EVALUATION OF THE MYCOHERBICIDE POTENTIAL OF FUNGI FOUND ON BROOM AND GORSE IN NEW ZEALAND

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SUMMARY

A New Zealand-wide survey of fungi associated with tip dieback and stem and leaf lesions of broom (*Cytisus scoparius*) and gorse (*Ulex europaeus*) was carried out to find pathogens with potential for development as mycoherbicides. The fungi most commonly found on broom were *Pleiochaeta setosa*, *Fusarium* spp and *Microsphaeropsis* spp.; those on gorse were *Phomopsis*, *Fusarium*, *Microsphaeropsis*, *Septoria* and *Pleospora* species. Preliminary glasshouse inoculation tests showed *Pleiochaeta setosa* and *Fusarium tumidum* to be pathogenic on broom, and *F. tumidum* pathogenic on gorse.

Keywords: disease survey, mycoherbicide, gorse, broom, New Zealand

INTRODUCTION

Broom (*Cytisus scoparius*) and gorse (*Ulex europaeus*) are major weeds in New Zealand. Biological methods for their control are being investigated because of increasing awareness of issues of environmental safety associated with the use of chemical herbicides. The mycoherbicidal approach, one option for biological weed control, involves the manipulation of populations of a locally occurring pathogen so as to induce epidemic disease in the target weed population (Charudattan 1991). This is usually achieved by applying large amounts of inoculum to the target weed when it is highly susceptible to infection.

In practice the use of mycoherbicides is limited to situations where a single weed species predominates and can be controlled at the seedling stage. In New Zealand, plantation forests with dense gorse or broom populations provide an ideal opportunity for utilising mycoherbicides to reduce herbicide use. Fungi to be used for this approach must be pathogenic, reasonably host-specific, and easily grown in culture for the mass production of inoculum.

Both broom and gorse are being intensively studied in New Zealand using the classical approach to biological weed control with insects as the control agents (Syrett 1989; Hill and Gourlay 1989), but no experimental work has been carried out here on their control using pathogenic fungi. Johnston (1990) noted that few fungi which may be suitable as biological control agents were known from gorse or broom, and, because little is known about diseases on either weed, suggested that more detailed surveys should be carried out. There have been intriguing reports of death of gorse plants, often in large numbers, in quite localised areas. Old DSIR Plant Diseases Division files carry such reports dating back to the 1920s, from all parts of the country, yet no obvious cause has been identified by various researchers over the past 70 years.

METHODS

A New Zealand-wide survey of fungi associated with tip dieback and stem and leaf lesions of both broom and gorse was carried out during 1991 and 1992. Plant material with these symptoms was gathered during all seasons throughout New Zealand (104 sites for gorse, 50 sites for broom). Isolations were made onto Difco Malt Extract Agar with streptomycin (MEA) 1-5 days after collection by excising small pieces of tissue with a sterile scalpel from the centre of stems or leaves with disease symptoms. For

Proc. 47th N.Z. Plant Protection Conf. 1994: 121-124

macroscopic and microscopic examination and identification isolates were grown on MEA, Difco Potato Dextrose Agar (PDA) or Difco Oatmeal Agar (as appropriate for each isolate) under near UV lights with a 12 h photoperiod.

In a preliminary screening experiment most species isolated were tested for pathogenicity by inoculation onto 3-month-old plants of broom and gorse in the glasshouse. Plants were grown in sterile potting mix from field-collected seed, three or four plants to a 70 mm diameter pot. Inoculum was prepared as conidial suspensions (approximately 5×10^5 conidia/ml) in 0.01% Tween-80 from colonies grown on PDA. Before inoculation plants were held at 100% humidity for approximately 24 h. Inoculum was sprayed onto unwounded plants until runoff; the plants were then returned to 100% humidity at 25°C for 3 days. Controls were treated in the same way, but sprayed only with 0.01% Tween-80 solution. After 3 days the plants were transferred to the glasshouse (approximately 80% humidity and 15-30°C). The screening was carried out in a series of experiments, each separate experiment including 10-12 different species or isolates. Whenever possible several isolates of each species were tested, and in most cases each species was tested in more than one separate experiment. Disease symptoms were assessed visually, scored on a scale of 0-3 (see Table 1) 7-10 days after inoculation.

Representative cultures have been deposited in the ICMP culture collection (Landcare Research), and voucher specimens in Herbarium PDD.

RESULTS

During the survey of fungi associated with tip dieback and stem lesion symptoms the species most commonly isolated (those found at more than 20% of the sites sampled) from broom were *Pleiochaeta setosa*, *Fusarium* spp., and *Microsphaeropsis* spp.; those from gorse were *Phomopsis*, *Fusarium*, *Microsphaeropsis*, *Pleospora*, and *Septoria* spp. All these species were widely distributed through the country. Most were not restricted seasonally except for one of the *Fusarium* species, *F. tumidum*, which was more common in summer than winter.

TABLE 1: Pathogenicity of fungi isolated from stem and leaf tissue of broom and gorse on broom and gorse respectively - preliminary screening.

Potentially pathogenic fungi isolated from broom (No. isolates tested, No. plants treated)	Disease severity ¹	Potentially pathogenic fungi isolated from gorse (No. isolates tested, No. plants treated)	Disease severity
<i>Armillaria</i> sp.	n.t.	<i>Ascochyta ulicis</i> (2, 8)	0
<i>Botryosphaeria dothidea</i> (2, 4)	0	<i>Botryosphaeria dothidea</i> (1, 4)	0
<i>Colletotrichum acutatum</i> (1, 8)	0	<i>Colletotrichum gloeosporioides</i> (8, 7)	0
<i>Colletotrichum gloeosporioides</i> (3, 12)	0-1	<i>Fusarium avenaceum</i> (4, 7)	0
<i>Fusarium avenaceum</i> (12, 20)	0-1	<i>Fusarium gramineum</i> (3, 4)	0
<i>Fusarium lateritium</i> (4, 12)	1	<i>Fusarium lateritium</i> (4, 7)	0
<i>Fusarium sambucinum</i> (2, 8)	1	<i>Fusarium sambucinum</i> (1, 8)	0
<i>Fusarium tumidum</i> (3, 24)	2-3*	<i>Fusarium tumidum</i> (6, 27)	1-3*
<i>Microsphaeropsis</i> spp. (10, 16)	0	<i>Microsphaeropsis</i> spp. (10, 19)	0
<i>Phoma exigua</i> (2, 4)	0	<i>Phomopsis</i> spp. (7, 24)	0
<i>Pleiochaeta setosa</i> (4, 20)	3	<i>Pleiochaeta setosa</i> (2, 12)	0
		<i>Pleospora herbarum</i> (1, 4)	0
		<i>Septoria slamptonensis</i> (3, 19)	0

¹ Disease severity scale (7 days after inoculation): 0 = no visible lesions; 1 = limited lesions, usually flecking on leaves; 2 = lesions spreading over entire leaves; 3 = stem lesions causing wilting; n.t. = not tested. * = variation encountered between different isolates tested.

New disease records for New Zealand from broom are: *Armillaria* sp., associated with crown and stem rot (found at only one site where mature *Pinus radiata* had recently been harvested and scattered pine seedlings as well as broom plants were becoming infected); *Fusarium avenaceum* (Fr.) Sacc., associated with collar rot;

Fusarium lateritium Nees, associated with collar rot; and *F. tumidum* Sherb., associated with stem lesions. Newly recorded from gorse are: *Ascochyta ulicis* (Grove) P.K.Buchanan and *F. tumidum*, associated with thorn and stem lesions and tip dieback; *Microsphaeropsis* sp. (possibly *Coniothyrium sphaerospermum* Fuckel, originally described from *Cytisus*, but reported on gorse by Grove 1937), associated with flecking on thorns; and *Septoria slaptonensis* D.Hawksw. & Punith., associated with tip dieback.

Results of the preliminary screening for pathogenicity of the species isolated from both broom and gorse are summarised in Table 1. These experiments showed that *P. setosa* and *F. tumidum* from broom, and some isolates of *F. tumidum* from gorse to be highly pathogenic when inoculated as a conidial suspension onto their respective hosts, causing symptoms similar to those seen in the field. Some *F. tumidum* isolates caused the death of one or more of the gorse plants in a pot 4-8 weeks after inoculation. Although *Fusarium avenaceum* and *F. lateritium* were associated with often severe collar rots of broom throughout New Zealand, causing death of scattered plants in the localities where they were found, neither species caused significant disease when inoculated as conidial suspensions onto the aerial parts of broom plants.

DISCUSSION

Of the species found during the survey *Pleiochaeta setosa* and *Fusarium tumidum* on broom and *F. tumidum* on gorse may have potential for development as mycoherbicides. Other species associated with disease in the field were not suitable. Because *Armillaria* is a serious pathogen of *Pinus radiata* it cannot be used as a mycoherbicide in plantation forests. Although *Fusarium avenaceum* and *F. lateritium* are associated with a collar rot disease, they were not pathogenic when inoculated by methods traditionally used to apply mycoherbicides. If an alternative inoculation method could be developed, possibly adding inoculum to soil around the plant bases, these species might be useful as biological control agents. However, both have a wide host range, and some strains of *F. lateritium* have been reported as pathogenic to *Pinus* species (Booth 1971).

Fisher and Petrini (1987) reported a *Colletotrichum* species and *Phomopsis ligulata* as the dominant xylem endophytes of gorse sampled from the United Kingdom. As several *Colletotrichum* species are being used or developed as mycoherbicides, this gorse-inhabiting species is worth further investigation. However, using the same methods as Fisher and Petrini (1987), no *Colletotrichum* species have been isolated from gorse xylem from New Zealand (unpublished data).

Although fungi have been found which cause disease of both broom and gorse under ideal conditions, their suitability as mycoherbicides can be determined only after methods are developed for inducing disease under field conditions. *Fusarium tumidum* is being further investigated; its taxonomic position has been clarified (Broadhurst and Johnston in press), variation in pathogenicity between isolates has been investigated (unpublished data), and highly pathogenic isolates have been selected. These isolates will be used to carry out field trials following the development of appropriate inoculum formulations.

ACKNOWLEDGEMENTS

This work was partially funded by the Foundation for Research, Science and Technology under contracts BIO 91113 and CO 9205. We thank Phil Broadhurst, of Crop and Food Research, Mt Albert Research Centre for the *Fusarium* species identifications.

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