Biological control of annual grass weeds—progress and prospects

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Why biocontrol?

The advantages of biological control in reducing use of chemicals, non-target damage and environmental contamination are well known. Application of pathogenic organisms to grass weeds remains a scarcely investigated option for weed control (Evans 1991). In the early 1990s, five of the six recorded herbicide resistant weeds in Australia were grasses (Davis 1992). Herbicide resistant populations of annual ryegrass (*Lolium rigidum* Gaudin) (Holtum and Powles 1991), wild oats (*Avena* spp.) (Powles and Holtum 1990) and vulpia (*Vulpia bromoides* (L.) Gray) (Purba *et al.* 1993) have been recorded in Australia. Calls for augmentation of chemical controls and the diversification of control strategies have been made following the appearance of herbicide resistance (Howat 1987).

Biocontrol and the biology of grasses

Many grasses produce large numbers of seeds which may have high dormant populations. Additionally, growth occurs from intercalary meristems situated near or just below the soil surface and sheathed in leaves. This allows recovery from injury e.g. grazing or foliar diseases (Terry 1991). Biological control strategies should target these aspects of grass biology and may aim to:

- reduce plant vigour, subsequently affecting the competitive influence and fecundity of the weed population e.g. leaf spots, root rots,
- directly affect reproductive structures, e.g. smuts, false smuts,
- destroy meristems and kill plants e.g. crown rots.

Progress

Biological control of annual grasses in wheat cultivation (Hetherington, Auld, Priest and Smith)

An Australian Centre for International Agricultural Research project is studying potential fungal biocontrol agents of weeds in cultivation. Emphasis has been placed upon *Avena* spp. and *L. rigidum.*

Surveys of diseased weedy annual grasses commenced throughout wheat growing areas of southern Australia as well as several coastal locations (e.g. Grafton and Brisbane) in August 1995. The samples are returned to the Agricultural Research and Veterinary Centre for processing. A collection of isolates has been established and a comprehensive record of each isolate kept on a database. Currently, approximately 700 fungal isolates have been isolated from *Avena fatua* and *L. rigidum* and stored. Representative isolates are identified by the fungal herbarium at Biological and Chemical Research Institute, Rydalmere.

Pathogenicity testing of these isolates has commenced. A simple bioassay of susceptibility to disease has been established. Leaf segments are floated on an agar medium containing the antisenescent benzimadazole. These segments are inoculated with potential fungal pathogens and if the interaction is compatible, lesions appear within days. Crop plants of interest can be included in this test (e.g. wheat is included in wild oats tests).

Whole plant inoculations have also been conducted. Fifty isolates of the fungal pathogen *Drechslera avenae* (Eidam) Sharif have been tested at low inoculum concentration (10^3–10^4 spores mL^{-1}) against wheat and wild oats. In all cases, wild oat plants were severely damaged and wheat unharmed. Optimization of environmental conditions and increased inoculum density may produce even more damage to wild oats. Other fungi found during surveys to be tested for pathogenicity to wild oats include *Pyrenophora seminiperda* (Brittlebank and Adam) Shoemaker, *Septoria avenae* Frank, *Ascochyta* spp. and *Colletotrichum* spp.

Pyrenophora seminiperda—possible bioherbicide for grass weed seeds (Medd and Campbell)

Pyrenophora seminiperda is a ubiquitous fungal pathogen infecting a wide range of hosts causing a variety of symptoms including seed sterilization, seedling blight, leaf spotting and leaf striping (Medd 1992, Medd and Jones 1992).

This pathogen may be used for biological control of a number of weedy annual grasses, notably *Avena fatua, Vulpia bromoides* and *Lolium rigidum*. The proposed strategy is based upon the pathogens ability to infect seed and subsequently decrease germination, emergence and vigour (Table 1).

While the fungus infects wheat it does not appear to affect milling quality. Levels of seed damage greater than 70% have been predicted as necessary to bring about population decline in wild oats (Medd and Campbell in press). The only limitation placed upon the grower is that treated seed cannot be used for grow-on.

Prospects

Biological control of annual grasses in wheat cultivation (Hetherington, Auld, Priest and Smith)

A listing of recorded pathogens compiled from the New South Wales host index (Table 2) gives an indication of the wide range of fungi which might be available for use in biological control systems. It is hoped that the survey will also find unrecorded pathogens which may be added to this range. *Leptosphearulina trifolii* (Rostr.) Petr. was previously unrecorded as a pathogen of wild oats in New South Wales, but has been found several times during this survey and its pathogenicity confirmed.

Drechslera avenae has caused severe damage to wild oats in pathogenicity tests. Optimization of the inoculation technique should increase this severity. At present, it is possible to produce inoculation with spore concentrations of only 10^3–10^4 spores mL^{-1}. It is likely that we will be able to increase this concentration using filter paper incubation techniques (Bournival *et al.* 1994).

The wide geographical range from which we are collecting pathogens may help to avoid the high humidity requirements of some biological control systems. It is hoped that, given the large number of

Table 1. The effect of field applications of a single isolate of *P. seminiperda* on caryopsis infection, germination and development of wheat and several annual grass weeds (Reproduced with permission from Medd and Campbell in press).

	Seed infected (%)	Reduction in germination (%)	Reduction in emergence (%)	Reduction in vigour (%)
Triticum aestivum L.	21	2	55	34
Bromus diandrus Roth.	62	35	51	26
Avena fatua L.	8	2	11	10
L. rigidum	18	12	12	22
Hordeum leporinum Link.	38	15	38	30
V. bromoides	59	16	70	54

Table 2. Listing of pathogens recorded on three grass weeds in New South Wales.

	Avena fatua	*Lolium rigidum*	*Vulpia* spp.
Bipolaris sorokiniana (Sacc.) Shoemaker		✓	
Cladosporium herbarum (Pers.) Link : Gray		✓	
Claviceps phalardis		✓	✓
Claviceps purpurea (Fr.) Tul.		✓	
Cochliobolus sativus[A] (Ito & Kurib.) Drechslera : Dastur		✓	
Colletotrichum graminicola (Ces.) Wilson	✓	✓	
Drechslera avenae (Eidam) Sharif.	✓		
Drechslera sp.		✓	
Gaumannomyces graminis[A] (Sacc.) von Arx & Oliv.	✓		
Phoma sorghina (Sacc.) Boerema, Dorenbosch & van Kesteren		✓	
Phytophthora macrospora (Sacarardo) Ito & Tanaka	✓	✓	
Phytophthora sorghina		✓	
Pseudocercosporella herpetrichoides (Fron) Deighton	✓	✓	
Puccinia coronata Corda	✓	✓	
Puccinia graminis[A] Pers	✓	✓	✓
Puccinia recondita[A] Roberge : Desm.			✓
Pyrenophora seminiperda[A] (Brittlebank and Adam) Shoemaker	✓	✓	✓
Ramularia pusilla		✓	✓
Sclerophthora graminis	✓		
Selenophoma donacis (Pass.) Sprague & Johnson			✓
Septoria avenae Frank	✓		
Septoria tritici[A] Roberge in Desm.	✓	✓	
Stomaticola spp.			✓
Tilletia fusca (Ellis & Everh.)			✓
Urocystis agropyri[A] (Preuss) Schrot.		✓	
Urocystis occulta Rabenh		✓	
Ustilago avenae (Pers.) Rostr.	✓		
Ustilago bullata Burk. In Hook. f.		✓	
Ustilago nuda[A] Kellerman & Swingle		✓	

[A] recorded as infecting wheat.

isolates of each pathogen which we have stored, certain isolates will be able to infect under drier conditions. A new project, run in conjunction with this work will be examining formulations to overcome dew requirements such as invert emulsions (Womack *et al.* 1996).

Pyrenophora seminiperda—possible bioherbicide for grass weed seeds (Medd and Campbell)

A provisional patent has been granted for the novel use of *P. seminiperda* against grass weeds. The concept is still largely unexplored and much remains to be done. The results presented are from a single isolate. It is likely that more virulent isolates exist. Therefore, collection and screening is a priority. Formulation and field delivery systems must be explored and optimized. Because wheat is also a host of *P. seminiperda*, particular emphasis will need to be placed upon the toxicity of infected grain since the agent could affect grain used for human consumption (Medd and Campbell in press).

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