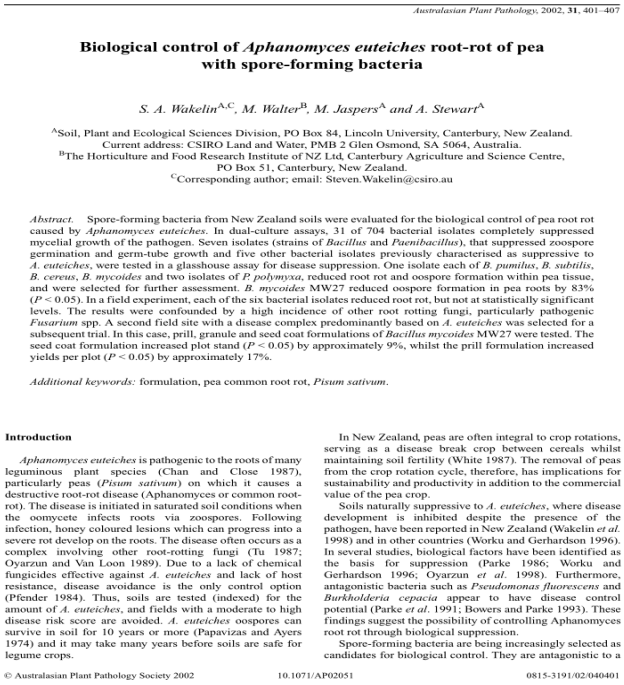
The Aerobic Endospore-forming Bacteria: Classification And Identification



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Biological control of *Aphanomyces euteiches* root-rot of pea with spore-forming bacteria

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Abstract. Spore-forming bacteria from New Zealand soils were evaluated for the biological control of pea root rot caused by *Aphanomyces euteiches*. In dual-culture assays, 31 of 704 bacterial isolates completely suppressed mycelial growth of the pathogen. Seven isolates (strains of *Bacillus* and *Paenibacillus*), that suppressed zoospore germination and germ-tube growth and five other bacterial isolates previously characterised as suppressive to *A. euteiches*, were tested in a glasshouse assay for disease suppression. One isolate each of *B. pumilus*, *B. subtilis*, *B. cereus*, *B. mycoides* and two isolates of *P. polymyxa*, reduced root rot and oospore formation within pea tissue, and were selected for further assessment. *B. mycoides* MW27 reduced oospore formation in pea roots by 83% ($P < 0.05$). In a field experiment, each of the six bacterial isolates reduced root rot, but not at statistically significant levels. The results were confounded by a high incidence of other root rotting fungi, particularly pathogenic *Fusarium* spp. A second field site with a disease complex predominantly based on *A. euteiches* was selected for a subsequent trial. In this case, prill, granule and seed coat formulations of *Bacillus mycoides* MW27 were tested. The seed coat formulation increased plot stand ($P < 0.05$) by approximately 9%, whilst the prill formulation increased yields per plot ($P < 0.05$) by approximately 17%.

Additional keywords: formulation, pea common root rot, *Pisum sativum*.

Introduction

Aphanomyces euteiches is pathogenic to the roots of many leguminous plant species (Chan and Close 1987), particularly peas (*Pisum sativum*) on which it causes a destructive root-rot disease (Aphanomyces or common root-rot). The disease is initiated in saturated soil conditions when the oomycete infects roots via zoospores. Following infection, honey coloured lesions which can progress into a severe rot develop on the roots. The disease often occurs as a complex involving other root-rotting fungi (Tu 1987; Oyarzun and Van Loon 1989). Due to a lack of chemical fungicides effective against *A. euteiches* and lack of host resistance, disease avoidance is the only control option (Pfender 1984). Thus, soils are tested (indexed) for the amount of *A. euteiches*, and fields with a moderate to high disease risk score are avoided. *A. euteiches* oospores can survive in soil for 10 years or more (Papavizas and Ayers 1974) and it may take many years before soils are safe for legume crops.

In New Zealand, peas are often integral to crop rotations, serving as a disease break crop between cereals whilst maintaining soil fertility (White 1987). The removal of peas from the crop rotation cycle, therefore, has implications for sustainability and productivity in addition to the commercial value of the pea crop.

Soils naturally suppressive to *A. euteiches*, where disease development is inhibited despite the presence of the pathogen, have been reported in New Zealand (Wakelin *et al.* 1998) and in other countries (Worku and Gerhardson 1996). In several studies, biological factors have been identified as the basis for suppression (Parke 1986; Worku and Gerhardson 1996; Oyarzun *et al.* 1998). Furthermore, antagonistic bacteria such as *Pseudomonas fluorescens* and *Burkholderia cepacia* appear to have disease control potential (Parke *et al.* 1991; Bowers and Parke 1993). These findings suggest the possibility of controlling Aphanomyces root rot through biological suppression.

Spore-forming bacteria are being increasingly selected as candidates for biological control. They are antagonistic to a

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