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DISTRIBUTION AND SOCIO-ECONOMIC IMPACTS OF *Mikania micrantha* IN PAPUA NEW GUINEA AND FIJI AND PROSPECTS FOR ITS BIOCONTROL

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ABSTRACT

Mikania micrantha or mile-a-minute is a fast growing Neotropical vine found throughout much of Asia and the Pacific, invading small subsistence farms as well as plantations. In 2006, a biocontrol project, funded by the Australian Government and managed by the Queensland Government, commenced in Fiji and Papua New Guinea (PNG). To help plan activities and determine possible benefits from the project, the distribution, growth rate and socio-economic impacts of *M. micrantha* were determined before the importation of biocontrol agents. *Mikania micrantha* was recorded in all 15 lowland provinces in PNG and on all major islands in Fiji. Plants grew up to 1 m/month in PNG and about 0.5 m/month in Fiji. A socio-economic survey (of over 380 respondents in over 230 villages from 15 provinces in PNG) found that 79% of respondents considered *M. micrantha* to be a serious weed, with over 40% considering *M. micrantha* reduced their crop yield by more than 30%. About 44% of the respondents had over a third of their land infested with *M. micrantha*, which they spent 1-2 days per fortnight weeding. About 85% of respondents controlled *M. micrantha* by physical means, such as slashing and/or hand-pulling. In Fiji, *M. micrantha* infestations were less problematic than in PNG. There were 52 respondents from four islands, of which over 60% considered *M. micrantha* a serious weed, losing about 30% of potential crop yield due to the weed and 33% reported having more than 30% of their farm lands infested. Only 15%

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of respondents needed to weed fortnightly, with 56% using slashing and/or hand-pulling as the main means of control. Nearly 90% of respondents used *M. micrantha* as a medicinal plant to treat cuts and wounds. To help control the weed, the rust *Puccinia spegazzinii* was imported into both countries, following host specificity testing by CABI in the UK, and subsequently released widely. Initial laboratory trials and monitoring at a few sites, found that the rust can significantly reduce the growth of *M. micrantha* and offers great potential for the control of this weed in Fiji and PNG and other countries where *M. micrantha* is a problem.

Key words: Distribution, socio-economic impact, biocontrol.

INTRODUCTION

Mikania micrantha (Asteraceae) or mile-a-minute is an invasive plant originating from Central to South America and the Caribbean. The weed is widespread throughout Southeast Asia and the Pacific Islands (Waterhouse and Norris, 1987), including Fiji and Papua New Guinea (PNG). At a regional workshop on invasive alien species, *M. micrantha* was ranked as one of the most important weeds of the Pacific (Dovey *et al.,* 2004).

Mikania micrantha flowers prolifically and produces thousands of light-weight barbed seeds that are spread by wind or by people on clothing or possessions. The weed can also propagate vegetatively by producing roots and shoots from broken stems or leaves. *Mikania micrantha* grows rapidly and is one of the major weed invaders of subsistence gardens and trees grown in plantations in PNG and Fiji (Waterhouse and Norris 1987; Holm *et al*. 1991). It forms a thick ground cover, out-competing, smothering and causing the death of plants of many species, including food and cash crops such as sweet potato, taro, papaw, bananas and cassava. *Mikania micrantha* can also reduce flowering and yield of cocoa and interfere with the harvesting of coconut, oil palm and cocoa (Waterhouse and Norris 1987). Apart from a study by Teoh *et al*. (1985) in Malaysia and Muraleedharan and Anitha (2001) in India, there have been few studies quantifying the impacts of *M. micrantha* on agriculture and none have been undertaken in PNG and Fiji.

Mikania micrantha can be controlled by herbicides or manually through slashing and/or hand-weeding. However, these conventional methods of control are not practical as they are costly, time consuming and labour intensive. Biological control is seen as the only sustainable and cost-effective means to control this weed (Waterhouse and Norris, 1987; Cock *et al*., 2000). A biological control program was first initiated against this weed in 1988, when the thrips *Liothrips*

mikaniae was introduced into Solomon Islands and then Malaysia but it failed to establish in either country. The thrips was also introduced into PNG but died in quarantine before field releases could be conducted (Cock *et al*., 2000).

As part of a renewed effort against *M. micrantha*, an Australian Government-funded biocontrol program, aiming to reduce the impact of *M. micrantha* in PNG and Fiji, began in 2006 and involved the introduction of the rust fungus *Puccinia spegazzinii* (Pucciniales: Pucciniaceae) (Orapa *et al*. 2008). This paper reports on the distribution and growth of *M. micrantha* in PNG and Fiji and the physical and socio-economic impacts of the weed. Information gained in these studies will be used in the biocontrol agent release program and also to assess the benefits of the project.

MATERIALS AND METHODS

Distribution of *M. micrantha*

The distribution of *M. micrantha* in both PNG and Fiji was ascertained through field surveys undertaken by project staff travelling throughout both countries or from feedback from regional staff reporting on locations of the weed in their jurisdictions. Locations of the weed were recorded using a hand-held GPS unit and mapped using Arcview GIS. *Mikania micrantha* infestations closer than 5 km were deemed as a single infestation. Where locations could not be recorded using a GPS unit, the nearest village was used as the site descriptor.

The Growth and Physical Impact of *M. micrantha*

The growth rate of *M. micrantha* was obtained by tagging 10 shoots at each of eight sites in PNG and four sites in Fiji and measuring the length from the node immediately above the tag to the tip of the shoot. As handling the plants will often damage the growing tips, recordings of the length of the shoot from the tag to the tip were only taken after two and four weeks.

The physical impact of *M. micrantha* on crops and plantation species was measured through visual observation and photographs. Descriptions of the weed infestations and crop health were also recorded.

Socio-Economic Impact of *M. micrantha*

A questionnaire was developed to determine the social and economic impact of *M. micrantha* on crop production, including cost and time spent controlling the weed and farmer income, as well as the control methods used across different land uses. Project staff conducted surveys in their own provinces and in provinces to which they travelled. The questionnaire was also sent to other lowland provinces where *M. micrantha* was reported for completion by

provincial staff. Results were tabulated and the proportion of each class for various questions graphed.

Effectiveness of the Rust *P. spegazzinii*

Twenty three-week old cuttings infected with rust and 20 three-week old plants not infected with rust and used as a control, were placed in a quarantine glasshouse and monitored weekly. Their height and number of nodes present were recorded. The number of pustules present on the leaves, stems and petioles were also recorded. The experiment was terminated after five weeks due to the rapid growth of the plants.

At a field site near the research station at Kerevat, East New Britain Province, PNG, the percent cover of *M. micrantha* was estimated monthly and the number of pustules present on the leaves, stems and petioles recorded.

RESULTS

Distribution of *M. micrantha*

Mikania micrantha was found in all 15 lowland provinces in PNG, from sea level to 1200 m asl. It was particularly prevalent in the wetter provinces of East and West New Britain and New Ireland. Infestations were less prevalent in the drier areas, particularly in Central, Gulf, Madang and Morobe provinces (Fig. 1).

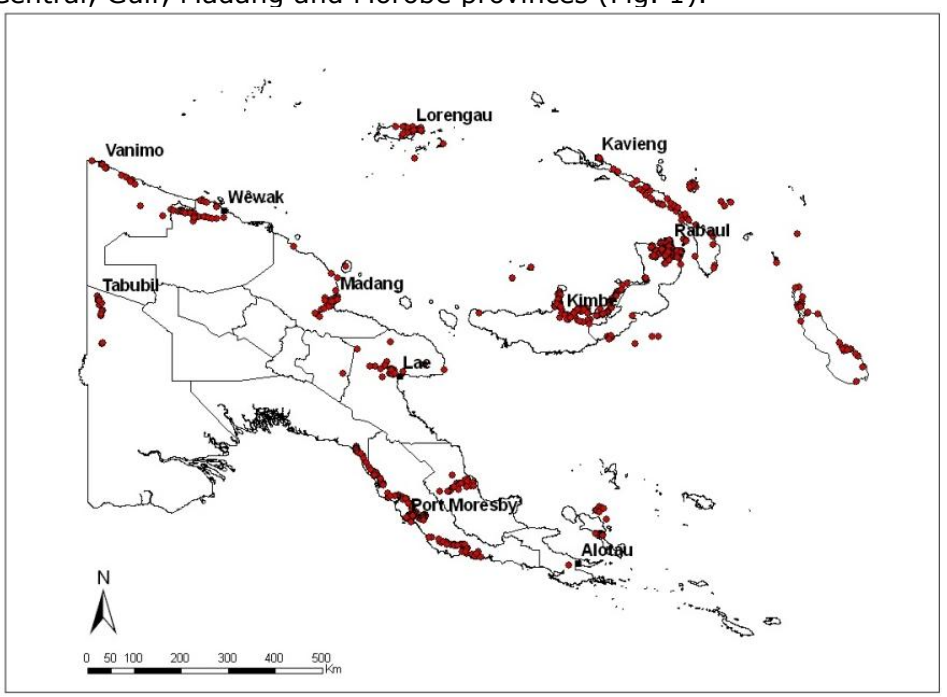

Figure 1. The distribution of *M. micrantha* in Papua New Guinea.

In Fiji, *M. micrantha* was found on all major islands, with the largest infestations being on Kadavu, Ovalau, Taveuni, Vanua Levu and Viti Levu (Fig. 2). Infestations were less prevalent in the drier areas, particularly in the western parts of Viti Levu.

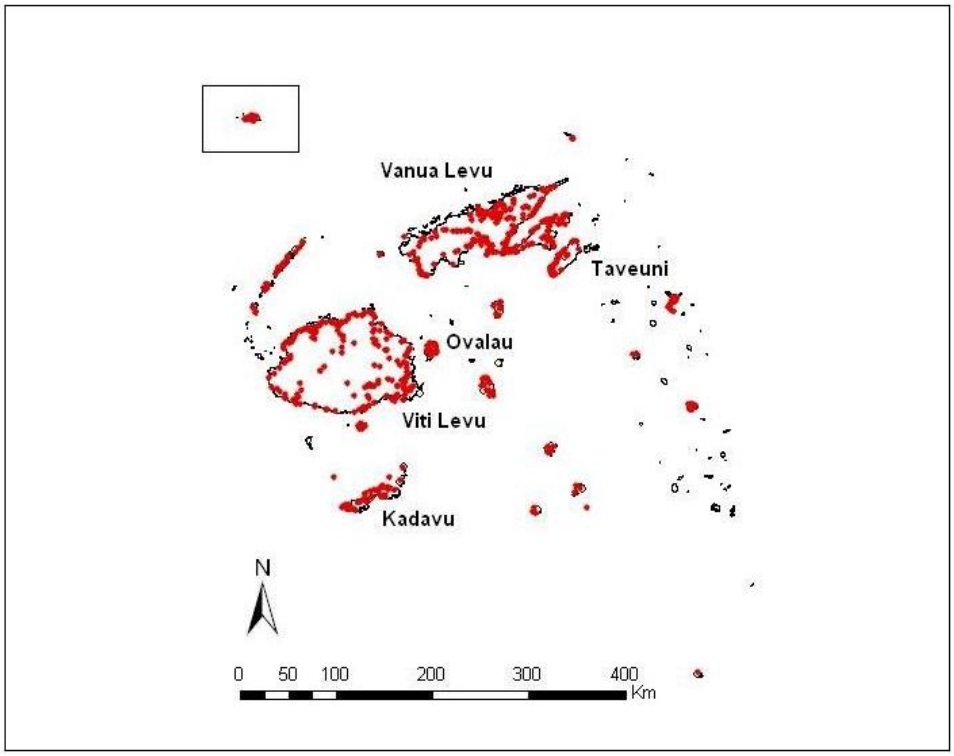

Figure 2. The distribution of *M. micrantha* in Fiji.

The Growth and Physical Impact of *M. micrantha*

Mikania micrantha was found growing in dense infestations along roadsides and creeks where adequate moisture was available and in smallholdings and plantations in both PNG and Fiji. In PNG, *M. micrantha* was found to grow about 1 m/month, while in Fiji, it grew about 0.5 m/month. In small blocks, its rapid growth rate enabled it to grow over cash crops such as taro, cassava, papaw and banana, smothering the plants and often killing them. In plantations, *M. micrantha* can grow over cocoa, young oil palms and coconut palms, retarding growth. Plants covered with *M. micrantha* had reduced flowering and fruit compared to those free of *M. micrantha*, while harvesting fallen coconuts is difficult due to the smothering effect of *M. micrantha*.

Socio-economic impact of *M. micrantha*

More than 380 respondents, covering all 15 provinces in PNG in which *M. micrantha* is present, completed the questionnaire. Over 70% of respondents were involved in mixed cropping or subsistence farming, while the remaining respondents were commercial or semi-commercial farmers. Approximately 79% of all respondents considered *M. micrantha* a serious weed, with over 40% considering it reduced their crop yield by more than 30% (Fig. 3). About 44% of the respondents had over a third of their property infested with *M. micrantha*, which they spent 1-2 days per fortnight weeding (Fig. 4). About 96% of respondents who practise mixed cropping, controlled *M. micrantha* by physical means such as slashing and/or hand-pulling, while only 68% of respondents involved in commercial or semi-commercial practices used physical means only. Approximately 32% of respondents used *M. micrantha*, with most utilizing the plant to treat cuts and wounds.

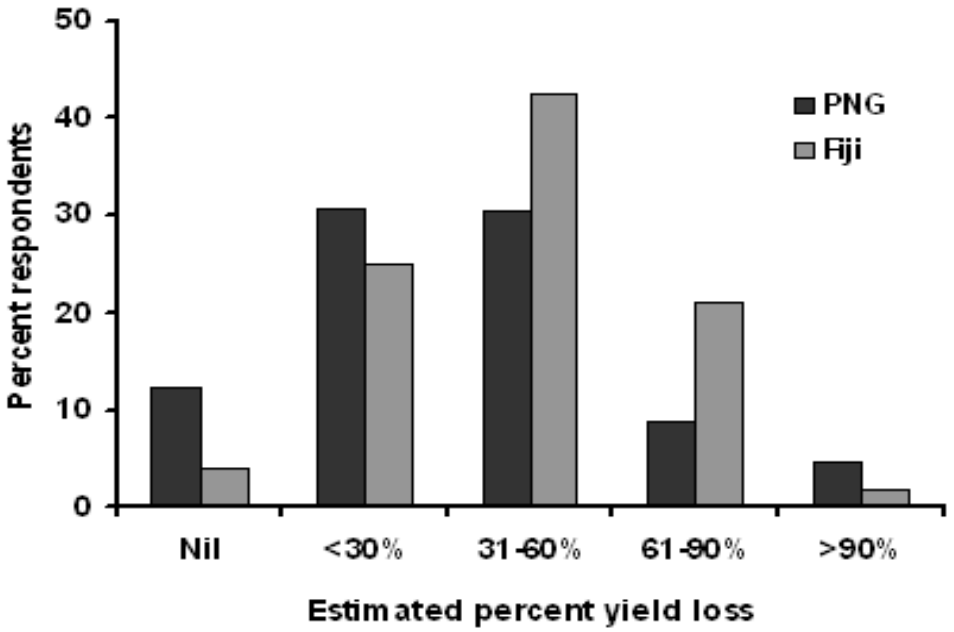

Figure 3. Yield losses due to *M. micrantha* as estimated by respondents in PNG and Fiji.

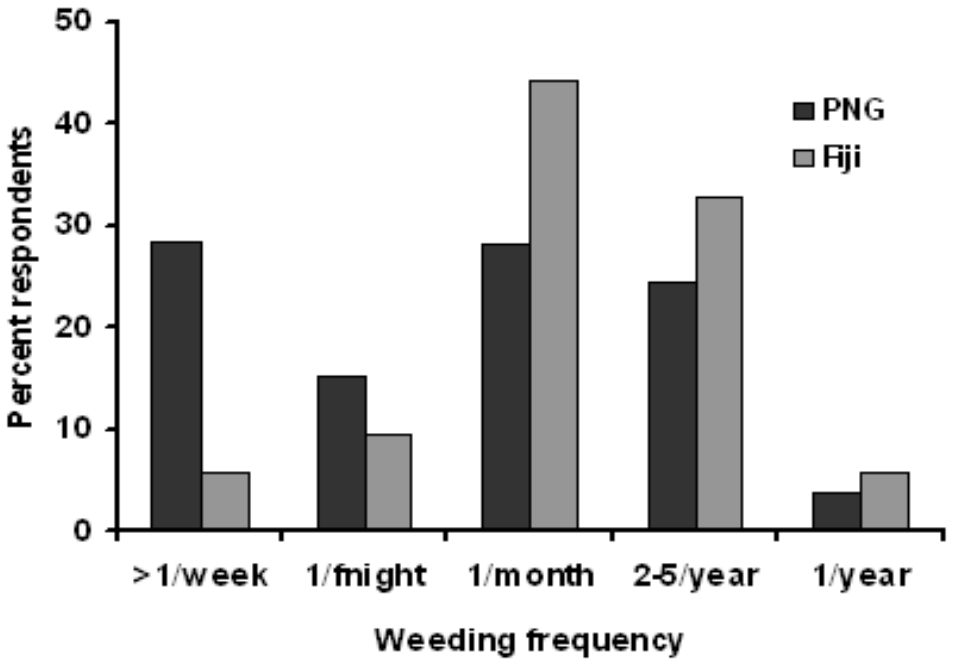

Figure 4. Weeding frequencies of *M. micrantha* as estimated by respondents in PNG and Fiji.

In Fiji, only 52 questionnaires were completed by farmers representing four islands. Approximately 60% of respondents considered *M. micrantha* a serious weed, losing about 30% of potential crop yield due to the weed (Fig. 3), while 33% had more than 30% of their farms infested. Only 15% of respondents needed to weed fortnightly (Fig. 4), with 56% using slashing and/or hand-pulling as the main means of control. Nearly 90% of respondents used *M. micrantha* as a medicinal plant to treat cuts and wounds.

Effectiveness of the Rust *P. spegazzinii*

In laboratory trials, the growth rate of both single stem (2.14±0.3 S.E. cm/day) and multiple stem (1.62±0.13 S.E. cm/day) plants infected with *P. spegazzinii* was significantly lower than that of single stem (3.36±0.3 S.E. cm/day) and multiple stem (2.42±0.36 S.E. cm/day) plants not infected with rust ($F_{1,36}$=13.41, $p<0.001$) (Fig. 5). In field trials, as the number of leaves, petioles and stems of *M. micrantha* become infected with the rust, the percent plant cover decreased (Fig. 6). This was due in part to the number of dead stems and petioles found infected with *P. spegazzinii* but also to the presence of *Glycine wightii* (Fabaceae), which grew over the site and further suppressed *M. micrantha*.

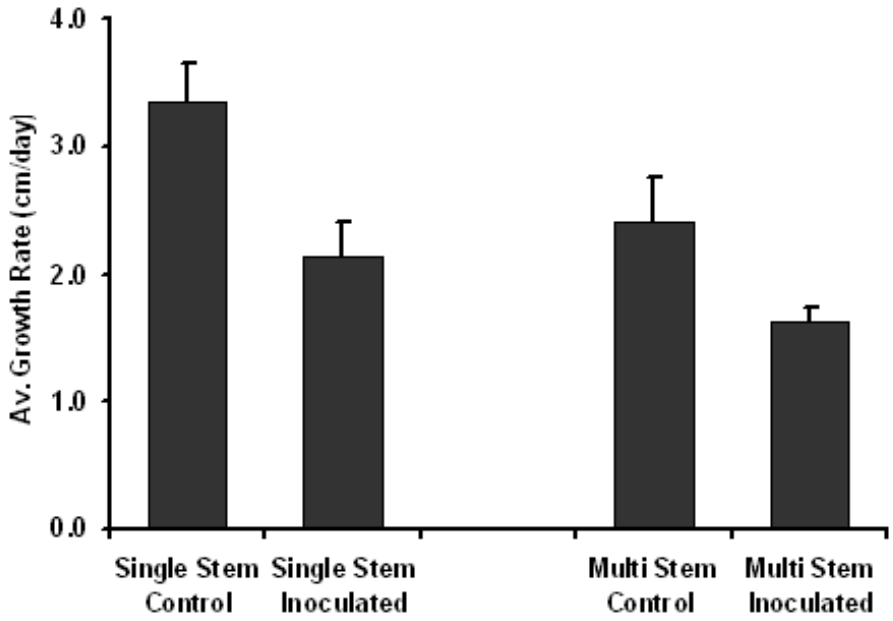

Figure 5. Growth rates of *M. micrantha* with and without rust under glasshouse conditions.

DISCUSSION

Mikania micrantha is becoming an increasing problem in many Pacific island countries and Southeast Asia (Dovey *et al*, 2004;Ellison *et al*. 2008). Its rapid growth and ability to climb and smother plants severely impacts on crop production and net income of farmers, who report that the weed can retard the growth of crops through direct competition for space, nutrients or light by smothering plants, thus reducing yield and income. Where *M. micrantha* is left untouched, it grows quickly over plants. In both countries, it kills bananas, taro and papaw, while in PNG it also reduces flowering and subsequent yield of cocoa.

Farmers in PNG slash and pull *M. micrantha* on a weekly basis, sometimes up to five days a week, while in Fiji, where infestations are not as large, farmers are weeding monthly.

The amount of weeding required by farmers to keep *M. micrantha* out of their blocks reduces net income through increased labour costs or reduces the time available for other activities such as maintaining houses and fishing nets.

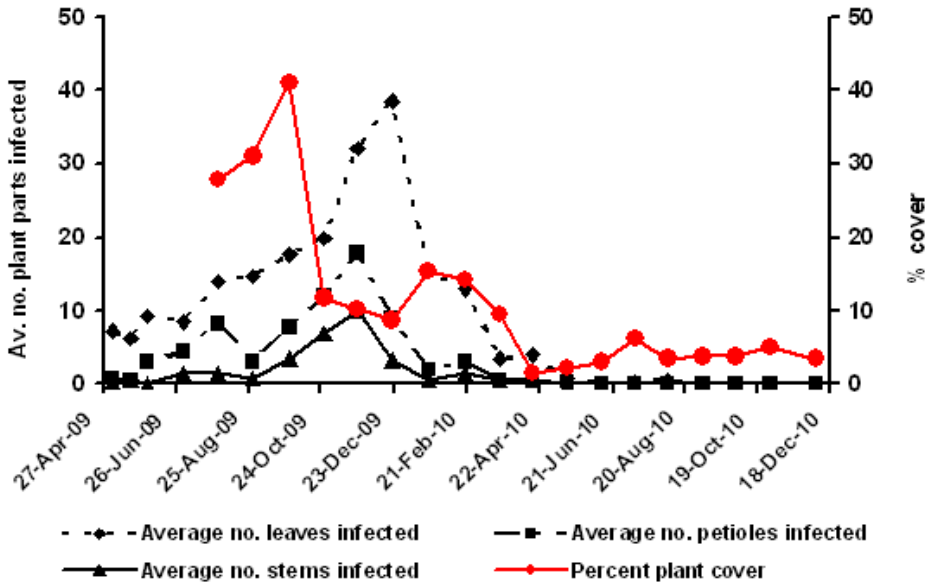

Figure 6. The number of plant parts infected with *P. spegazzinii* and the percent cover of *M. micrantha* at a field site at Kerevat, ENB, PNG.

As a consequence, landholders are resorting to farming smaller blocks, which are easier and less time-consuming to keep free of *M. micrantha,* but this also results in reduced production and income.

In Malaysia, *M. micrantha* has been reported to reduce yield of oil palm by 20%, particularly in the first five years, and the girth of rubber trees by 27% (Teoh *et al*. 1985). While the cost of *M. micrantha* in PNG and Fiji has not been estimated, in Malaysia the weed costs between US$ 8-10 million pa. In India, *M. micrantha* was identified as the number one problem faced by farmers in Kerala, with the presence of *M. micrantha* increasing production costs by about 10% (Muraleedharan and Anitha, 2001).

Field surveys reveal that *M. micrantha* is widespread in both PNG and Fiji and it is likely that it is spreading to other climatically and edaphically suitable areas where it is not already present. The small seeds are easily dispersed, mainly by wind but also by people through attachment to clothing and possessions (Holm *et al*., 1991). *Mikania micrantha* will readily grow from stem fragments, which suggests that slashing may not be an effective control technique as first thought. The broken fragments can take root and, as a result, infestations may become thicker.

Herbicides have been used to control *M. micrantha* but their use has been mainly restricted to commercial plantations. Applying herbicides offers more effective control and reduces the frequency of control applications. However, the cost of herbicides is prohibitive for most smallholders.

As *M. micrantha* grows rapidly and conventional control measures are costly and time consuming, biological control is seen as a feasible, environmentally friendly and self-sustaining option to control large stands of *M. micrantha*. The rust *P. spegazzinii* has been introduced in several countries, including India, China, Taiwan, PNG and Fiji (C. Ellison CABI pers. comm.). In PNG and Fiji, it has been widely released and has established. In laboratory trials and preliminary field monitoring, it has reduced the growth of *M. micrantha* and it is expected to assist in the control of the weed in areas that are climatically suitable. Thus, it should reduce the costs and time that landholders spend in controlling the weed and increase food production and income.

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