Prospects for the biological control of the weedy sporobolus grasses in Australia

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Summary This paper reports one of the first attempts at biological control of an invasive weedy grass. Five exotic *Sporobolus* spp., collectively known as the weedy sporobolus gsses, have become serious weeds along the entire eastern seaboard of Australia. The grasses are of extremely low palatability such that cattle can not utilise them and are also invasive and easily spread to new properties and areas. In 2000, a project to develop a biological control commenced. Surveys of southern Africa, where *S. pyramidalis* P.Beauv., *S. natalensis* (Steud.) Dur. & Schinz. and *S. africanus* (Poir.) Robyns & Tournay originate, were undertaken. Some 70 phytophagous insect species and 23 plant pathogens were found on these grasses but only two organisms were considered potential biocontrol agents; the leaf smut *Ustilago sporoboli-indici* L.Ling and the stem wasp *Tetramesa* sp. These two agents were studied further. Techniques to culture the smut were developed and it was found to be infective for Australian populations of four of the target species, but not the American *S. jacquemontii* Kunth. However it was also infective on four Australian native *Sporobolus* spp. and was therefore rejected. All attempts to rear the stem wasp failed and as this is an essential prerequisite for further study, work on this agent was discontinued. Although other areas such as Asia and North America could be searched, the prospects for biological control of these grasses are not good. Issues relating to the biological control of grasses are discussed.

Keywords Biological control, *Sporobolus*, leaf smut, stem wasp, termination.

INTRODUCTION

Five grasses (*Sporobolus africanus*, *S. fertilis* (Steud.) Clayton, *S. jacquemontii*, *S. natalensis* and *S. pyramidalis*), collectively known as the weedy sporobolus grasses, are serious pastoral weeds in Australia, affecting productivity, property management and, ultimately, land values. The detrimental effects of these grasses are such that the potential annual losses to beef production in northern Australia, if weedy sporobolus grasses spread to their limits, have been estimated at $60 million per year (Walton 2001).

Biological control offers a cost effective method of reducing the detrimental economic effects of this weed complex in the longer term. Biological control seeks to alter the presently favourable dynamics for a weed, thereby weakening the weed's ability to compete with other plant species in the sward. A typically successful biocontrol might return a benefit/cost ratio of $2–10 per research dollar and in some cases this is considerably higher (Page and Lacey 2006).

A typical classical biological control project involves ascertaining the origin of the weed, surveying for natural enemies in its land of origin, testing prospective agents to ascertain whether they are safe to release in Australia, mass rearing and releasing the agent if approved for introduction, and then evaluating the effect of the agent after it has established.

The weedy sporobolus grasses are all exotic and belong to a section of the *Sporobolus* genus known as the *indicus* complex (Simon and Jacobs 1999). The species included in the *indicus* complex are morphologically very similar and it is quite likely that these species will be redefined should appropriate molecular studies be conducted. The *indicus* complex is presently represented in Australia by 11 species, including six native species. A further 13 species outside this complex complete the 24 *Sporobolus* spp. found in Australia.

Because three of the five weedy species (*S. africanus*, *S. natalensis* and *S. pyramidalis*) originate in southern Africa, this area was a logical starting point for a search for biological control agents. Further, it was also logical to conduct the search from an existing biological control facility, the Queensland Department of Natural Resources and Mines' South African Field Station. This paper describes the surveying efforts in southern Africa, the preliminary host testing of the leaf smut, *Ustilago sporoboli-indici* and the biology study of the stem wasp *Tetramesa* sp.

MATERIALS AND METHODS

Survey of Southern Africa The study was undertaken over a two year period, 2001–2003, from the South Africa Field Station situated near Pretoria, South Africa. The study involved surveying the phytophagous arthropod fauna and pathogens on all three grasses throughout as much of their ranges as possible. In that respect it was not possible to visit some countries, such as Zimbabwe, because of political and safety issues. Ultimately, South Africa, Botswana and Swaziland were surveyed. Insect identifications were made by staff of the National Collection of Insects.

Identification of the individual species of *Sporobolus* presented some difficulty, as they are morphologically quite similar. Further, these species interbreed. The taxonomy of the weedy sporobolus grasses remains problematic and is outside the scope of this project. By project's end the survey team was confident in their diagnoses but also collected appropriate plant specimens at collecting sites so that future changes in species concepts can be accommodated. *S. pyramidalis* and *S. natalensis* did not occur in the Western Cape, whereas *S. africanus* was quite abundant in pastures in this region. All three species co-occur in areas further north and are particularly abundant in disturbed sites. A second difficulty was that southern Africa experienced drought conditions similar to Australia for much of the two years of the project.

Leaf smut investigations The leaf smut *U. sporoboli–indici* was studied at the University of KwaZulu-Natal from 2005 to 2006. The first step was to develop a satisfactory laboratory method of culture and knowledge of the life cycle of the smut. The pathogenicity of the smut fungus was tested against Australian populations of the five weedy sporobolus grasses (*S. pyramidalis, S. africanus, S. fertilis, S. natalensis* and *S. jacquemontii*).

A primary screen for host range was then undertaken. This involved testing the smut against 10 species of *Sporobolus* native to Australia. These were: *S. actinocladus* (F.Muell.) F.Muell., *S. australasicus* Domin, *S. caroli* Mez, *S. contiguous* Blake, *S. coromandelianus* (Retz.) Knuth, *S. creber* De Nardi, *S. disjunctus* R.Mills ex B.Simon, *S. laxus* Simon *S. scabridus* Blake and *S. sessilis* Simon. If the smut were to cause serious damage to any of these species, it would most likely lead to rejection of the agent.

Stem wasp investigations A one year study was undertaken in 2006 at the ARC-PPRI centre at Rietondale to investigate the biology of the stem wasp *Tetramesa* sp. and to develop a method of laboratory culture.

RESULTS

Survey of Southern Africa An arthropod fauna of at least 70 species was found on the three weedy sporobolus grasses. Many of the species were only partially determined (usually to genus) as they belonged to groups that have not yet been properly described in southern Africa. Most species represented casual associations with the plant rather than utilising the grass as a true host plant.

The only insect seen as a prospective biological control agent was the eurytomid wasp, *Tetramesa* sp. The larvae of this wasp feed in the culm, which results in the malformation of the inflorescence and hence significant damage. The wasp was found at many localities throughout the survey area and often at high levels of infestation.

Twenty-three pathogens, including five primary pathogens, were found on the *Sporobolus* spp. Only the leaf smut *U. sporoboli-indici* was thought to be sufficiently host-specific to be considered further as a potential biological agent for Australia.

Leaf smut investigations The smut was successfully cultured in the laboratory and a method for infecting plants experimentally was devised. Basidiospores or inoculum obtained from washed agar plates previously dusted with teliospores and germinated overnight was more effective and quicker to cause symptoms of infection on susceptible *Sporobolus* grasses than when inoculum was generated from continuous or submerged broth culture.

The results obtained from the pathogenicity trials against the five weedy alien invasive sporobolus grasses indicate that four species (*S. pyramidalis*, *S. africanus*, *S. fertilis* and *S. natalensis*) were susceptible and hence hosts for the leaf smut. However *S. jacquemontii* did not show any symptoms of infection even after prolonged periods of inoculation with the smut fungus, indicating that it is probably a non-host to the smut fungus.

Host range trials with the leaf smut against 10 native Australian *Sporobolus* species resulted in *S. creber*, *S. elongatus*, *S. sessilis* and *S. scabridus* developing typical symptoms of infection. Infections on *S. creber* and *S. elongatus* were serious while those on *S. sessilis* and *S. scabridus* were minimal, did not spread to other uninfected leaves of the same plant, and remained localised.

This result was sent to about 20 stakeholders (agronomists, regulators, botanists, plant pathologists, industry representatives) to see whether there was a consensus as to whether the weedy sporobolus grasses problem warranted considering a biocontrol agent that

might also attack a native plant. No such consensus emerged and it was decided to terminate work with the leaf smut.

Stem wasp investigations All efforts to rear *Tetramesa* sp. in the laboratory were unsuccessful. Supplementary biology studies suggested that the wasp might have a winter diapause mechanism and that its effect on the plant may be less than originally thought. Laboratory culture of the insect was an essential prerequisite before considering importing the insect into Australian quarantine. Further work on the insect was therefore terminated.

DISCUSSION

Weedy grasses have not been considered good biocontrol targets for a number of reasons, including the great economic and ecological importance of related species, the simple chemical composition and morphology of grasses (which may preclude any great degree of specialisation in their natural enemies), and the great adaptability of grasses to grazing and harvesting. However in recent years programmes against *Nassella* spp. (McLaren *et al.* 2002), *Spartina alterniflora* Loisel. (Grevstad *et al*. 2003) and *Arundo donax* L. (Jones and Sforza 2007) have been initiated.

The relationship between the five weedy sporobolus grasses and the native Australian congeners was always recognised as the major impediment to finding biological control agents. When *U. ustilago-sporoboli* did not infect *S. jacquemontii* there were high hopes that there might be sufficient difference between the natives and the exotic weeds to allow safe agents to be selected. That was not to be and the experimental evidence, albeit from laboratory, was that at least two native Australian *Sporobolus* spp. could be infected similarly to the exotics. This leaf smut has a narrow host range and the fact that it can infest both exotics and some natives similarly does not bode well for finding suitable agents elsewhere in the world.

In light of these results it has been decided to terminate the project.

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