The New Zealand Institute for Plant & Food Research Limited

The Psa prediction model for disease risk management

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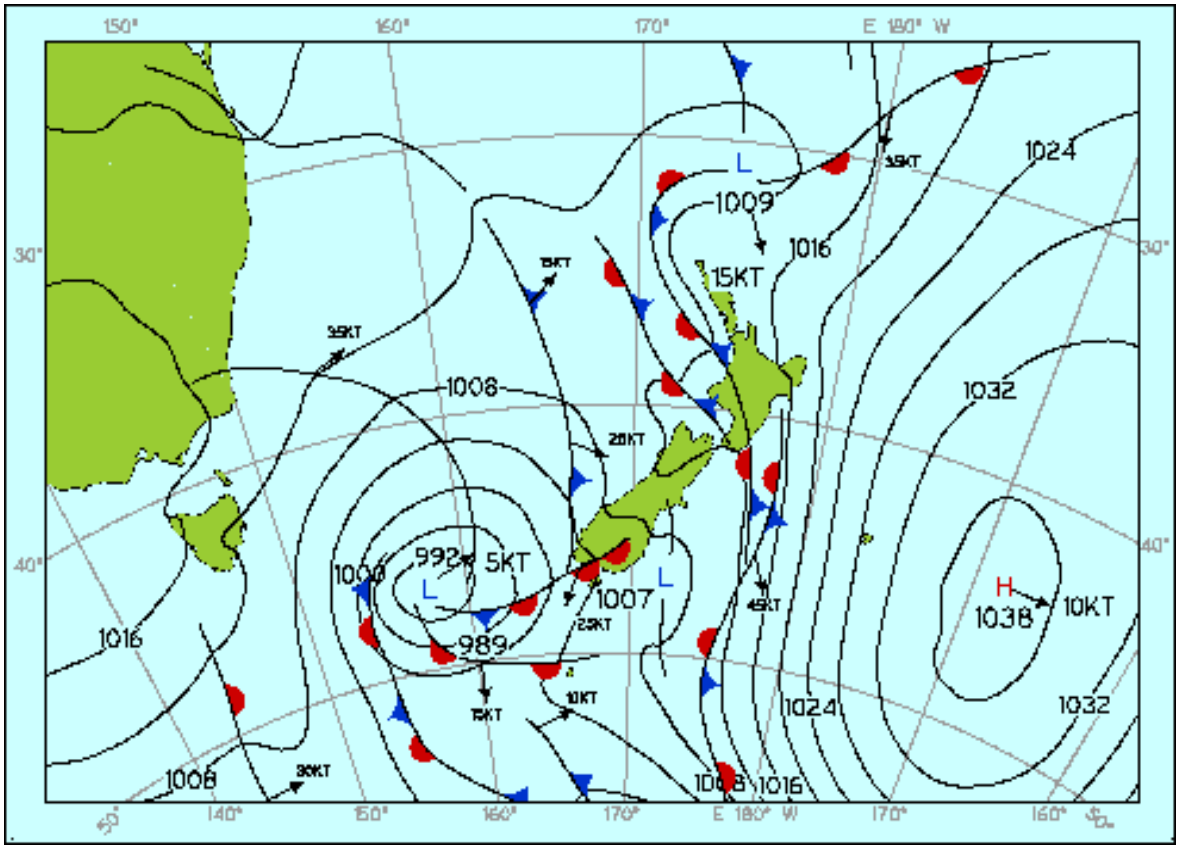
The Psa weather-based risk model

An online decision support tool for kiwifruit growers to identify daily risk of kiwifruit infection by Psa, based on monitored or forecast weather variables

The Psa weather-based risk model

Designed to identify approaching weather conditions that will create high infection risk over the next 2-5 days



The Psa weather-based risk model

- It will identify low risk periods in which to undertake orchard management practices, such as pruning, thinning, spraying etc

- Provide warnings of high infection risk 2-5 days ahead to help plan the application of protectants

Preliminary Psa risk model

- In October 2011 we developed a preliminary risk model for Psa, based on methods used internationally for prediction of fire blight disease in apples

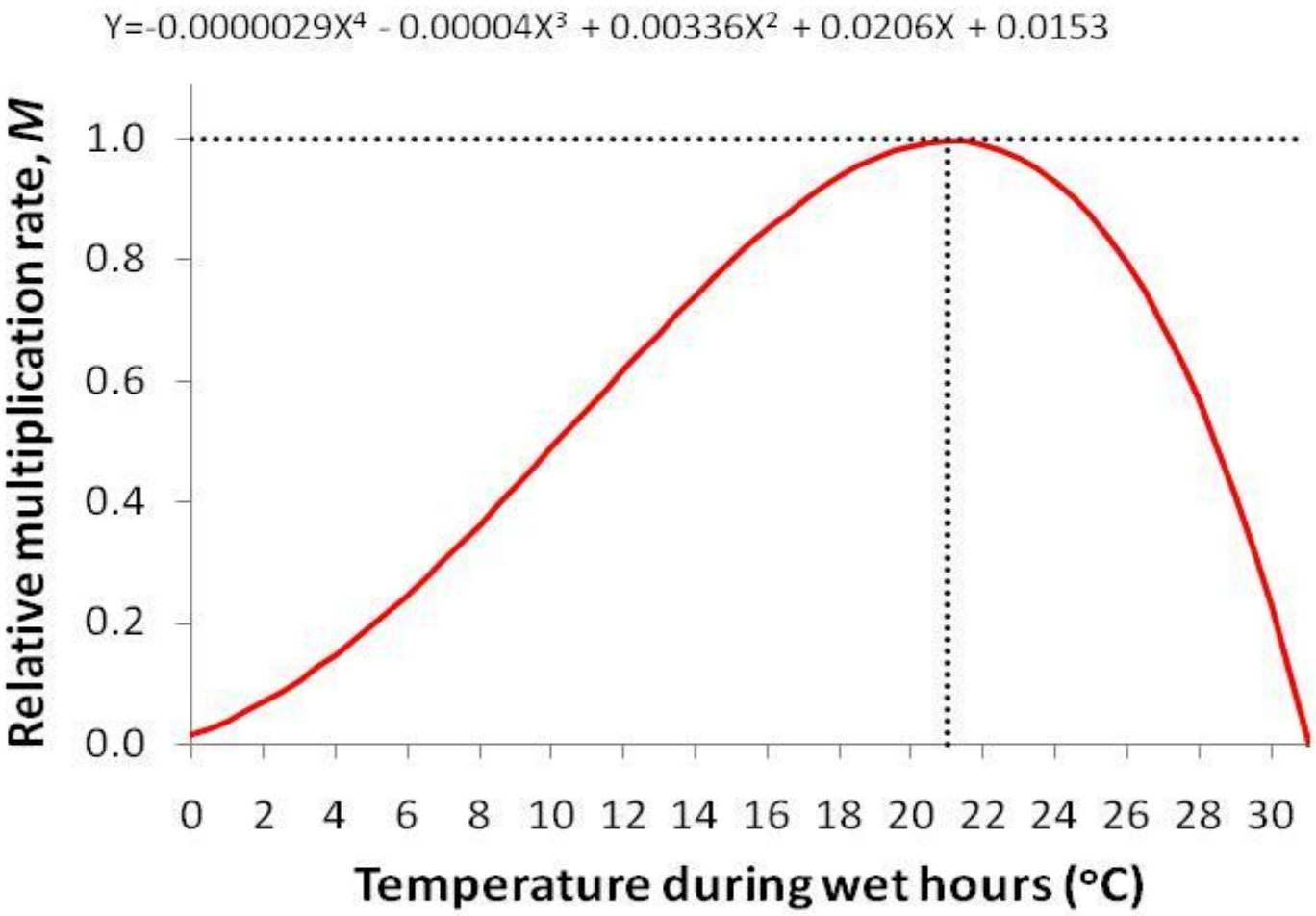
- Preliminary model tested at PFR's Te Puke Research Orchard

Conditions for bacterial infection

- *Pseudomonas* diseases generally develop during wet weather at cool temperatures
- Possible reasons why cool temperatures favour infection:
  - The bacteria may grow better at low temperatures
  - Cold temperature injury of plants may allow infection
  - Wet periods long enough for infection may occur mostly when field temperatures are cool
- We don't yet know the exact relationship between temperature, wetness and Psa infection, so the preliminary model used a "best guess"

Psa – preliminary temperature response

Hourly bacterial multiplication index, *M*

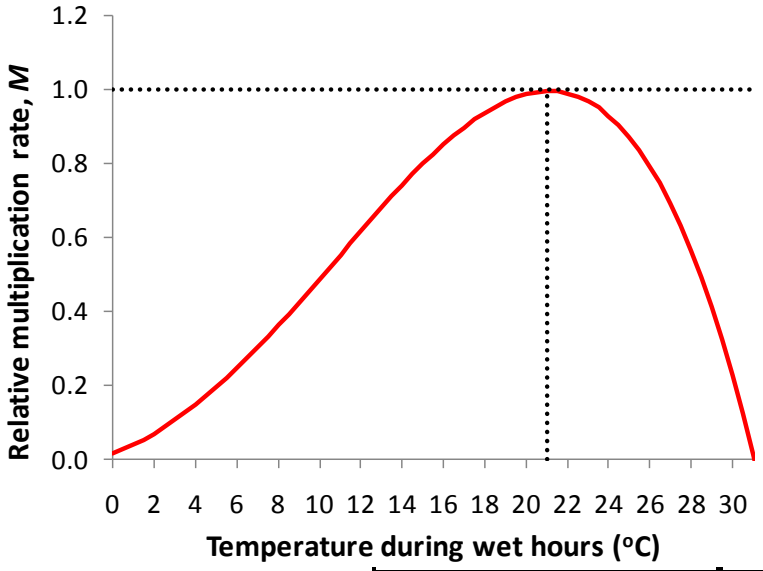


Use of the hourly *M* index with weather data

- Hourly temperature data generate *M* values
- *M* values are accumulated over three days (e.g. current day + two preceding days)
- *M* is only accumulated for hours when relative humidity is high (>81%)

M values for a weather data segment at Te Puke Research Orchard

15-Sep-11, 0200 to 16-Sep-11, 0300



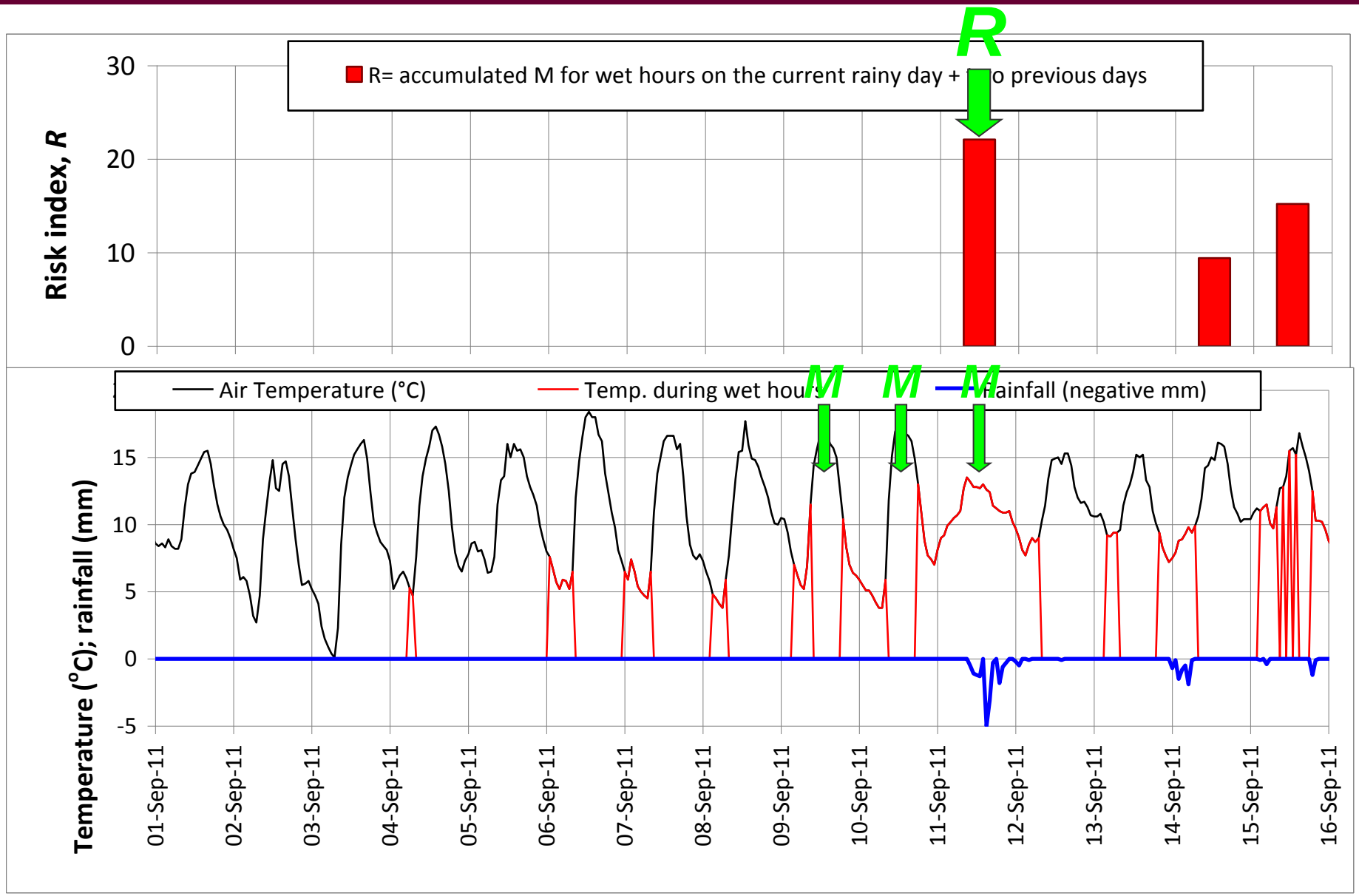
		mp (°C)	Rainfall (mm)	Relative humidity	M for high RH hours
15-Sep-11	12	15.5	0	51.5	
15-Sep-11	13	15.7	0	50.1	
15-Sep-11	14	15.2	0	48.5	
15-Sep-11	15	16.8	0	50.9	
15-Sep-11	16	15.8	0	58	
15-Sep-11	17	15	0	55.9	
15-Sep-11	18	14	0	56.2	
15-Sep-11	19	12.5	1.2	69	
15-Sep-11	20	10.3	0.1	77.6	
15-Sep-11	21	10.3	0	82.8	0.51
15-Sep-11	22	10.2	0	85.9	0.50
15-Sep-11	23	9.6	0	90.4	0.46
16-Sep-11	0	8.8	0	92.2	0.41
16-Sep-11	1	8.4	0	94.4	0.39
16-Sep-11	2	8.3	0	95.1	0.38
16-Sep-11	3	8.4	0	95.7	0.39
		11.2	0	95	0.57
		11	0.1	94.8	0.55
		11.3	0	94	0.57
		11.5	0.4	92.9	0.59
		10.1	0	85.7	0.49
		9.7	[illegible]	89.1	0.47
		11.3	0	87.9	0.57
		12.7	0	77.1	
		12.8	0	65.8	
		13.6	0	60.4	

Daily risk index, *R*

- The three-day accumulation of *M* values gives a daily risk index, *R*

- *R* is generated for days with rainfall (>1mm)

Daily *R* values, 1-16 September 2011



Categorising *R* index risk

- To use the model, we need to define what the *R* index means in terms of risk of Psa infection in orchards

- *R* index has a maximum value of 72 (accumulated *M* values over 3 days)

- The model's R-index output is divided into categories

***R*-index category no.**	**Daily *R*-index range**
No risk information	R unknown
1	0 ≤ R ≤ 10
2	10 < R ≤ 20
3	**20 < R ≤ 30**
4	**30 < R ≤ 40**
5	40 < R ≤ 50
6	R > 50

Risk category interpretation

Following apple fire blight, we know that:

- Amount of infection depends on weather and amount of bacterial inoculum present
  - Risk is greatest within already infected orchards
  - Risk is high in clean orchards neighbouring infected orchards
  - Risk is lowest in orchards in Psa-free zones
- Cultivar susceptibility affects risk, but has not yet been quantified

Daily Risk Category	Risk category description
No risk information	Risk forecast not available at this time or location
1 Low risk	Infection is unlikely, although a small amount may occur where inoculum load is high (e.g. orchards with existing Psa symptoms)
2 Slight risk	A small amount of infection is likely in any orchard in an infected zone
3 Slight to Moderate risk	New infection is likely to produce an increase in disease where inoculum load is high (e.g. orchards with existing Psa symptoms). Symptomless orchards have slight risk
4 Moderate risk	New infection is likely to produce an increase in disease in any orchard in an infected zone
5 High risk	Substantial infection leading to disease increase is likely where inoculum load is high (e.g. orchards with existing Psa symptoms). Symptomless orchards have moderate risk
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Orchard calibration of the *R* index

- What does the *R* index mean in terms of actual Psa infection in orchards?

- The *R* index was compared with infection arising in a Psa-infected ‘Gold’ kiwifruit orchard at Te Puke Research Orchard

Calibration of the *R* risk index

Al McKay developed a method for exposing potted kiwifruit seedlings for week-long periods under Psa-infected 'Gold' vines at the research orchard

- Weekly trap plant exposures for nine weeks from 1 Sep to 3 November 2011
- Eight trays of six plants per week

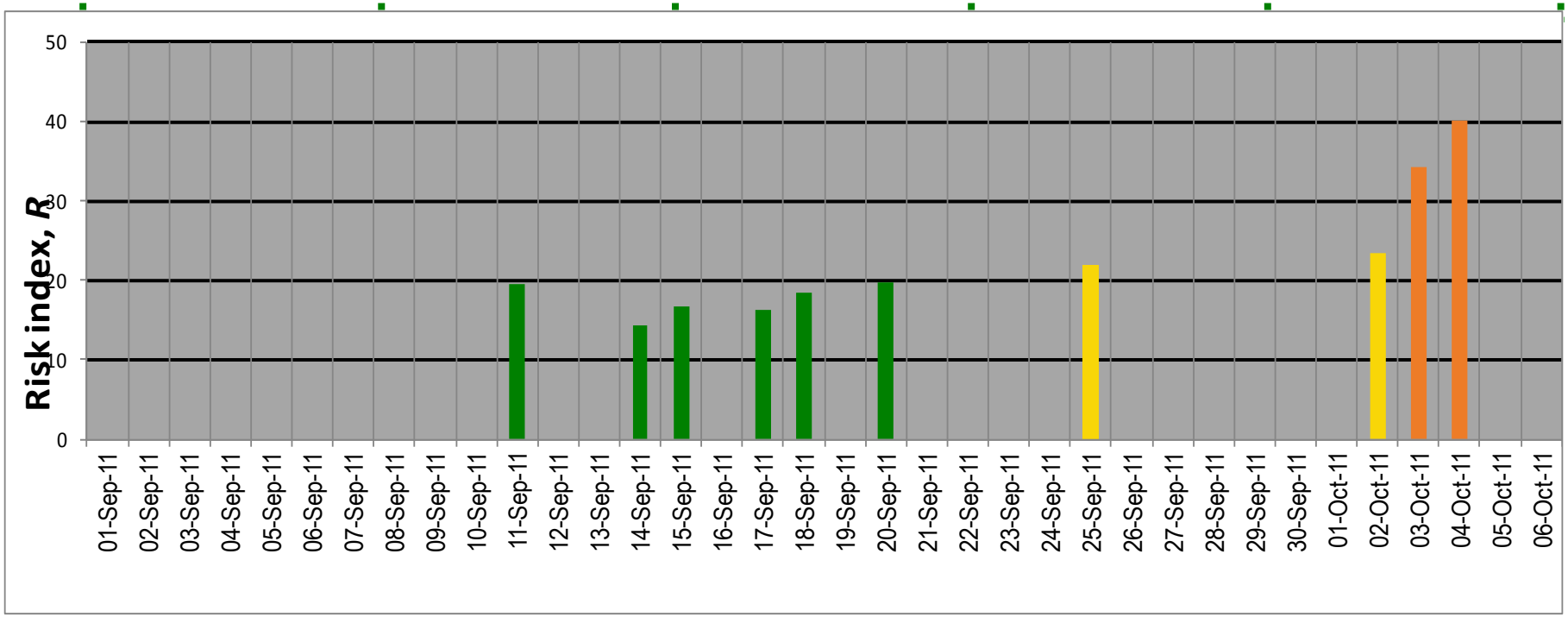
Trap plant symptoms after 20 days

» The seedling leaf symptoms were confirmed as Psa “V-strain”

Trap plant exposure periods

(Amount of infection measured by number of Psa lesions/leaf)

1-8 Sep	8-15 Sep	15-22 Sep	22-29 Sep	29 Sep-6 Oct
No leaf spots	13 spots/leaf	12 spots/leaf	11 spots/leaf	29 spots/leaf



Trap plant exposure periods

(Amount of infection measured by number of Psa lesions/leaf)

6-13 Oct

29 spots/leaf

13-20 Oct

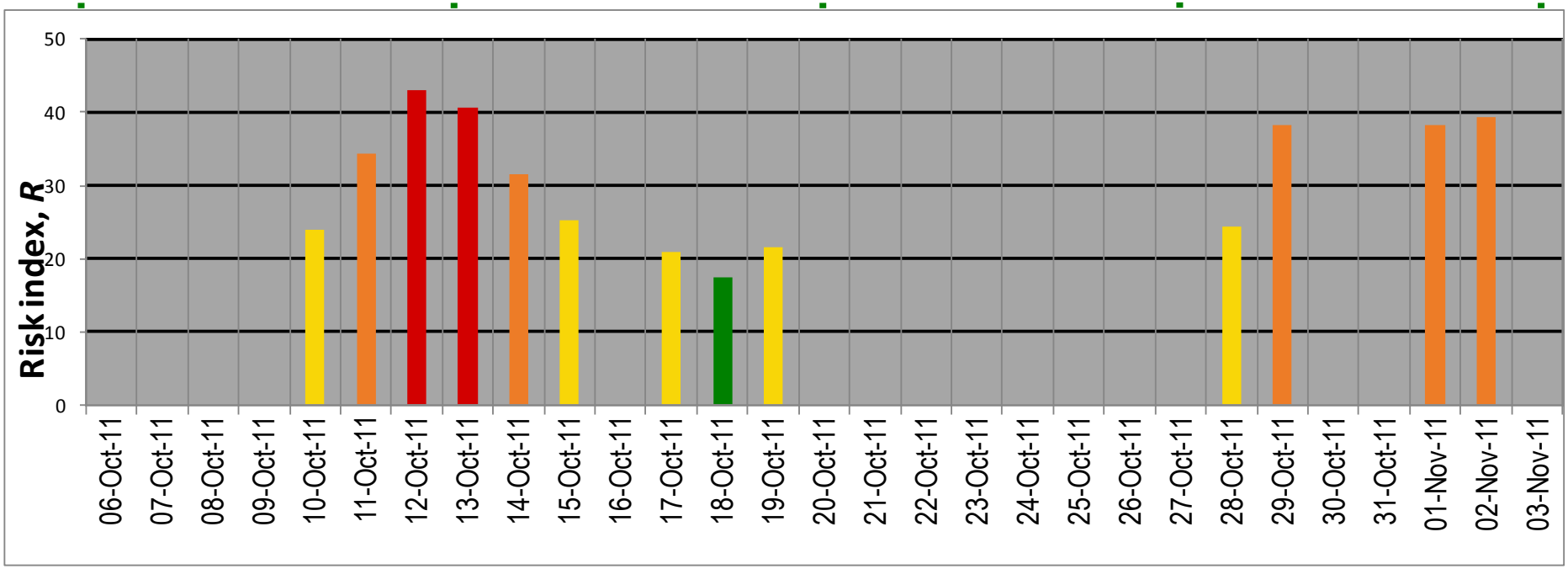
43 spots/leaf

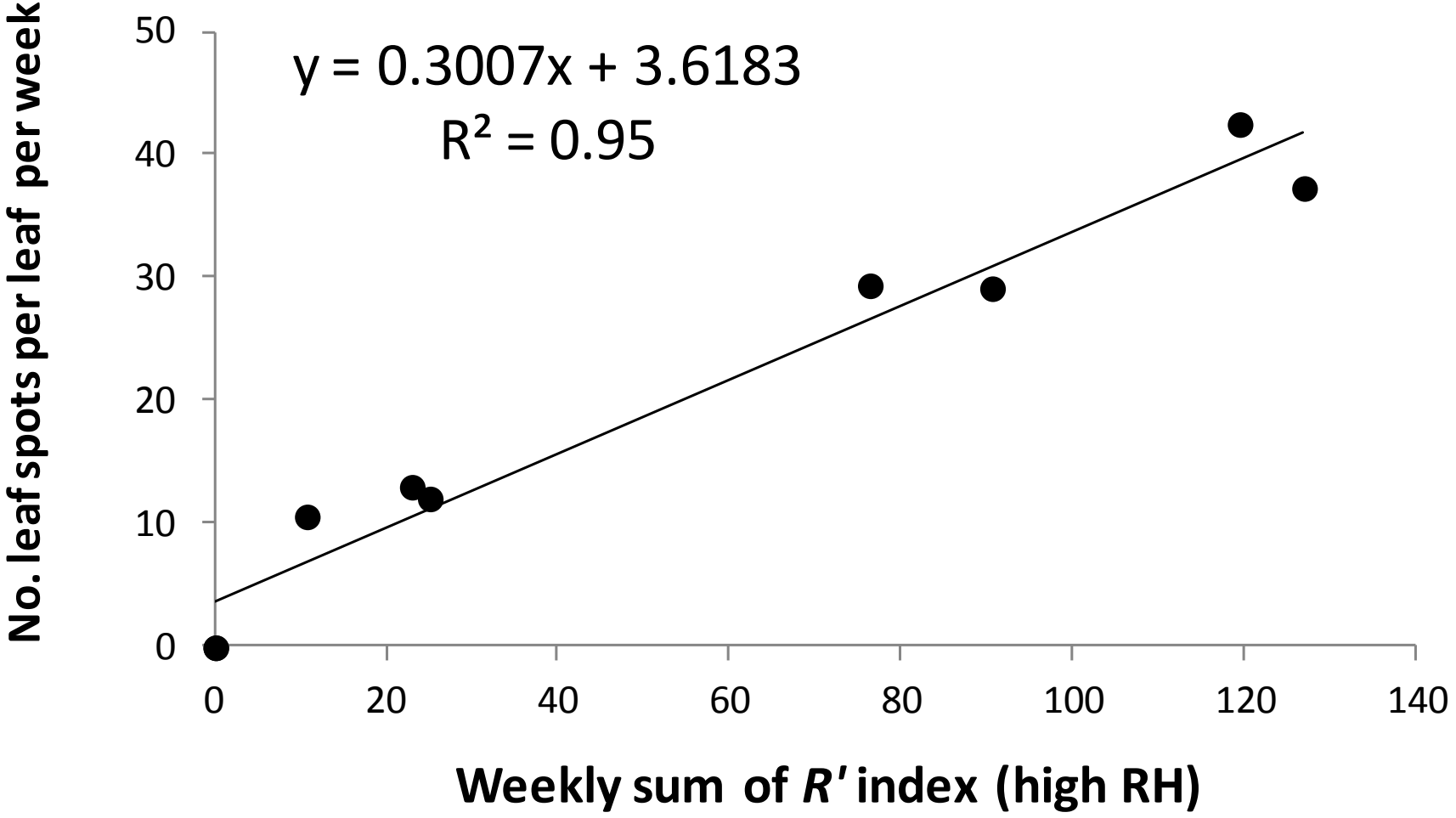
20-27 Oct

No leaf spots

27 Oct – 3 Nov

37 spots/leaf




y = 0.3007x + 3.6183
R² = 0.95
No. leaf spots per leaf per week
Weekly sum of R' index (high RH)
0
10
20
30
40
50
0
20
40
60
80
100
120
140

Conclusions from the orchard studies

- The Psa risk model accurately predicted conditions for leaf infection
- Rain is required for infection
- Infection can occur in most weeks
- What about cane infection?

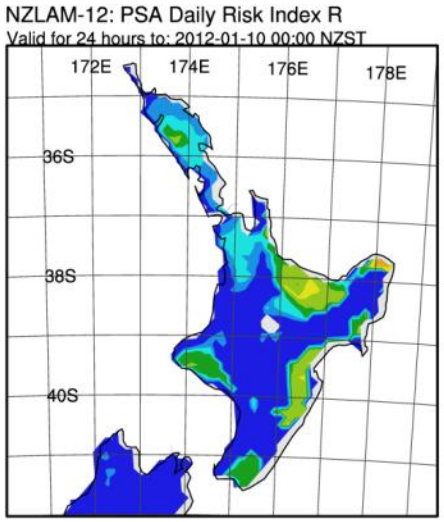
Photo courtesy of Dr Kerry Everett

Next steps in risk model development

- Experiments are underway at PFR in Auckland to study infection under controlled temperature and relative humidity
- New data will be used to improve the risk model
- Epidemiology studies will determine conditions for cane infection

Psa risk model implementation

- We are working with NIWA to implement the preliminary Psa risk model on the KVH website for growers to access



Acknowledgements

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The New Zealand Institute for Plant & Food Research Limited

Thank you

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