Prospodium tuberculatum, lantana rust, a new agent released for the biocontrol of the woody shrub *Lantana camara*

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Summary The recent importation and field release of the rust fungus *Prospodium tuberculatum* from Brazil heralds a new approach to the biocontrol of *Lantana camara*. The biocontrol effort for this important weed began in 1914 and until now has relied on insect agents only. Detailed host specificity testing in the UK showed that *P. tuberculatum* was safe to release in Australia and permission was granted by AQIS and EA for its importation and release in 2001. The rust's biology, pathogenesis, host specificity and climatic requirements, as well as progress of the field release program are discussed.

Keywords Lantana, *Lantana camara*, *Prospodium tuberculatum*, lantana rust.

INTRODUCTION

Between 1914 and 2002, 29 insect species have been introduced for the biocontrol of lantana, (*Lantana camara* L.) in Australia. These introductions have resulted in only limited success, especially on the pink flowered biotypes of the weed.

The rust fungus *Prospodium tuberculatum* Speg. Arthur is a naturally occurring leaf parasite of lantana that coevolved with the host genus in the tropical and sub-tropical regions of South America. It is the first pathogen to be released on lantana in Australia. This constitutes a new approach to the biocontrol of this important weed in a project jointly funded by governments in Queensland and New South Wales.

In Australia, lantana is present as a series of complex polyploids of mixed origins. These plants were derived from man-made hybrids developed in Europe during the 17th–19th centuries that were introduced to Australia as ornamentals in the 1840s (Stirton 1977, Swarbrick 1986).

Lantana is a weed of national significance in coastal and sub-coastal eastern Australia impacting on grazing, forestry and conservation areas. Impacts on the production of various industries and associated control measures are estimated to cost $17 million annually (Day and Tomley 2000). Of the weedy biotypes of lantana, the pink flowered form appears to be the most abundant with infestations between Ulladullah south of Sydney to north of Cairns. Pathogenicity tests in the UK showed that the strain of *P. tuberculatum* collected from Brazil is mainly specific to these pink flowered biotypes.

REPRODUCTIVE BIOLOGY

Extensive field observations in its native geographic range suggest that *P. tuberculatum* is a short cycled (microcyclic) autoecious rust completing all of its life cycle on lantana (Ellison *et al.* 2000). Pycnia and aecia were not found in nature and attempts to germinate teliospores collected in the field were unsuccessful.

The rust continuously cycles by the urediniospore stage. Spores germinate and infect leaves at temperatures between 15° and 30°C with an optimum temperature of 20°C. Infection rates are highest with a dew period of 24–48 hours (Ellison *et al.* 2000).

PATHOGENESIS

Infection occurred via the stomata on the lower leaf surface. At about 25°C, chlorotic patches develop within 14–18 days after infection. Dark brown pustules (uredinia) with powdery wind dispersed spores (urediniospores) develop in a further 3–7 days within the chlorotic patches and continue to produce spores for up to 28 days. Under optimum conditions, the rust can complete its lifecycle in 21 days. Both higher and lower temperatures increase the time required for pustules to develop. Very high infection levels (>300 uredinia cm^{-2}) may result in early chlorosis and leaf abscission prior to full development of the pustules. At lower levels of infection (30–50 uredinia cm^{-2}, leaves become chlorotic and fall from the plant 5–7 weeks after infection.

HOST SPECIFICITY AND DAMAGE

Host specificity tests conducted in the UK showed that the isolate of *P. tuberculatum* tested is specific to lantana (Ellison *et al.* 2000). Apart from the target plant, 53 other related plants were tested. Pathogenicity tests on 40 different Australian biotypes of lantana including various pink, red, orange and white-flowered biotypes showed that 10 out of 15 pink flowered forms in the series were susceptible. Since *P. tuberculatum* was released, further specimens of pink flowered lantana collected over a wide geographical range have been tested by inoculating the foliage with the

same method used to bulk up inoculum. A total of 16 biotypes out of 20 tested so far have proved to be susceptible (Table 1).

Prospodium tuberculatum mainly attacks the leaves of its host. Occasionally under conditions of high moisture uredinia also form on the green upper sections of the stems. Under suitable environmental conditions it is capable of inflicting sustained defoliation on susceptible biotypes of lantana. As the life cycle can be completed in 21 days, *P. tuberculatum* can reach damaging population levels much faster than insect biocontrol agents.

BULKING UP INOCULUM AND FIELD RELEASE

Bulking up of inoculum for field release is achieved by culturing the rust on potted plants in the greenhouse. Spores are applied to the lower leaf surface in dry form mixed with industrial talc or as a suspension in water. When applied in dry form the spores are diluted with the talc at the rate of 1:50 (spores: talc). Spores are applied evenly to the lower leaf surface using a fine artist's brush or are sprinkled on using a 25 mm diameter vial covered with nylon gauze, which is much faster and far less arduous than the former method. Spore suspensions are prepared with distilled water at a dilution rate of ca 1×10^6 spores mL^{-1} and sprayed onto the undersides of the leaves with a domestic trigger sprayer. The use of a surfactant such as Tween 20 is not required provided that the mixture is shaken vigorously. Both methods are equally effective.

Inoculated plants are incubated in a misting chamber for 48 hours at 20°C, then transferred to the greenhouse bench (30°/20°C day/night) to allow the development of pustules. The dry spores are vacuumed from the leaves using a purpose built spore collecting device that was developed for harvesting rubber vine rust (Tomley and Hardwick 1996), dried in a desiccator jar over silica gel for 48 hours and stored in liquid nitrogen prior to use.

Since October 2001, several releases have been made in Queensland and New South Wales using talc as previously described. Successful field infection was achieved at the first three sites that were inoculated during moist weather conditions. Hot dry conditions that ensued after this period prevented ongoing infection and further propagation of rust inoculum. Unfortunately, in south-eastern Queensland and north-eastern New South Wales hot dry conditions that persisted over summer prevented establishment of the rust at other release sites inoculated during this period.

Table 1. Susceptibility of pink flowered lantana biotypes to *P. tuberculatum*.

Location	Susceptibility
Grafton, New South Wales	Yes
Richmond, New South Wales	Yes
Moruya, New South Wales	Yes
Coolum, Queensland	Yes
Brookfield, Queensland	No
Mt. Crosby, Queensland	Yes
Blunder Ck., Queensland	No
Tamborine, Queensland	Yes
Eungella, Queensland	No
Biloela, Queensland	Yes
Kempsey, New South Wales	Yes
Nowra, New South Wales	Yes
Bundaberg, Queensland	Yes
Harrys Hut, Queensland	Yes
Coolooli Ck., Queensland	Yes
Eurong, Queensland	Yes
Tuan Forest, Queensland	Yes
Wycarbah, Queensland	No
Mt. Warning, New South Wales	Yes
Paluma, Queensland	Yes

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