Field release and initial impact of groundsel bush rust in Australia

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Summary Groundsel bush (*Baccharis halimifolia* L. Asteraceae), a perennial woody shrub native to the USA, is a serious weed over 1000 km of the coastal plain and adjacent sub-coastal areas of mid-eastern Australia. Extensive introductions of insect biocontrol agents over 25 years have been only partially successful. The only pathogen to be introduced for the biocontrol of groundsel bush is the rust, *Puccinia evadens* Hark. from Florida, USA. It was first released near Brisbane in late 1997. This rust is now widely established throughout most of the coastal part of the geographic range of groundsel bush in Queensland. Field observations show that groundsel bush rust is capable of significantly reducing the vigour of the weed, particularly in shaded situations where rust damage is combined with that of previously released, stem-boring insects. Persistent dry conditions in south-east Queensland during 2000 and 2001 have had an adverse impact on disease development

Keywords *Baccharis halimifolia*, groundsel bush, *Puccinia evadens*, groundsel bush rust, pathogen, biocontrol.

INTRODUCTION

Groundsel bush (*Baccharis halimifolia* L. Asteraceae), a perennial woody shrub native to the USA, was recorded as being naturalised in Australia in 1888 (Bailey 1900). It now appears to have reached its geographic limits with infestations present over 1000 km of the mid-eastern coastal plain and adjacent sub-coastal areas (Tomley 1989).

Groundsel bush is a declared pest plant in Queensland and New South Wales and is an aggressive weed of pastures, forestry and conservation areas. It rapidly colonises weakened pastures or disturbed areas, but is also capable of invading undisturbed native wetlands where it becomes the dominant under-storey in *Melaleuca* and *Casuarina* communities.

Significant infestations remain throughout the plant's entire range despite the rigorous spraying program based mainly on the use of 2,4-D that commenced around 1950. Adjacent areas that have been cleared can be rapidly recolonised via wind borne seed that is produced in abundance in mid- autumn.

A long and intensive biocontrol campaign beginning in 1963 saw 35 insect species introduced over a 25-year period but has this has been only partially successful. Only seven of the insects introduced are established and of these only three provide useful control. The groundsel bush plume moth, *Oidaematophorus balanotes* Meyerick is found throughout the geographic range of the plant. The larvae of this moth tunnel extensively within the woody stems, causing poor vigour and dieback of the branches. Scattered and single plants growing in open situations are the most heavily damaged while plants growing in dense shade are less affected (Tomley, unpublished). Another stem borer, the beetle *Megacyllene mellyi* Chevrolat, also tunnels in the woody stems inflicting severe damage to plants growing in salt marsh habitats from which it has successfully eliminated the weed. However, this insect does not do well on plants growing in better soils due to the high mortality of neonate larvae in the consequent heavier sap flow (Tomley 1990). The leaf-feeding beetle, *Trirhabda baccharidis*, is also restricted to similar sites, needing the peaty soils for successful pupation. Its larvae severely defoliate groundsel bush during early autumn and can reduce seed production (Tomley, 1989).

The rust fungus, *Puccinia evadens* Hark. from Florida USA was first released in Australia in late 1997 and established readily in coastal areas. Details of the release program, establishment and dispersal, life cycle and phenology in Australia together with preliminary assessment of target damage are documented in this paper.

MATERIALS AND METHODS

Bulking up of inoculum Three methods were used to release *P. evadens* in the field: application of spore suspensions; deployment of infected potted plants and redistribution of field collected infected foliage.

Inoculum in the form of dry urediniospores was bulked up by *in vivo* culture of the rust on 300 mm high plants grown in 150 mm plastic pots kept in a greenhouse at day/night temperatures of 25°–30°C/ 18°–22°C. Plants were inoculated by spraying a spore suspension of approximately 10^6 spores mL^{-1} in distilled water on the foliage with an airbrush. Inoculated plants were then held in a sealed plastic misting chamber in which leaf wetness was maintained by an ultrasonic room humidifier for 24 hours at 20°C. They were then returned to the greenhouse bench to allow development of pustules.

Spores were harvested from the leaves with a purpose built spore-collecting device originally designed for harvesting rubber vine rust (Tomley and Hardwick 1996). After harvest, the spores were dried in a desiccator jar over silica gel and stored in a freezer at -18°C prior to use.

Infected potted plants of a similar size to those used for spore production were produced by artificial inoculation as previously described or by natural inoculation. The latter was achieved by interspersing 10 infected plants amongst batches of up to 100 plants that were kept outside the greenhouse. Each batch of plants was held in a tray to facilitate watering.

Infected foliage was harvested from plants in the field by cutting branches about 1 m long which were transported to the release site in a well ventilated, cool vehicle.

Field inoculation Plants were inoculated by spraying a spore suspension of 10^6 spores mL^{-1} in distilled water, mixed just prior to application, onto the foliage with an air-brush or a domestic trigger sprayer. Such inoculations were timed to ensure leaf wetness from imminent rainfall or dew formation within 10 hours.

Infected plants were transplanted into the soil amongst plants growing in the field. Five to 10 plants spaced at 2 m intervals were deployed at each release site. Provided that the plants continued to grow once transplanted, a continuous supply of fresh spores was released onto surrounding plants over the ensuing 3–4 weeks, increasing the chance of natural infection.

Cut foliage was hung amongst the foliage of the plants to be inoculated, 10–20 branches about 1 m long typically being set out. This method was only practised when leaf wetness was highly likely.

Between October 1997 and August 2000, 50 releases were made at 39 sites located in coastal areas from south of Brisbane to the Bundaberg area in the north.

Assessment Establishment and dispersal of the rust was assessed by regular inspection of groundsel bush plants surrounding the release sites. As the rust continued to spread, the search area was expanded. Roughly aligned transects that followed roads radiating from the release sites were used to monitor directional dispersion. Disease incidence (percentage of diseased leaves) and phenology were determined by inspection of harvested foliage samples. Five representative branches about 0.5 m long were selected randomly from separate plants also selected randomly at particular sites of interest. Sets of 25 randomly selected plants were tagged at two sites and monitored for disease levels and damage. Target damage was also assessed by direct counts of diseased plants at various locations

RESULTS AND DISCUSSION

The *in vivo* culture of the rust reliably produced a sufficient supply of inoculum (dry spores) for both laboratory and field use. Natural inoculation of potted plants was also effective during periods of adequate rainfall, but proved unreliable during prolonged periods of dry weather. In the field, infected cut foliage was available from autumn to early summer when rainfall was adequate.

Establishment and dispersal While an overall success rate of 90% establishment was achieved from field inoculations with spore suspensions, the deployment of infected potted plants was the main method of field inoculation used. This method had several advantages. It was the most reliable, with only two failures being recorded. Also, it was easy to carry out and no special equipment was required, thus untrained personnel could make releases. Further, infected potted plants were robust and easily transported to release sites and, if necessary, release could be delayed.

Natural spread rate of the rust increased exponentially over time covering 100 km from a cluster of three closely adjacent release sites near Tewantin north to Maryborough in four years. This is a slow dispersal rate when compared with rubber vine rust (*Maravalia cryptostegiae* (Cummins) Ono) that spread 60 km in three months (unpublished data). Dispersal northwards was far greater than to the south and east. This is most likely due to the influence of frequent south-east winds that tend to produce moist airflows compared with winds from other directions.

Puccinia evadens is now well established over most of the coastal plain within the range of groundsel bush. Establishment further inland has been hampered by prolonged dry conditions during 2000 and 2001.

Life cycle and phenology *Puccinia evadens* is a macrocyclic autoecious rust, thus being long-cycled with all of the spore stages occurring on *B. halimifolia*. The urediniospores are bright yellow to orange in colour, form in isolated pustules (0.5–1 mm diameter) mainly on the undersides of the leaves, are dry and powdery and spread by the wind. Teliospores are also borne under the leaves in similarly sized pustules that may coalesce and are dark red/brown in colour. Pycnia and aecia are formed on both the leaves and young stems, forming characteristic swellings (Charudattan *et al.* 1992). The aeciospores are similar in colour to the urediniospores and are also wind borne. In Florida the rust occurs throughout the year; pycnia and aecia are most abundant in spring with uredinia and telia being more common in late spring. Rust incidence is generally low over summer and high in winter.

In Australia all of the spore forms were found throughout the year. Urediniospores were most abundant in autumn and winter, telia in spring, with pycnia and aecia being most abundant in spring and early summer. As in Florida, rust activity is reduced in mid to late summer, particularly when hot dry conditions prevail.

Target damage Rust incidence measured on plants growing in cool shaded situations was 16 times higher than for plants growing in open sunny situations. This difference was directly related to the length of the dew period and supported overall field observations that plants growing under shade were also more heavily infected than plants growing in sunny sites. Prolonged periods of dry weather also lowered the amount of disease that developed. Rainfall was low in south-eastern Queensland during 2000–2001 compared with 1998–1999. This has dramatically lowered disease incidence over the present geographic range of the rust which in early summer has recently fallen from ca 100% to 6% causing patches of localised extinction. However, disease incidence is expected to increase with a return to moist conditions.

As a consequence, the highest levels of damage were recorded in 1998–1999. During this period, plants growing in shade at several release sites near Brisbane suffered heavy dieback, or indeed, died as a result of heavy rust infection. At the Kangaroo Island site in southern Moreton Bay a dense, shaded infestation of mature plants 2–3 m high weakened by plume moth larva damage progressively died over an 18-month period. Data collected from plants near this site that were tagged in early 2000 show a similar but slower trend due to the recent dry conditions. Similar levels of damage were recorded at two sites north of Tewantin. Small plants about 300 mm tall are particularly vulnerable to sustained heavy infection and have been observed to die within a 12 month period.

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