Reproductive phenology of *Pennisetum pedicellatum*

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**Summary**  *Pennisetum pedicellatum* Trin. was introduced to northern Australia for pasture trials and is now a major environmental and agricultural weed in northern Australia. Regular monitoring of populations on heavily disturbed sites showed that plant density and seed numbers per plant were very high, resulting in high annual seed input. The population had a short and synchronised flowering and seeding period. Control by combinations of fire, slashing and herbicide should occur prior to seeding or the large seedbank will result in re-establishment of the stand.

**Keywords** Annual mission grass, denanth grass, seed bank, savanna.

**INTRODUCTION**
Exotic grass invasions are a recognised threat to tropical savannas (Williams and Baruch 2000). In northern Australia there is an increasing awareness of the impacts of such grasses (Whitehead and Wilson 2000), and current research is revealing that they may have long-term impacts on savanna ecosystems (Douglas *et al.* 2004). Significant resources are currently being committed to exotic grass control in Australia’s savannas and there is a significant need for research to ensure the most effective use of the limited weed management budget (Setterfield *et al.* 2004). Understanding the life history traits of a weed, in particular, its growth and phenological patterns, number of seeds produced and abundance and longevity of its seedbank, is critical for effective control and post-control restoration (Myers and Bazely 2003). The timing of flower and seed production should inform the timing of control activities, but weed management programs are not often planned to ensure control prior to seed set. The longevity of the soil seedbank is also important as it is a major determinant of the length of time over which germinants from the original invasion will need to be controlled (Setterfield *et al.* 2004).

There is a growing body of research on the biology and impacts of exotic grasses in northern Australian savannas. This research has focused on Gamba grass (*Andropogon gayanus* Kunth) and, to a lesser extent, perennial mission grass (*Pennisetum polystachion* (L.) Schult.). However, there is increasing concern that annual mission grass, *P. pedicellatum*, may also be a serious weed. It frequently re-colonises sites where perennial mission grass has been controlled. This study describes the establishment, growth and phenology of annual mission grass, the size of the soil seedbank before and after seed fall, and provides some recommendations on control of annual mission grass.

**METHODS**
*Pennisetum pedicellatum* was introduced to northern Australia from Uganda in the 1940s. The species was introduced for use in pasture plant screening trials by the CSIRO (Harrison 1983). Spread of the plant from experimental sites between Katherine and Darwin was noted from the 1950s (Harrison 1983). By 1970, *P. pedicellatum* was widespread over large areas for northern Australia, and considered a major weed of grain sorghum crops (Wood 1970).

This study was undertaken on the ERA Ranger Mine Lease at Jabiru East, adjacent to Kakadu National Park, NT. The site is heavily disturbed and densely populated by *P. pedicellatum*. The climate of this region is characterised by a distinct wet season (December to March), alternating with an almost rainfall dry season (Taylor and Tulloch 1985). The average rainfall is approximately 1500 mm (Jabiru Airport data 12°39’S, 132°53’E, Commonwealth Bureau of Meteorology). Temperatures are high throughout the year, with the mean monthly mean maximum ranging from 31.5°C in June to 37.5°C in November (Jabiru Airport data 12°39’S, 132°53’E, Commonwealth Bureau of Meteorology).

**Establishment, growth and phenology** Three 30 m transects were established on 8 March 2005 at the study site across the *P. pedicellatum* population. Five quadrats were placed across each transect. In each quadrant ten germinants (giving a total of 150 seedlings) were tagged and monitored regularly (21 March, 5 April, 20 April, 10 May and 7 July 2005), until plant death.

In each quadrant, emerging seedlings (live and dead) and the total number of plants were counted. The height (to tip of longest leaf blade), the total number of tillers per plant, and the stage of inflorescence development were recorded for all tagged plants.

Seed heads were collected from randomly selected plants at maturity. The total number of seeds per seed head were counted and recorded. Sub-samples of seed were weighed and tested for viability. Seed production and viability per inflorescence was calculated from the data.
Seedbank To describe the seasonal variation in *P. pedicellatum* seedbank, a series of soil cores (8 cm diameter by 5 cm deep) were taken. Replicate samples consisting of 10 soil cores were taken on three occasions at both study sites: once before *P. pedicellatum* seeded (21 March 2005), soon after seed shed (7 July 2005) and again at the end of the wet season. Each collection sample represented a soil surface area of 0.05 m². Seedbank samples were sifted and the visible seed was removed and counted. The remaining seed was spread over a sterilised sand and coconut peat mix in germination trays and monitored for emergence of *P. pedicellatum* seedlings.

RESULTS

Establishment, growth and phenology Germination and seedling emergence commenced in the early wet season (December 2004) and new seedlings continued to establish into March 2005. The total number of seedlings per 1 m² plot ranged from 16 to 198, with an average total of 94 ± 6.6 seedlings m². The average number of seedlings per plot in early April, at the time of peak flowering, was 79 ± 5 seedlings m² and the number in late April, the time of peak seeding, was 56 ± 4 seedlings m².

The reproductive phenology of *P. pedicellatum* was very short, with the cycle of inflorescence initiation to seed fall and plant death completed within 3.5 months (Figure 1). Floral bud initiation had commenced by March. Shortly after initiation the developing inflorescence enlarges, the enclosing sheath swells and the first external evidence of flower stalk development, is noticeable. This stage of flower stalk development is occasionally referred to as the ‘boot’ stage. By 21 March, 85% of tagged plants had reproductive structures, although at this time there was only an average of two reproductive structures per plant, and the majority (~60%) were at boot stage. New inflorescences continued to develop on the plants throughout the reproductive cycle, and were still developing on most plants even at the time of their death in May/June. Flowering peaked in early April (Figure 2) when 95% of plants had reproductive structures, with an average of 13.9 ± 2.5 plant⁻¹. Approximately half of these were at boot stage, or were flowering, and the rest had already developed mature seed with seed fall occurring. By 21 April, there was a substantial variation in the number of reproductive structures per plant, ranging from 5 to 221. The average number was 25 ± 4.5 plant⁻¹, of which 75 ± 5%...
were seeding (Figure 2). This period from late April to early May represented the peak input of seed fall. By 10 May, 20% of plants had seeded and died (Figure 1). The remaining plants there was an average of 29 ± 6.5 reproductive structures plant\(^{-1}\), of which 30 ± 2.7% held mature seed and 56 ± 4.6 had shed seed (Figure 1). Seed shed was completed by late June.

The average total number of seed heads per plant was approximately 29.5 ± 5.2. There was an average of 53 ± 3.6 seeds head\(^{-1}\). Therefore, the average number of seed produced at Jabiru East was 1563 seeds plant\(^{-1}\). Based on an average of 56 seedlings m\(^{-2}\), there was an average seed production of approximately 120,000 m\(^{-2}\).

### Seed bank and seed longevity

The seedbank samples collected in March 2005 did not contain any *P. pedicellatum* seed. This indicates that there was no carry-over of seed from 2004. By contrast, the seedbank after seed fall (June) and in the early wet season (November) were extremely high. The seedbank in June was 39,000 viable seeds m\(^{-2}\). There was little difference with the seedbank at the commencement of the wet season with 30,000 viable seeds m\(^{-2}\).

### RECOMMENDATIONS FOR CONTROL

The project described reproductive phenology in the absence of disturbance, such as fire or clipping. These preliminary results demonstrate that populations of *P. pedicellatum* do have a short and synchronised flowering and seeding period in the absence of disturbance. This may vary in sites with more regular disturbance, and flowering of annual mission grass is often observed at irregular times along roadsides following slashing.

There was no carry-over of seed from one year into the following wet season, which has previously been observed in sorghum paddocks in the NT (Mott 1980). Therefore, the population at this site was determined by seed input from the previous year. However, carry-over between years has been observed at other sites and may be the result of variations in site conditions or reflect genetic variation among populations.

*Pennisetum pedicellatum* control should be concentrated at the end of the wet season prior to seeding. The effect of burning on *P. pedicellatum* at this time has not been studied, but it may reduce the seeding population and reduce seed available for germination. Herbicide spraying of plants should occur prior to seeding and, if this opportunity is missed, then control should be postponed until the following year because the large seedbank will result in rapid re-establishment of the stand.

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### REFERENCES


