Epidemiology and management of cercospora leaf spot (*Cercospora zonata*) of faba beans (*Vicia faba*)

by

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ABSTRACT

The disease cercospora leaf spot (CLS), caused by the fungus *Cercospora zonata*, has affected faba bean (*Vicia faba*) production regions in southern Australian in recent years. This study provides new information on the prevalence and significance of the disease and the factors that affect severity.

Temperature, wetness period, plant maturity, pathogen variability and inoculum concentration all influenced infection of faba bean by *C. zonata* in a controlled environment. Disease severity was positively correlated (R^2=0.83 P<0.001) with wet-degree hours (DH_w) and premature defoliation (40-50%) of the lower canopy, which was most severe when the pathogen was inoculated at the mid- to late-vegetative crop growth stages. Pathogenicity tests showed that 29 isolates of *C. zonata* collected from 1999 to 2008 varied in aggressiveness; this was not related to geographical origin of isolates or growth rate *in vitro*, but isolates collected from 2005 to 2008 were more aggressive than those collected in the period 1999-2004.

The temporal and spatial dynamics of the disease on susceptible and resistant genotypes of faba bean were examined. A strong association between the incidence and severity of CLS and soil-borne inoculum was established using comparative analyses of disease on plants in soil sown with faba bean every 3 years since 1997 and in adjacent soil with no history of cultivation of faba bean. Spatial patterns of disease development showed that inoculum spread primarily over short distances during the early stages of CLS epidemics, though dispersal of 4 to 16 m from the infested soil was observed. Non-linear regression using a logistic model described disease development over time on susceptible plants in soil with *in situ* inoculum, whereas an exponential model best described disease gradient with distance from the inoculum source and disease development on resistant plants. There was a positive relationship (R^2=0.93, P<0.05) between disease severity on susceptible plants grown

in soil with infested residue on the surface and the amount of DNA of *C. zonata* detected in the soil. When residues were removed from the soil surface, or depleted rapidly through grazing, the infectivity of soil and the amount of DNA of *C. zonata* detected were significantly less than for soil with residue remaining on the surface. *C. zonata* survived in soil, on infested residue or as fungal propagules in the soil profile, and remained infective for at least 30 months.

The distribution and occurrence, host range and management of CLS of faba bean in southern Australia were studied. *C. zonata* infected narbon bean, lentil and vetch but did not infect pea, chickpea, lathyrus, lupin or canola. A disease survey of 100 commercial faba bean crops in southern Australia showed that CLS was endemic to all districts examined, observed in 87% of crops. Disease severity varied in all districts but was most severe in crops in the south-east of South Australia. Disease incidence and severity were highest in fields planted with faba bean in short rotations (1-4 years) and decreased (R^2=0.13, P=0.006) as the interval between faba bean crops increased. Severity also appeared to be influenced by faba bean residue remaining from the previous year in adjacent fields. CLS manifested as severe lesions on foliage and extensive defoliation, resulting in a 7% reduction in yield in field experiments. Applications of carbendazim, tebuconazole, chlorothalonil and triadimefon significantly reduced CLS severity compared with untreated controls and a single application of either carbendazim or tebuconazole prior to disease onset was identified as an economical application strategy for control of the disease.

A rapid screening technique was developed to identify resistance to *C. zonata* in faba bean genotypes in a controlled environment. All faba bean cultivars commercially available to the Australian industry were susceptible to the disease. The mode of inheritance of resistance to *C. zonata* was determined to be monogenic dominant and this has allowed a relatively simple pathway by which sources of resistance identified in this study can be transferred to adapted faba bean genotypes available to the southern Australian industry.

DECLARATION

This work contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text.

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STATEMENT OF THE CONTRIBUTIONS TO JOINTLY AUTHORED PAPERS

1. Kimber, R. B. E., Paull, J. G., Scott, E. S. and Davidson, J. A. 2011. Host range, prevalence and management of cercospora leaf spot (*Cercospora zonata*) of faba bean (*Vicia fab*a) in southern Australia. Phytopathology X:X-X [prepared manuscript].

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Presented in Chapter 8. Author contributions: RBEK developed and conducted all disease screening experiments, analysed the data, and drafted/constructed the manuscript. JGP supervised all research, issued germplasm, designed and analysed genetics of resistance studies, contributed to the research ideas and design, and the editing of the manuscript.

Each of these manuscripts is displayed in this thesis in either submitted or published form according to the instructions to author of the specific journal.

This thesis has been prepared according to the University of Adelaide's specifications for 'combination conventional/publication format'.

The following authors agree that the statement of the contributions of jointly authored papers accurately describes their contribution to research manuscripts 1, 2, 3 and 4 and give consent to their inclusion in this thesis.

Kimber, R.B.E.

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This thesis is dedicated to the memory of my father,

Barrington Litchfield Kimber

1936 – 1995

So rarely are great and good the same man.

If we are to go forward, we must first go back and rediscover those precious values - that all reality hinges on moral foundations and that all reality has spiritual control.

Dr Martin Luther King Jr.

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ABBREVIATIONS

ANOVA	analysis of variance
AWS	automatic weather station
BSA	bean seed agar
CA	carrot agar
CER	controlled environment room
CJA	carrot juice agar
CLDA	carrot leaf decoction agar
CLPA	carrot leaf pulp agar
CLS	cercospora leaf spot
CMA	cornmeal agar
CRB	completely randomised block
CSIRO	Commonwealth Scientific and Industrial Research Organisation
cv.	cultivar
cvs	cultivars
DAI	days after inoculation
DAS	days after sowing
Diam	diameter
DNA	deoxyribonucleic acid
GS	growth stage
ITS	internal transcribed spacer
LAD	leaf area diseased
LPLA	loss of photosynthetic leaf area
NSW	New South Wales
NUV	near ultraviolet
PCR	polymerase chain reaction
PDA	potato dextrose agar (full strength)
RCBD	randomised complete block design
RDTS	Root Disease Testing Service
RO	reverse osmosis
SA	South Australia
SARDI	South Australian Research and Development Institute
V8A	V8 juice agar
V8B	V8 juice Broth
Vic.	Victoria
WA	Western Australia
WAS	weeks after sowing