Suppression of native wild rice germination by exotic para grass

Penny A.S. Wurm[1], Sean M. Bellairs[2] and Beckie Kernich[2]
[1] Tropical Savannas CRC, Charles Darwin University, Darwin, Northern Territory 0909, Australia
[2] School of Science and Primary Industries, Charles Darwin University, Darwin, Northern Territory 0909, Australia

Summary Wild rice (*Oryza meridionalis* Ng) underpins vertebrate food chains on the monsoonal floodplains. This native annual grass is displaced by the introduced pasture, para grass (*Brachiaria mutica* (Forssk.) Nguyen). This study investigates whether the mechanism for this displacement is through effects on the germination of wild rice seed.

Wild rice has a seed dormancy mechanism that prevents seeds germinating when they are first dispersed into the moist floodplain soil at the end of the annual wet season. The presence of para grass may prevent or change environmental cues that would otherwise break dormancy and stimulate germination of wild rice.

Initially we found that, under wild rice cover, some 76% of seeds had germinated, 17% had died and 5% remained ungerminated after two wet seasons. When wild rice seeds were sown into a well established para grass cover, almost no seed germinated, a large proportion remained alive but ungerminated, and a greater proportion died than under wild rice cover.

We then investigated how para grass may prevent germination of wild rice, by (a) determining dormancy breaking cues for wild rice seeds and (b) comparing floodplain seed bed conditions under para grass and wild rice cover.

In the laboratory, breaking of dormancy was dependent on the seeds being exposed to high temperatures. In the field, para grass produced much higher above ground biomass than wild rice, and modified the seedbed. Temperatures were lower at the soil surface under para-grass cover than under wild rice cover.

This study showed wild rice has a dormancy mechanism, which prevents germination under significant canopy and litter cover. Thus, a weed species (para grass) can modify habitat conditions so that dormancy breaking and germination in a native species (wild rice) is prevented. Managers may need to deal with habitat modification by weeds, as well as direct competition with natives, when dealing with environmental weeds.

Keywords *Oryza meridionalis*, *Brachiaria mutica*, seed dormancy, seedbed conditions, monsoonal floodplains.

INTRODUCTION

This study addresses interactions between wild rice and para grass. Wild rice seeds underpin the vertebrate food chain on the monsoonal floodplains in northern Australia, being an important food resource for both magpie geese and dusky plains rats (Redhead 1979, Frith and Davies 1961).

Para grass was introduced from tropical Africa and South America, initially to Queensland in the 1880s and to the NT by 1910 (Cameron and Lemke 2002). Its productivity and stoloniferous habit meant it was valued as a ponded pasture species and for bank stabilisation. In Queensland it is now considered an environmental weed in wetlands, a weed of sugar cane plantations and has been shown to alter stream hydrology (Bunn *et al*. 1998). In the Northern Territory (NT), it is still valued as a pasture species in grazed landscapes, but is an environmental weed in conservation reserves, including Kakadu National Park. It is not a declared weed in either jurisdiction.

Wild rice is being displaced by para grass on NT floodplains (Knerr 1996, Wilson *et al.* 1990, Ferdinands *et al.* 2001). On the Magela Creek floodplain, Knerr (1996) found that the distribution of para grass increased by some 300 ha in five years, while that of rice decreased concomitantly. Ferdinands *et al*. (2001) predict that, without proactive management, further displacement of wild rice by para grass will occur on the Mary River floodplain. The mechanism for this displacement is unknown, but may be due to direct competition or via habitat modification, and may operate at germination, establishment or during the growing phase.

The aim of this study is to determine if para grass affects wild rice seed germination. Here we measure wild rice germination under undisturbed wild rice cover and under para grass cover, characterise wild rice seed dormancy and germination in the laboratory, and describe the seedbed under both types of cover in the field.

MATERIALS AND METHODS

The study sites on the Adelaide, Mary and South Alligator River floodplains lie in the wet-dry tropics of northern Australia. Germination and seedling emergence of annual wild rice occur in the early wet season, before the floodplains are inundated. Plants establish as the water levels rise. Flowering occurs in the mid-to-late wet season and seed are shed into inundated or wet soils. The black cracking clay seedbed desiccates during the ensuing dry season, until the next wet season rains.

Wild rice germination in the field Wild rice sites were located on the South Alligator River floodplain. Seed was buried in April 1992, and retrieved in January 1993 and January 1994. Para grass sites were located on the Mary River floodplain. Seed was buried on these sites in April 2002 and retrieved in October 2003 and October 2004. Replicate nylon bags of freshly collected wild rice seeds (25 seed per bag) were buried under each cover type. At each site, a sub-sample of bags was retrieved after the first and second wet-dry cycles after burial, and seed condition was recorded. Retrieved seeds were described as ungerminated, germinant (indicated by the presence of a radicle), or husk (including empty husks or husks containing rotten seeds).

Seed dormancy and germination of wild rice Wild rice seeds were collected in April/May 2005 from the floodplains of the Adelaide River and Mary River, NT.

Germination testing was carried out on wild rice seeds, with or without removal of the palea and lemma (husk). Intact seeds were pretreated by dry storage at 25°C (control) or heated to 35°C for 60 days.

All tests used four replicates of 50 seeds, pooled from two field populations, and were incubated at 30°C in a controlled temperature incubator with a 12 h light/dark regime. Seeds were treated, placed on filter papers in Petri dishes and monitored for 28 days. Germinated and dead seeds were recorded and removed.

Characterisation of the seed bed Six sites along the Mary River were sampled in vegetation dominated by either wild rice or para grass. Litter biomass, soil moisture (by weight) and soil surface temperatures (using a soil temperature probe) were recorded as once-off measurements during October 2005 dry season.

RESULTS

In wild rice stands, an average of 46% of seed germinated by the end of the first wet-dry cycle after burial and 37% percent remained ungerminated (Table 1) (Wurm 1998). After two wet seasons only 5% remained ungerminated. However, under para grass 68% percent of seeds remained ungerminated after one wet-dry cycle and 37% percent remained ungerminated after two wet-dry cycles. Very little germination was detected at all at these sites (Table 1). While some germinants may have been mistaken for empty husks in the para grass study (due to logistic constraints it was not possible to access study sites until well into the subsequent dry season), there were clearly more wild rice seeds remaining ungerminated or rotting under para grass cover.

Intact wild rice seeds are dormant at seed shed, with dormancy being broken by the removal of the palea and lemma. For intact seeds, treatment with dry heat resulted in dormancy release (Figure 1).

Table 1. Percentage of wild rice seeds present under wild rice and para grass cover as germinants, ungerminated seeds, husks or germinants, one and two wet-dry cycles after burial.

	Under wild rice cover	Under para grass cover
One wet-dry cycle after burial		
Ungerminated (%)	36.8 ± 3.3	67.7 ± 4.6
Husks (%)	16.8 ± 1.3	30.4 ± 4.5
Germinants (%)	46.4 ± 2.9	1.9 ± 1.0
	(n = 60)	(n = 18)
Two wet dry cycles after burial		
Ungerminated (%)	5.0 ± 0	37.5 ± 5.9
Husks (%)	63.6 ± 0	61.9 ± 5.7
Germinants (%)	31.4 ± 0.1	1.4 ± 1.3
	(n = 42)	(n = 11)

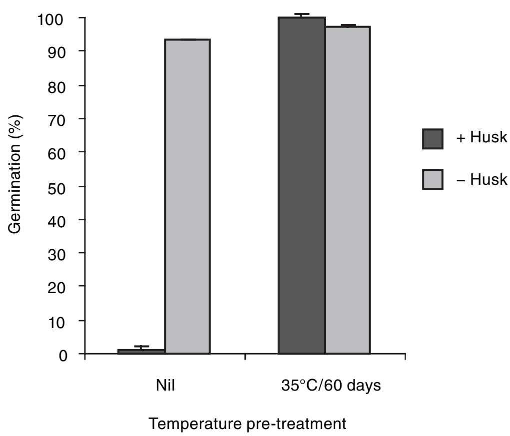

Figure 1. Effect of removal of the palea and lemma (husk) and of temperature storage conditions on wild rice seed germination.

Conditions in the seedbed in wild rice and para grass stand differ (Table 2). Soil temperatures were lower and cover biomass was much greater under para grass than under wild rice. Soil moisture did not differ.

Table 2. Characteristics of para grass and wild rice patches.

	Under wild rice cover	Under para grass cover
Temperature (°C)[A]	38.8 ± 2.0	28.4 ± 0.3
Soil moisture (%)	21.2 ± 2.0	21.1 ± 2.3
Litter and standing biomass (tones ha^{-1})	7.3 ± 0.7	36.1 ± 3.9

[A] Air temperature was 37.7°C.

DISCUSSION

Reduced germination of wild rice seed under para grass cover may be explained by the requirement for heating of the seed to break dormancy in wild rice. Seed dormancy may be broken by exposure to high temperatures, which occurs in more sparsely littered or bare floodplains soils during the annual dry season (Londsdale 1993, Wurm 1998). The soil temperature under para grass cover was found to be lower than under wild rice cover in this study. This is apparently due to the shading effect of the much higher cover biomass for para grass, recorded here and elsewhere (Finlayson 1991, Douglas and O'Connor 2004). Microclimate (e.g. soil temperature) affects the seed dormancy of wild rice such that dormancy is released under more open canopy of native grass canopy and maintained under the cover of para grass.

This study showed wild rice has a dormancy mechanism, which prevents germination under significant canopy and litter cover. Thus a weed species (para grass) can modify habitat conditions so that dormancy breaking and germination in a native species (wild rice) is prevented. Weed species may also affect other characteristics of the soil that affect seed dormancy and germination, such as the quality and quantity of light, and soil nitrate levels. Thus, managers may need to deal with habitat modification by weeds, as well as direct competition with natives, when dealing with environmental weeds.

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