Mimosa pigra in Queensland

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Summary The soil seedbank and growth rates of mimosa (*Mimosa pigra* L. (Mimosaceae)) have been monitored at Peter Faust Dam, near Proserpine in central coastal Queensland, since early 2002. This infestation is the only known *M. pigra* infestation to have established in Australia outside of the Northern Territory. Originating from Central America, *M. pigra* poses a major threat to the integrity of northern Australia's wetlands, reducing biodiversity and affecting primary production. In the Northern Territory, it has formed impenetrable nearly mono-specific thickets over 800 km^2, whilst in Queensland it is found over 80 hectares of land bordering the Proserpine water supply.

This study on *M. pigra*'s biology has provided accurate and timely information that has assisted the efforts of the on-ground Queensland mimosa eradication program (which began in 2001). Studies on the soil seedbank have shown it to have declined by 90% from 2002 to 2005, with initial soil seedbanks measuring up to 19,000 seeds m^{-2} at the Proserpine site. No seeds have been found below 10 cm of soil. Queensland *M. pigra* plants were found to flower as early as 67 days and pod at 155 days after emergence, compared to 180 days and approximately nine months, respectively, for Northern Territory plants. Flowering and podding in Queensland occurs all year round, whilst flowering in the Northern Territory occurs from February to May and podding from March to July, though flowering can occur whenever sufficient water is available.

Information derived from the basic ecological studies at the Queensland site has assisted the timing of control activities (involving manual and chemical control), surveillance, extension and how long eradication should continue. The study has also shown that ecological studies can occur simultaneously within a control environment without compromising the objectives of eradication.

Keywords Soil seedbank, growth rates, Queensland.

INTRODUCTION

Mimosa pigra is a branched, thorny shrub which can reach a height of six metres. Leaves are bi-pinnate, sensitive to touch, and contain small prickles. Flowers are pink or mauve in colour, ball-shaped and about 1 cm in diameter, producing clusters of hairy seed pods (Lonsdale *et al.* 1989). The pods turn brown when mature and break into segments, with each segment containing a green-brown oblong seed 4–6 mm long and 2 mm wide (Lonsdale *et al.* 1989).

Mimosa pigra is an Australian Weed of National Significance (Thorp and Lynch 2000) and a declared Class 1 plant in Queensland (Queensland Department of Natural Resources, Mines and Water 2006). It has the ability to form impenetrable infestations over vast areas of wetlands (Lonsdale 1992). Until 2001, the Northern Territory held the dubious honour of hosting the only known infestations of *M. pigra* in Australia. Then, in February 2001, confirmed sightings of this exotic and noxious weed, native to Central America, were made in and around Peter Faust Dam, near Proserpine, Queensland. Surveys of the site found plants less than two metres in height growing in several locations around the dam, and also found two small infestations of large mimosa plants growing in five metres of water (Chopping 2004). As the dam's water level continued to recede in 2001 (from the 83% water storage capacity), seedlings were found along the water's edge in several locations. Previous water level readings for Peter Faust Dam (supplied from SunWater) indicate that the area where the large *M. pigra* plants were growing had been exposed from December 1994 to February 2000.

With *M. pigra* invasion no longer just a threat but a reality in Queensland, a stakeholders' group consisting of the Department of Natural Resources, Mines and Water (NRMW), SunWater, Whitsunday Shire Council, Mackay Whitsunday Natural Resource Management Group, Proserpine Canegrowers, Whitsunday Rivers Integrated Catchment Management Association (WRICMA), Proserpine Irrigators Committee and local landholders was formed in 2001 to work together to eradicate the Peter Faust Dam infestation. On-ground control efforts involving both manual removal and chemical control (using metsulfuron-methyl at 60 g a.i. ha^{-1}) to eradicate *M. pigra* from Queensland began in April 2002 (Chopping 2004). One of NRMW's contributions was to provide research on the biology and control of *M. pigra* at Peter Faust Dam to aid in, and complement, the eradication efforts by advising

on the timing of site revisits (to ensure plants detected are controlled prior to setting seed) and predicting how long the eradication effort needs to continue. This paper reports on the growth rates and soil seedbanks of *M. pigra* growing at Peter Faust Dam.

MATERIALS AND METHODS

Mimosa pigra was found throughout an area of more than 80 hectares around Peter Faust Dam (20°22'15"S, 148°20'50"E). Built in 1990, the dam is located on the Proserpine River, 27 kilometres upstream of Proserpine. It has a total catchment area of 352 km^2, and is utilised for both water storage and recreational activities. At full water supply, the dam's perimeter is 74 kilometres holding 491,400 ML. Water has not flowed over the spillway since construction.

In January 2002, an east/west transect line was established through the densest *M. pigra* infestation (Figure 1) from the 65% capacity line running to the edge of the water. This transect was extended as the water receded. An area 20 metres either side of the transect line was marked for research purposes and was excluded from control by the eradication team. *M. pigra* found anywhere else around the dam was subject to manual or chemical control. Chemical control consisted of the foliar application of metsulfuron-methyl at 60 g a.i. ha^{-1}, and is covered under the minor use permit PER7488 (http://permits.apvma.gov.au/PER7488.PDF).

The research zone was divided into three sections: a) upper (from 65% water capacity line to 50.5% line, area dominated by three melaleuca species; *Melaleuca quinquenervia* (Cav.), *M. viridiflora* Sol. ex Gaert., *M. leucadendra* L.); b) core (from 50.5% to 49%, area dominated by a dense stand of *M. pigra*); and c) lower (from 49% to 23%, area between the core and the water's edge). In each of these three sections, seedling counts per square metre were recorded for twenty randomly selected quadrats (50 cm × 50 cm), and 50 *M. pigra* seedling plants of known age were also randomly selected and tagged. Plant height, basal diameter, number of flowers and pods were recorded monthly for each plant. Developing pods were securely covered with stockings and allowed to mature on the plant. These were collected after three to four weeks and numbers of clusters per tree, pods per cluster and seeds per pod were recorded. No pods were left on trees to fall and add to the seedbank. In July 2003 and March 2004, plants were culled, leaving fifteen and eventually ten plants in each section. Only data for days from emergence to first flower and first pod are presented in this paper.

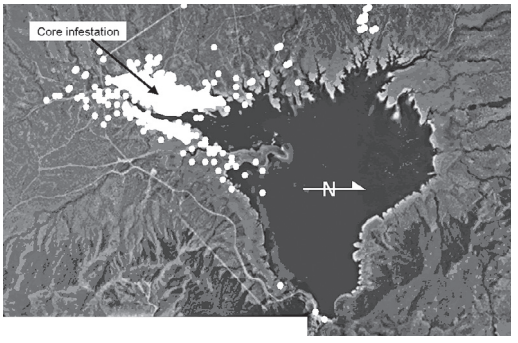

Figure 1. Aerial photograph of Lake Proserpine (2004 – water storage capacity 34%) showing the location of *M. pigra* plants (white dots) and the dense area where a research site was established.

Twenty soil cores (40 mm diameter and 30 cm deep) were taken from each of the three sections annually (from April to June) from 2003 to 2005. Cores were sectioned into four depths: 0–5, 5–10, 10–20 and 20–30 cm. In addition, 80 soil cores (40 mm diameter and 10 cm deep) were also randomly collected from each section, with five samples bulked per replicate and a total of 16 replicates per section. All soil was sieved and *M. pigra* seeds counted. Seedbank data for 2002 consisted of seedling counts in December 2002, plus the soil seedbank of early 2003. Inundation until October 2002 prevented earlier soil seedbank determination.

Seeds from the soil cores and the fresh seeds collected from the *M. pigra* plants were tested each year in September for germination and viability. Four replicates of 50 randomly selected seeds from each section were placed on moist filter paper in Petri dishes and placed in a germination cabinet set at 35°/20°C light/dark 12 h cycle for 10 days and checked daily for germination. Seeds not germinated (after 21 days) were scarified and replaced in the germination cabinet for two days. Any remaining seeds were placed in a 1% 2,4,5-triphenyl tetrazolium chloride (pH 7.0) solution for 24 h at 35°C. Seeds were then dissected and those with a dark pink endosperm were considered viable. Only seedbank data from the core section is presented here.

Seed viability and years were subjected to a two-way analysis of variance after an arcsine transformation.

RESULTS

Mimosa pigra flowered as early as 67 days after emergence (DAE), though the mean for all plants was 129 DAE (±36 SD) (Table 1). A plant that had died

back nearly to ground level took 350 DAE to flower. Plants were found to pod from 155 to 1172 DAE (in the upper section) with a mean of 389 DAE (±204 SD) across all sections (Table 1). Flowering and podding occurred year round, though numbers fluctuated. Percentage of mature plants flowering at any one time ranged from 80 to 100%, with podding plants ranging from 7.5 to 89%.

Eighty-three percent of seeds were found in the upper 5 cm of soil, with the remaining seeds found in the 5–10 cm zone. The seedbank declined from 8205 seeds m^{-2} in 2002 to 786 seeds m^{-2} in 2005 (Figure 2). One quadrat sampled in 2003, one week after the receding water line uncovered the soil, had over 19,000 seedlings m^{-2} emerge, the largest seed reserve counted in the seedbank at Peter Faust Dam.

Seed viability was high for all seeds tested (Table 2) with mean viability ranging from 98–100% for both fresh seed harvested from *M. pigra* plants and seed collected from the soil seedbank. No significant differences were observed for seed type or year.

DISCUSSION

The *M. pigra* eradication management plan was initially based on information found in literature from *M. pigra* infestations in the Northern Territory. Periodic surveys of the dam's perimeter and foreshore were planned to coincide with flowering of new *M. pigra* plants (180–240 days after emergence) (Lonsdale *et al.* 1989). Initially three surveys were scheduled per year (Austin 2003). In eradication efforts, however, it is critical to know the earliest that a plant will flower and set seed, rather than an average time. At Peter Faust Dam, *M. pigra* was found to flower as early as 67 DAE and pod from 155 DAE. The number of control surveys was therefore increased to allow the entire area around the dam to be surveyed every two months. This would allow plants that might be missed during one survey to be found during a subsequent survey before they had time to drop mature seed. Similarly, *M. pigra* in the Northern Territory generally flowers from February to May and pods from March to July (Miller 1988), though flowering can occur whenever sufficient water is available. The fact that mature *M. pigra* plants at Peter Faust Dam can flower and pod year round necessitated a continuous control effort of manual removal and chemical spraying.

Regular monitoring of the area has ensured *M. pigra* plants are removed or sprayed before setting seed. Without additional soil seed input the trend of the soil seedbank depletion curve indicates that the seedbank reserve may be spent in 10–12 years, though data for the next few years will be critical to substantiate this. One positive finding is that, to date, seed has been found only in the top 10 cm of soil, unlike the Northern Territory where *M. pigra* seed has been found to depths of 30 cm (Lonsdale *et al.* 1988). The deeper the seed is in the soil, the slower the seed density declines (Lonsdale *et al.* 1988).

Table 1. Days after emergence of *M. pigra* at first flower and first pod in upper, core and lower sections of the research site at Peter Faust Dam.

	Core	Upper	Lower
First flower (DAE)			
N	50	38	38
Min–Max	70–180	71–181	67–350
Mean ± SD	132 ± 30	125 ± 24	128 ± 52
First pod (DAE)			
N	14	10	15
Min–Max	198–501	155–1172	188–892
Mean ± SD	335 ± 100	505 ± 311	363 ± 167

Table 2. Mean percent viability (± standard deviation) for fresh and seedbank *M. pigra* seeds from the core section of the research site at Peter Faust Dam, 2003–2005.

Year	2003	2004	2005
Fresh seeds	100	98 ± 4	99.5 ± 1
Seedbank	98 ± 2.8	98 ± 1.6	100

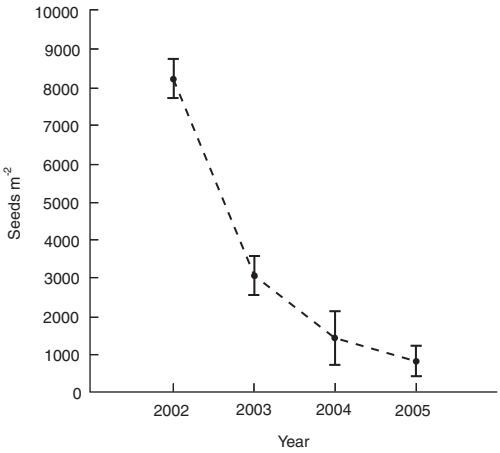

Figure 2. Mean number of *M. pigra* seeds m^{-2} in the top 10 cm of soil cores from 2002–2005. Vertical bars indicate the SEM.

Seed dormancy for unscarified *M. pigra* seed can be broken by diurnal temperature fluctuations of 20°C (Dillon and Forcella 1985). Most *M. pigra* seed at Peter Faust Dam would have been underwater for several years, and thus kept from major temperature fluctuations. Once the water level dropped, soil and seeds would be subject to fluctuating temperatures, breaking dormancy and allowing for massive seed germination. Seed viability was not significantly different between soil seedbank and fresh seeds when subjected to fluctuating temperatures in a germination cabinet.

The objective of the Queensland *M. pigra* strategic plan is to eradicate *M. pigra* from the area around Peter Faust Dam (Austin 2003). Zamora *et al.* (1989) state that an effective eradication plan needs 1) early detection, 2) identification of noxious potential, 3) surveys, 4) understanding population dynamics and 5) development of an eradication technology and strategy. In the case of Queensland's *M. pigra* infestation, detection occurred before the core infestation of plants and its corresponding large seedbank were exposed. The plant's weedy potential had already been documented in the Northern Territory (Lonsdale *et al.* 1989). Surveys made soon after the discovery of *M. pigra* at Peter Faust Dam showed that the plant was contained in the dam's watershed. Eradication technology and strategy was initiated, based on information gathered from the Northern Territory. Without compromising current eradication efforts, research was undertaken *in situ*, with responsibility taken by the researchers for controlling *M. pigra* plants that emerged within the research site. Information gained from this research was used to customise control efforts, surveillance and extension activities. The end result has been a cohesive multi-disciplinary alliance focused on the eradication of *M. pigra* from Queensland.

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