1986 and 1988.

The infection indices are 0 (nil), 1 (light), 2 (moderate), and 3 (severe). The unmodified indices are calculated directly from hourly rainfall, leaf wetness and temperature data. The indices in the columns marked 'T+3' are calculated from the same rainfall and wetness data, but the temperatures have been increased by 3°C.

Kumeu 1986				*Kumeu 1988*			
Duration of Wet Period		*Infection Indices*		*Duration of Wet Period*		*Infection Indices*	
Date	*(Hours)*	*Unmodified*	*T+3*	*Date*	*(Hours)*	*Unmodified*	*T+3*
12/ 9	15	0	1	5/ 9	15	1	2
15/9	26	3	3	20/9	21	3	3
16/ 9	20	2	2	29/ 9	16	2	2
19/ 9	25	3	3	6/10	29	3	3
20/ 9	10	0	1	11/10	9	0	1
10/10	17	2	2	6/11	17	2	2
16/10	15	1	2	18/11	19	2	2
24/10	25	3	3	27/11	27	3	3
9/11	16	2	2				
18/11	12	1	1				
24/11	10	0	1				
25/11	14	1	2				
26/11	14	1	2				
27/11	15	2	2				

Table 2: Kiwifruit blossom blight infection calculation for Te Puke for 1986 and 1987.

Higher figures indicate a greater predicted disease incidence. Degree-days (10°C base) are summed on days with > 10 mm rainfall, and incidence calculated as in Young et al (1988). Unmodified degree-day values are calculated from actual microclimate data, but for calculations in the columns marked 'T+3' temperatures have been increased by 3°C.

Te Puke 1986				*TePuke 1987*			
Rainfall		*Degree-Days (10°C)*		*Rainfall*		*Degree-Days(10°C)*	
Date	*(mm)*	*Unmodified*	*T+3*	*Date*	*(mm)*	*Unmodified*	*T+3*
21/10	17.1	1.9	4.9	28/10	14.7	3.8	6.8
24/10	21.8	4.6	7.6	29/10	17.5	4.8	7.8
12/1	16.5	7.3	10.3	8/11	21.9	5.6	8.6
				13/11	52.1	3.8	6.8
				14/11	19.5	6.1	9.1
Total		13.8	22.8			24.1	39.1
Predicted Incidence (%)		1.4	5.3			6.1	19.2

References

Mills, W.D. 1944. *Cornell Agricultural Experimental Station Extension Bulletin No. 630*, 4 pp.

Young, J.M.; Cheesmur, G.J.; Welham, F.V.; Henshall, W.R. 1988. *Annals of Applied Biology, 112:* 91-105.