Germination and viability of mesquite (*Prosopis pallida*) seed following ingestion and excretion by feral pigs (*Sus scrofa*)

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Abstract

A study in northern Queensland aimed to determine if feral pigs disperse viable seeds of the invasive woody weed, *Prosopis pallida*. Thirty-eight dung samples were collected, 19 from within a dense *P. pallida* infestation and 19 from an adjacent area that had been mechanically cleared of *P. pallida*. All seeds were removed from the dung and undamaged seed tested for germination and viability. Mean (± s.e.) dry weight of collected dung samples averaged 51.1 (± 2.9)g, with no difference between infested and cleared sites. Visual estimation of the contents of these samples showed that *P. pallida* seed pods were the major component of the dung, averaging 69 (± 4)% from samples collected within dense infestation and 57 (± 4)% for those from the adjacent area. Fifty-eight % and 42% of the pig dung samples collected from within and adjacent to the infestation, respectively, contained viable seed. No significant difference (P>0.05) was found between the number of viable seeds present in dung samples from the two areas; an average of 2.4 seeds per sample was recorded with a range of 0–19. The germinability of this seed was high, with 70% of all viable seed germinating within 21 days and the remainder germinating immediately after scarification.

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Introduction

In Queensland, *Prosopis* spp. (mesquite) are among the growing list of exotic woody weeds invading large areas of grazing land. *Prosopis* spp. were introduced into Australia to provide shade, as potential fodder and for soil stabilisation (Jeffrey and March 1995). However, they have a tendency to form dense thickets that reduce pasture growth, interfere with mustering, injure livestock and cause damage to vehicles (Jeffrey and March 1995).

The most widespread of the 4 species in Queensland, *P. pallida*, is estimated to infest 0.5M ha (Jeffrey and March 1995). Fortunately, most of this infestation consists of isolated plants or light infestations with very few dense stands having developed. The aggressive weediness of *P. pallida* has been recognised through its listing as a 'declared plant' under the Queensland *Rural Lands Protection Act 1985* and as a 'weed of national significance' under The National Weed Strategy (ARMC 1997).

Successful strategies have been developed to control *P. pallida* including the use of fire, biological control and chemical and mechanical techniques (Jeffrey and March 1995; Campbell *et al.* 1996; Campbell and Setter 1998). Fencing of infestations has also been promoted as an important management technique for reducing the risk of infesting 'clean areas' (P.L. Jeffrey, personal communication), as domestic animals are recognised as significant dispersal agents of seeds of *Prosopis* spp. (Brown and Archer 1987; Harding 1991). Although fencing may halt the movement of domestic animals, it will not necessarily prevent smaller native and/or feral animals from moving between infested and clean areas.

In the United States of America, a wide array of native herbivores, including rodents, coyotes (*Canis* spp.), peccary (*Dicotyles* spp.) and numerous ungulates (Bogusch 1952 cited in Brown and Archer 1987) have been observed to disseminate *Prosopis* spp. Field observations by the authors at a *P. pallida*-infested site in

northern Queensland revealed the presence of pods in the dung of feral pigs (*Sus scrofa*).

This study aimed to clarify whether *P. pallida* seed that passed through feral pigs was viable. We tested the germinability and viability of seeds collected from dung within an infestation of *P. pallida* and in an adjacent clean area where all plants had been treated.

Materials and methods

The field site

The experimental site was located at Hughenden (20°51'S, 144°12'E), north Queensland. Dense stands of *P. pallida* (average density of 2070 plants/ha) occur over approximately 50% of the site, with the remainder having been cleared as part of research aimed at developing best practice control strategies. Improved pasture grasses such as buffel (*Cenchrus ciliaris*) and urochloa (*Urochloa mosambicensis*) dominated the herbaceous vegetation between *P. pallida* plants. The 173 ha property on which the site is located has had domestic livestock excluded for 5 years and adjoins several grazing properties that have cleared all mature mesquite trees. Feral pigs were able to move freely within the research site, from and within neighbouring properties.

Prosopis pallida *seed and pod characteristics*

When mature in late summer, the straw-coloured seed pods of *P. pallida* are smooth and slightly curved, with slight constrictions between the seeds. Individual hard-coated seeds are encased within a larger seed hull, each of which is covered in a dark sugary coating and finally sheathed by the outer layer of the pod.

Sampling method

The binding effect of *P. pallida* pods coagulated the dung and made it relatively easy to identify individual dung samples. However, not all faecal matter was voided in discrete units; therefore, dung samples were defined as all faecal pellets, of similar colouration and states of decay within close proximity. In total, 38 dung samples were collected on August 12, 1999, 19 from within a dense *P. pallida* infestation and 19 from an adjacent area that had been cleared of *P. pallida* in December 1998. Collections from both sampling locations were made within an area of approximately 1 ha.

It was estimated that dung samples had all been excreted some time since the end of the wet season. All samples were intact with no apparent breakdown in structure and no signs of seedling emergence. There was, however, some obvious variation in the age of the dung samples, with some appearing much fresher than others. Samples ranged from those having a slight odour and substantial pigmentation to those with no distinct odour and a loss of pigmentation.

Seeds were recovered by manually breaking apart the dung, collecting any loose seed and opening intact hulls to obtain seed. Undamaged, filled seeds, partially damaged seeds and weevil[1]-damaged seeds were noted and retained. At this time a visual estimation was made of the percentage of the dung sample that was *P. pallida* pod material. Dry weight of all sample material remaining after extraction of seeds was measured following placement in a drying oven for 48 h at 80°C.

The undamaged, filled seeds from each dung sample were placed on moist Whatman™ No. 4 filter papers in petri dishes. The petri dishes were then placed in growth cabinets under continuous lighting, set at a constant temperature of 29 ±1°C and were moistened daily with distilled water. Seeds were considered germinated if the emergent radicle extended at least 2 mm beyond the seed coat. Germinated seeds were counted and removed daily for 21 days after which the seed coats of remaining seeds were scarified with a scalpel to break dormancy. These seeds were then placed back in the germination cabinet for a further 7 days, and any germination recorded daily. Seed viability is expressed as all seeds that germinated during the first 21 days plus those seeds that germinated once dormancy was broken. Germinability is the proportion of seeds that germinated within the first 21 days over the total number of viable seeds.

T-tests were used to determine whether significant differences occurred between dung samples collected from within and adjacent to the *P. pallida* infestation.

1 Identified as *Algorobius prosopis* an introduced mesquite bio-control agent released to assist in integrated management of *P. pallida*.

Results

Mean dry weight of collected dung samples (Table 1) averaged 51.1g irrespective of whether samples came from within or adjacent to the *P. pallida* infestation. Visual estimation of the contents of these samples showed that *P. pallida* pods were present in all samples, and were the major component, averaging 69% from samples collected within dense infestation and 57% for those from the adjacent cleared area.

A total of 150 *P. pallida* seeds were recovered from the 38 dung samples. Of these seeds, 22 were insect-damaged and 29 were partially damaged during ingestion. Ninety-nine undamaged, filled seeds were kept for germination. Fifty-eight % and 42% of the dung samples collected from within and adjacent to the infestation, respectively, contained viable seed.

No significant difference occurred between the number of viable seeds present in dung from the infested areas compared with the adjacent cleared areas. On average, individual dung samples contained 2.4 viable seeds with a range of 0–19. The germinability of this seed was high, with 70% of all viable seed germinating within 21 days following placement in a germination cabinet. The remaining 30% of viable seed germinated within 3 days after scarification.

Discussion

The high proportion of *P. pallida* found in the dung, combined with evidence of regular pig activity, including formation of tracks and rooting, suggests that *P. pallida* pods are a food source favoured by feral pigs. Kingsolver *et al.* (1977) reported that a range of predators seek pods of *Prosopis* spp. because of their high sugar and protein contents. Free-ranging feral pigs have high nutritional requirements so high protein food sources such as fruit and pods (when available) are actively sought (Baber and Coblentz 1987).

This study has shown that some viable seed of *P. pallida* passes through the digestive tract of feral pigs. However, we have not quantified what percentage of ingested viable seed survives digestion. The relatively small amount of viable seed found in the dung in relation to the large proportion of pods present suggests that some mortality occurs. Campos and Ojeda (1997) found that the European wild boar damaged all *P. flexuosa* seeds that were consumed, which led them to conclude that these animals were not dispersers but merely a predator. Controlled feeding studies under laboratory conditions would clarify the impact feral pigs have on germination and viability of *P. pallida* seeds. A similar procedure to that used by Shayo and Udén (1998) could be adopted. Worthy of note was the finding of insect bio-control agents that had survived within the dung samples; we have not examined the effects of such activity.

While the number of *P. pallida* seeds per individual dung sample appears low, the risk that feral pigs may spread *P. pallida* into weed-free areas remains. Further studies are required to determine the size of this risk. Specifically, information is needed on density of feral pig populations and the extent of their home ranges in locations where *P. pallida* infestations occur.

Material consumed by feral pigs is likely to be defaecated 14–16 hours after ingestion (Castle and Castle 1950 cited in Diong 1982) and feral pigs can have an aggregate home range of 33.5 km^2 (Caley 1997) with the mean distance travelled in a 24-hour period being 8.4 ±3.6 km (Saunders and Kay 1991).

Table 1. Mean values (± s.e.) for dung composition and seed characteristics of feral pig dung samples collected from within and directly adjacent to a dense *P. pallida* infestation at Hughenden, north Queensland.

Parameter	Within	Adjacent	Significance level (P<0.05)
Weight of sample (g)	51.7 (± 3.8)	50.5 (± 4.3)	NS
% *P. pallida* pods in sample	69.0 (± 4.0)	57.0 (± 4.0)	*
Number of insect-damaged seeds	1.2 (± 0.4)	0.0 (± 0.0)	NS
Number of partially damaged seeds	1.0 (± 0.4)	0.6 (± 0.4)	NS
Number of germinable seeds	2.4 (± 0.7)	0.9 (± 0.6)	NS
Number of viable seeds	3.5 (± 1.1)	1.2 (± 0.6)	NS
Germination (% of viable seed)	78.9 (± 6.7)	79.2 (± 12.1)	NS

Anecdotal evidence suggests that many of the large *Prosopis* infestations currently in Australia originated from a few trees (Condon and Alchin 1979), often from those planted around homesteads for shade. Fortunately, an extensive awareness and education program implemented in recent years has made landholders much more aware of the negative impacts of *Prosopis* spp., and it is highly unlikely that known small infestations would now be allowed to spread. However, if feral pigs can disperse seed into remote areas, or locations where *Prosopis* is not expected, there is a risk of new infestations establishing. The risk increases the burden of surveillance on landholders.

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