Physiological and genetic basis of *Phytophthora* disease resistance in Sturt's desert pea, *Swainsona formosa* (G.Don) J. Thompson, (Fabaceae)

By

Naser Panjehkeh

B.Sc.: Plant Protection (Ahwaz University, Iran)

M.Sc.: Plant Pathology (Tarbiat Moddares University, Iran)

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Red, pink and white lines of Sturt's desert pea (*Swainsona formosa*)

Declaration

I certify that the substance of this thesis has not already been submitted for any degree and is not being currently submitted for any other degree at this or any other higher education institution.

I certify that to the best of my knowledge any assistance received in preparing this thesis, and all sources used, have been acknowledged.

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Naser Panjehkeh

DEDICATION

I dedicate this dissertation to the spirits of my eldest brother-in-law, Haj Hossein-Ali Sargazi and my eldest uncle on my father's side, Shikh (Hossein) Panjehkeh, who were respectively martyred and passed away when I was performing the research.

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Most importantly of all, I would like to thank God who brings meaning and purpose to my life, and who has guided me through the good times and the bad over the past four years.

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ABSTRACT

The susceptibility of Sturt's desert pea (*Swainsona formosa*), an ornamental legume with red, pink and white flowers, to fungal root pathogens such as *Phytophthora cinnamomi*, acts as a constraint to large-scale commercial production. Developing lines resistant to such pathogens is the most desirable method of control, as chemical control often results in chemical resistance or tolerance, and environmental pollution. Observations from the *S. formosa* breeding program at the University of New England suggested that the white and pink lines may be more susceptible to root disease than the more common red line. Therefore, the objectives of this project were to establish whether a link exists between flower colour and resistance to *P. cinnamomi*, to identify any biochemical or physiological mechanisms of resistance to *P. cinnamomi*, and to determine whether it is possible to breed white- or pink-flowered lines resistant to some common soilborne diseases.

Root, hypocotyl and detached stem assays were conducted using each *S. formosa* line to identify those lines resistant and susceptible to *P. cinnamomi*, and the mode of resistance inheritance was determined in the F_2 generation. Biochemical and physiological resistance mechanisms to *P. cinnamomi* were determined by measuring anthocyanin content, soluble phenolic compounds and β-1,3-glucanase activity in inoculated and non-inoculated hypocotyls and stems from each line. In addition, the concentrations of leucoanthocyanidins and proanthocyanidins extracted from non-inoculated stem buds were measured. Anthocyanin toxicity to *P. cinnamomi* was directly examined, and proanthocyanidin toxicity was indirectly assessed following precipitation by bovine serum albumin.

Red-flowered plants were asymptomatic after inoculation with *P. cinnamomi*, but inoculated white-flowered plants showed severe symptoms and pink-flowered plants exhibited intermediate symptoms. In addition, the reaction of the three *S. formosa* lines to *Pythium irregulare* and *Fusarium solani* was similar to their reaction to *P. cinnamomi.* Anthocyanin content of red and pink line hypocotyls was similar, indicating that absolute and partial resistance respectively, were not related to anthocyanin content and that anthocyanins were not toxic to *P. cinnamomi.* β-1,3-glucanase activity did not differ between lines, or between inoculated tissue and controls, suggesting that red line resistance was not associated with these pathogenesis-related protein. Soluble phenolic concentration was significantly

different among the three *S. formosa* lines, but no difference was evident between inoculated and non-inoculated plants, indicating that soluble phenolic compounds prevented infestation by *P. cinnamomi* in the red line. The proanthocyanidins of soluble phenolics were identified to be toxic to the fungus. This was confirmed when the supernatant of soluble phenolic compounds after precipitating proanthocyanidins, by bovine serum albumin, was not toxic to the fungus.

A 3:1 ratio of resistant to susceptible plants in the F2 generation indicated that proanthocyanidin content was controlled by a single dominant gene which also determined flower colour. Polymerase chain reaction (PCR) was used to amplify a portion of the gene for anthocyanidin reductase, which converts anthocyanidin to epicatechin, one of the precursors of proanthocyanidin. This confirmed the presence of this pathway in *S. formosa*, which would explain the linkage between flower colour and resistance. The presence of epicatechin in the red and pink lines, but not in the white line, was also observed in chromatograms obtained using high performance liquid chromatography. In conclusion, it may be possible to get white flowered lines with high disease resistance.