THE POTENTIAL OCCURRENCE OF *PUCCINIA ASPARAGI* IN NEW ZEALAND

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ABSTRACT

Wind dispersal of plant pathogens is one of the pathways of entry for rust fungi into New Zealand from Australia. Asparagus rust (caused by *Puccinia asparagi*) has already caused damage to asparagus crops in Australia. It poses a serious risk to New Zealand's biosecurity and the 2000 ha asparagus industry. CLIMEX Match Climates simulations showed that climates in locations where asparagus rust is already present are similar to New Zealand climates.

Keywords: *Puccinia*, rust, long-distance dispersal, modelling, CLIMEX.

INTRODUCTION

The atmospheric pathway enables organisms, such as plant pathogens and pests, to move along dynamic but definable routes created by airflows across landforms on the earth's surface (Isard et al. 2005). Plant pathogens can be transported over hundreds of kilometres. For example, *Puccinia graminis* Pers. f.sp. *tritici*, causing stem rust of wheat, travels each year from central Mexico to the Prairie Provinces of Canada (Kolmer 2001), and tobacco blue mould (caused by *Peronospora tabacina* Adam) periodically travels from Cuba to the south-eastern USA (Davis & Monahan 1991). Long-distance dispersal is particularly relevant for obligate biotrophic fungi, such as those causing rust and powdery mildew diseases, as they are reliant on living host tissue for survival and reproduction. These fungi typically produce enormous numbers of mainly wind-dispersed spores, enabling them to colonise new areas or to migrate between summer and winter habitats (Brown & Hovmøller 2002).

The dispersal of plant pathogens and pests from Australia to New Zealand is well documented (Close et al. 1978; Fox 1978). Several rust pathogens have arrived in New Zealand from Australia, probably by natural dispersal of spores carried by wind (McKenzie 1998). Rust species thought to have arrived in this way include stem rust of wheat (caused by *Puccinia graminis* Pers. f.sp. *tritici*), Antirrhinum rust (*Puccinia antirrhini*), Euphorbia rust (*Melampsora euphorbiae),* sunflower rust (*Puccinia helianthi*), poplar rusts (*Melampsora medusae* and *Melampsora larici-populina*), wheat stripe rust (*Puccinia striiformis* Westend. f. sp. *tritici)* and blackberry rust (*Phragmidium violaceum* (Shultz) Winter). Some recent rust arrivals include blueberry rust (*Naohidemyces vaccinii* synonym *Pucciniastrum vaccinii*) found in Waikato, New Zealand in January 2004 (Anon. 2004) and bridal creeper rust (*Puccinia myrsiphylli)* first found in November 2005 (Anon. 2006).

Several other rust fungi, not yet present in New Zealand, pose risks to the country's biosecurity. Of these, the pathogen causing rust on asparagus, *Puccinia asparagi* DC. In Lam & DC, is already present in Australia. This pathogen was first found in Queensland, Australia, in March 2000 (Davis 2001). Initial attempts at eradication were unsuccessful, and the pathogen has since been found in the Bairnsdale, Koo Wee Rup and Sunraysia regions of Victoria (C.M. Horlock, pers. comm.). The rust is not known in New South

Wales because asparagus is not widely grown in that state, but it was not found in Western Australia in a survey carried out in 2004.

The symptoms of this disease on mature stems are elongated lesions that contain small, orange-red pustules arranged in concentric rings (Cheah & Davis 2002). The disease can decrease plant vigour and reduce the quality of the harvested asparagus spears. In severe cases, it can cause premature senescence and death of plants.

The objective of the present work was to assess the climatic suitability between locations in New Zealand and locations in Europe and North America where asparagus is grown and *P. asparagi* is present. The CLIMEX software program has been used to carry out risk assessments for various pests, weeds and diseases (Sutherst et al. 2004). For example, Yonow et al. (2004) used CLIMEX to determine the potential geographic range of *Pyrenophora semeniperda*, a fungal pathogen that causes leaf spotting in a wide range of annual and perennial grasses.

MATERIALS AND METHODS

The regional, climate-based risk-modelling software CLIMEX (CSIRO, Brisbane, Australia and Hearne Scientific Software Pty Ltd, Melbourne, Australia) allows climatic comparisons by calculating the climatic similarities between locations contained in its global meteorological database using either the Match Climates or Compare Locations modules. The Match Climates module enables comparison of meteorological data from different places, with no reference to the climatic preferences of a given species. It gives a rough assessment of the risk of a pest establishing in a new location and should only be used when no other data are available (Sutherst 2003). The climate similarity is described by an index ranging between 0 (no similarity) and 1 (a complete match). The Compare Locations module enables prediction of the potential geographical distribution of a species based on its climatic preferences (Sutherst et al. 2004).

The Match Climates module of CLIMEX was used to compare climate data from several European locations, where asparagus is grown and where *P. asparagi* originated, data from North America, data from Gayndah, Australia, where asparagus rust has been found, and data from five main asparagus growing areas of New Zealand (only selected locations are presented here).

RESULTS

The climatic match indices (CMI), using the Match Climates prediction for *P. asparagi* in New Zealand compared with climate data from four locations in Europe, varied from 0.8 to 0.6 (Table 1). The CMI between the site in Washington, USA, and New Zealand locations varied between 0.5 and 0.6. The CMI between Gayndah, Australia, and New Zealand locations varied between 0.4 and 0.5. The CMI is a mean of the indices derived from maximum and minimum temperature, rainfall pattern and total amount of rainfall, and relative humidity. These indices varied depending on the home and target location.

DISCUSSION

Approximately 2000 ha of asparagus are grown in New Zealand, mainly in the Waikato, Hawke's Bay, Manawatu-Wanganui, Bay of Plenty and Canterbury regions and the economic value of this industry is NZ$19 million p.a. (Kerr et al. 2006). The climatic similarity between these locations and overseas locations where asparagus is grown and where asparagus rust is present, varied from 0.4 to 0.8. As a rule-of-thumb, values below 0.6 indicate poor matches between locations, but it is important to consider the individual indices as well (Sutherst 2003). The climatic factor that was the most dissimilar between New Zealand locations and Barcelona, Spain, was minimum temperature, while maximum temperature was most dissimilar between New Zealand locations and Birmingham, UK. Relative humidity was most dissimilar between New Zealand locations and Walla Walla, Washington, and Gayndah, Australia. These results imply that climates in locations where asparagus rust is present, are similar to New Zealand climates, although

TABLE 1: CLIMEX climate match indices (0=no match, 1.0=complete match) between "home" meteorological records for European, North American and Australian locations where *Puccinia asparagi* has been recorded and "target" asparagus production areas in New Zealand.

"Home" (in bold) and "target" locations	Overall index	Maximum temperature	Minimum temperature	Rainfall pattern	Total rainfall	Relative humidity
Barcelona, Spain						
Christchurch	0.7	0.6	0.4	0.9	1.0	0.5
Napier	0.7	0.8	0.6	0.9	0.8	0.6
Palmerston North	0.7	0.6	0.5	0.8	0.6	0.6
Ruakura	0.7	0.8	0.5	0.9	0.5	0.5
Whakatane	0.7	0.8	0.6	0.9	0.5	0.5
Toulouse, France						
Christchurch	0.8	0.7	0.8	0.9	0.9	0.6
Napier	0.8	0.7	0.8	0.9	0.9	0.7
Palmerston North	0.7	0.7	0.8	0.9	0.7	0.6
Ruakura	0.7	0.7	0.8	0.9	0.6	0.5
Whakatane	0.7	0.6	0.8	0.9	0.5	0.5
Lisbon, Portugal						
Christchurch	0.7	0.6	0.4	0.8	0.9	0.5
Napier	0.8	0.8	0.6	0.8	0.9	0.7
Palmerston North	0.7	0.7	0.5	0.7	0.7	0.5
Ruakura	0.6	0.9	0.5	0.8	0.6	0.4
Whakatane	0.6	0.8	0.6	0.8	0.5	0.4
Birmingham, UK						
Christchurch	0.8	0.6	0.9	0.9	0.8	0.6
Napier	0.7	0.4	0.6	0.9	1.0	0.4
Palmerston North	0.7	0.5	0.7	0.9	0.8	0.6
Ruakura	0.7	0.4	0.8	0.9	0.6	0.7
Whakatane	0.7	0.4	0.6	0.9	0.6	0.7
Walla Walla, Washington, USA						
Christchurch	0.6	0.5	0.8	0.9	0.7	0.2
Napier	0.6	0.5	0.6	0.9	0.6	0.3
Palmerston North	0.5	0.5	0.6	0.9	0.5	0.2
Ruakura	0.5	0.5	0.6	0.9	0.4	0.2
Whakatane	0.5	0.4	0.6	0.9	0.4	0.2
Gayndah, Australia						
Christchurch	0.4	0.2	0.3	0.8	0.8	0.1
Napier	0.5	0.2	0.5	0.7	1.0	0.1
Palmerston North	0.5	0.2	0.4	0.8	0.8	0.1
Ruakura	0.4	0.2	0.4	0.7	0.7	0.1
Whakatane	0.4	0.3	0.5	0.7	0.6	0.1

other factors than climate, for example soil type and human impact, are not considered here. Further analyses using CLIMEX's Compare Locations module are underway to determine the climatic parameters that determine the suitability of New Zealand climate for the establishment and growth of *P. asparagi* in New Zealand.

As *P. asparagi* has already established in Queensland and Victoria, Australia, the arrival of this pathogen to New Zealand via wind currents or via human assisted pathways of entry, is very likely. Contingency plans, such as epidemiological studies of the pathogen

and identifying appropriate control strategies, have already commenced in Australia in case future eradication campaigns in New Zealand are not successful. The earlier the detection, the more chance there is of successful eradication of unwanted organisms, so good crop surveillance is vitally important to ensure any outbreaks are quickly detected and contained. It is equally important to have identified appropriate control strategies, such as resistant cultivars or chemical and cultural control methods, that can be quickly employed in case of outbreak to help minimise the potential economic damage from this pathogen.

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