Bioherbicide projects in Australia

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Bioherbicide projects in Australia include work in crops, pastures and natural ecosystems, with a range of pathogens and weed species. The largest centre for bioherbicide research is at NSW Agriculture, Agricultural Research and Veterinary Centre, Orange, where work is continuing on *Colletotrichum* spp. and *Altenaria* spp. on *Xanthium* spp., the use of *Rhynchosporium alismatis* on rice weeds, and of pathogens of thistles, grass weeds and bitou bush. Some of this work is in conjunction with Charles Sturt University and the University of New England. Other bioherbicide projects are conducted at the Royal Botanic Gardens in Sydney, the Cooperative Research Centre for Tropical Plant Pathology in Brisbane, and the Royal Melbourne Institute of Technology in Melbourne.

Success of an invert emulsion formulation in two bioherbicide systems

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An invert-emulsion formulation developed at Strathclyde University was tested in two weed/pathogen systems in Australia. The first system *Colletotrichum orbiculare/Xanthium spinosum* has an optimal dew-period of approximately 16 hours when applied as a simple aqueous suspension. The second system *Alternaria zinniae/Imazaquin/Xanthium occidentale* has a similar dew requirement. Invert emulsion formulations which included soybean oil and the surface active agents Arlacel 780® and Arlacel 989® overcame the need for any dew to induce death of plants in both systems.

Bioherbicides for pigweeds, nutsedges, grasses and other weeds in niche markets

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We are attempting to develop bioherbicides for tropical soda apple (*Solanum viarum*), pigweeds (*Amaranthus* spp.), nutsedges (*Cyperus* spp.), and several grasses and broad-leaved weeds of concern to citrus growers and to highway officials. Our primary goal is to develop bioherbicides to manage these weeds in niche markets in Florida, United States of America. Among the agents under intensive evaluation are: *Phomopsis amaranthicola* to control pigweeds; strains of *Pseudomonas solanacearum* specific to tropical soda apple; *Dactylaria higginsii* for purple and yellow nutsedges (*C. rotundus* and *C. esculentus*) and rice flatsedge (*Cyperus iria*); three isolates of

Helminthosporium spp. broadly pathogenic to bermudagrass (*Cynodon dactylon*), crabgrass (*Digitaria* spp.), goosegrass (*Eleusine indica*), guineagrass (*Panicum maximum*), johnsongrass (*Sorghum halepense*), pangola grass (*Digitaria decumbens*), Texas panicum (*Panicum texanum*), torpedo grass (*Panicum repens*), southern sandbur (*Cenchrus echinatus*), and yellow foxtail (*Setaria glauca*). We have received a USA patent for the bioherbicidal use and composition of *P. amaranthicola* and we are seeking an industrial partner to develop this agent. Some additional pathogens of tropical soda apple are being evaluated in Brazil. Also in progress are studies on: (i) ways to increase production of stress-tolerant, highly-virulent spores using *Cercospora* species as a model; (ii) the role of microorganisms in the decline of insect-damaged hydrilla (*Hydrilla verticillata*); and (iii) the epidemiology of two diseases of hydrilla.

Rhizo-organisms to manage *Bromus tectorum* and *Setaria viridis* in wheat

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Rhizo-organisms were isolated and evaluated, as live cells or cell-free extracts under low temperature (10°C) conditions in growth chambers, for their ability to reduce the germination and growth of *Setaria viridis* and *Bromus tectorum*. Results indicated that live cells were effective at inhibiting the germination of *Setaria viridis* but that they had very little effect on growth of the plants after germination. Cell-free extracts did not markedly reduce germination but did reduce root- and shoot-growth by 50 to 70%. Isolates have been identified that inhibit the growth of these weeds without any detrimental effect on wheat. The effectiveness of the live cells on the weeds was reduced as soil-moisture decreased. Field studies are required to understand the interactions among organisms in the rhizosphere and the effect of these organisms on plant species. Preliminary studies addressing this question have demonstrated that grass-weed-species are more frequently colonized by vesicular-arbuscular mycorrhizal fungi (VAM) than wheat. Roots colonized by VAM fungi usually have a different microbial community in the rhizosphere compared to uncolonized plants, and this has implications for weed management.

Progress in the development of *Rhynchosporium alismatis* as a biocontrol agent for Alismataceae weeds

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Rhynchosporium alismatis occurs naturally in Australia on three aquatic weeds of rice; *Alisma lanceolatum*, *A. plantago-aquatica* and *Damasonium minus*. It has been recorded elsewhere on four other species within the Alismataceae. The fungus appears to have little effect on vegetative growth of naturally-infected plants. However, analysis of data comparing seed weights from healthy- and naturally-infected inflorescences suggest a tendency ($p = 0.053$) towards lower seed-weights from diseased inflorescences. Pathogenicity to a further six species in the Alismataceae has been shown and application of conidia to the seedlings of most species will result in significant growth-suppression. The mechanism of suppression is not known and occurs without visible lesions. *Rhynochosporum alismatis* is stable in culture and in storage at 5°C on sterile soil. It grows well on a variety of solid- and liquid-media and will produce >106 conidia/ml of liquid-culture within five days. Higher yields are dependent on particular carbon sources. Conidia germinate readily and appressorium formation *in vitro* is readily