# PROPAGATION AND ESTABLISHMENT OF *PHRAGMITES AUSTRALIS* FOR ENVIRONMENTAL, AGRICULTURAL AND INDUSTRIAL USE IN CONSTRUCTED WETLANDS

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## ABSTRACT

For large-scale production of *P. australis* plants, propagation from seed has been investigated by comparing methods for seedling establishment and their subsequent growth. Seed germinated at temperatures ranging from a maximum of 35°C to a minimum of 9°C. Germination percentage was highest when seed samples were cleaned and separated from husks and trash. High rates (90-100%) of seed germination were obtained with cleaned seed, without the need for stratification.

Seedling growth following germination was affected by container size. Seedlings produced from germinating seeds in Petri dishes were the most adversely affected with a survival rate of only 40% and a plant height of 30 cm after 16 weeks. When these seedlings were planted out, their height after a further 4 weeks was only 85 cm. Seedlings which were raised from seed sown directly into plastic bags produced the tallest plants (50 cm) after 16 weeks. These plants established well (130 cm) during a further 4 weeks after planting out in large pots.

Key words: *Phragmites australis*, seed cleaning, germination, growth, environmental conditions.

## INTRODUCTION

During the past decade, the use of emergent macrophytes for environmental, agricultural and industrial applications has increased dramatically. Among the emergent aquatic plants, common reed *(Phragmites australis* (Cav.) Trin. *ex.* Stuedel) is a wetland plant with a variety of applications, including stabilization of river banks (Frankenberg 1992; De Maeseneer 1992), sewage treatment (Parr 1990) and the concentration of metals from industrial wastewaters and mine seepage (Dunbabin and Bowmer 1992). In Australia, information on the growth of the plant is limited to a study of nutrient accumulation and cycling in an enriched swamp (Hocking 1989).

Methods of propagation from seed need to be developed for the large-scale production of P. *australis* because vegetative propagation is limited to the growing season. Techniques for the vegetative and sexual propagation of *P. australis* and plant establishment in England have been described by Parr (1987). Only 40-50% of the plants survived from cuttings, clumps and rhizomes, compared with 81% of plants raised from seeds. The best results were obtained with alternating day/night temperatures (30°C / 20°C); light had no effect. For large-scale production of plants, the seed propagation method was considered the most suitable.

In our study, we examined seedling production from seed obtained from Australian sources representing environments different from those found in North America and Europe. In a Canadian study, stratification of P. *australis* seed at 4°C for 6 months improved percentage germination from less than 50% to 100% (Galinato and van der Valk 1986). We tested the germination of locally collected seed to examine the need for stratification. Our aim was to develop techniques to obtain good quality seed, and to study the effects of container size and temperature on the growth of P. *australis,* so that plants for wetland construction or restoration could be produced on a large scale.

## METHODS

A sample of mature P. *australis* seed collected in July 1991 from a river bank in the Murray Valley Basin (Union Bridge, Albury, NSW: 36° 10' S; 146° 50' E) was cleaned and separated by hand to ensure the existence of filled seed. A larger seed sample was collected from the same site in July 1992. To clean larger quantities of

seed more efficiently, a commercial food blender (Max Braun, Frankfurt) was used. Dried flower heads were placed in the blender without water and run at low speed (setting 1 on dial) for one min. Seeds collected at the bottom of the blender were sieved (1-mm opening) to remove traces of flower parts and husks. To separate seeds from husks in the remainder of the sample, a simulated gravity-table action was used. A thinly spread quantity of seed that had been collected from the bottom of the blender and retained in the sieve was placed on one corner of a sheet of cardboard (35 x 25 cm approx.). The card was held sloping gently down and on one side. Short light taps were applied at the upper side of the cardboard; heavy, full seeds rolled off the cardboard and were collected in a tray below.

*Germination in Petri dishes*

On 10 January 1992, triplicate subsamples of 20 seeds were placed on filter paper in 90mm Petri dishes to test germination. Distilled water was added to moisten the filter paper and the dishes were placed in a glasshouse shaded from direct sunlight. The temperature ranged between 25°C day and 10°C night, as recorded using a thermohydrograph (Thies, Gottingen). After 3 days, the number of germinated seed was recorded to ascertain seed viability. Germination was complete after a further 2 days and seedlings were transplanted into plastic pots (7 cm diameter x 7 cm deep) filled with washed river sand.

*Direct sowing into containers*

Seed was sown directly on 10 January into twenty 7 cm plastic pots; ten with sand and ten with commercial potting mix. In addition, seed was sown into twelve plastic potting bags (7 cm diameter x 17 cm) filled sand. Seed was placed on the surface of each container and covered with 1 mm of the respective medium. For the first two days, moisture was surface-applied by mist. Thereafter, pots and bags were sub-irrigated to maintain moist conditions during germination and emergence. To reduce drying of the growing medium surface, containers were enclosed in clear plastic bags and placed in a glasshouse under the same conditions as described in the germination study. Glasshouse temperatures ranged between a maximum of 25°C and a minimum of 9°C during this experiment.

*Seed germination in trays*

Two seed germination trays 34 cm x 28.5 cm x 6 cm deep were filled with either commercial potting mix or a 50% blend of potting mix and washed river sand. On 20 October 1992, seeds were spread evenly on the surface, covered with l mm of medium and pressed for firm contact before being placed in a glasshouse. The soil surface was moistened by mist application for 30 min. For comparison some uncleaned seed was also sown under the same conditions. To reduce heat loading during summer, whitewash was applied to the glasshouse roof and walls. Temperatures ranged between a maximum of 35°C and a minimum of 15°C with the exception of 2 days when the day temperatures were 25-30°C and the night temperature fell to 9°C-11°C. Thereafter, minimum night temperatures were kept within the range described by gas heating.

After 6 weeks, seedlings in the germination trays reached 5 cm in height and were transplanted into plastic potting bags 7 cm x 17 cm. Fertilizer (Aquasol; Hortico, Sydney) was applied weekly at half strength (0.5 g L-1) for seedlings up to 5 cm high; thereafter at the recommended rate (1 g L-1). A final measurement of seedling height of plants growing in trays was made after 8 weeks.

*Seedling growth after final transplanting*

After 16 weeks, four seedlings of each treatment were transplanted in to 40 cm plastic pots (Aurora-Collingwood Kiln, Melbourne) filled with sand. Pots received drip irrigation daily and liquid fertilizer every 10 days. Measurements of seedling growth were made after a further four weeks.

## RESULTS

A germination rate of 100% was recorded for the sample of clean seed incubated in Petri dishes. Every seed had germinated within 5 days at the alternating day/night temperatures of 25°/10°C in indirect

daylight. However, 60% of these seedlings died after transplanting due to damage caused to young roots during removal from the filter paper.

Germination of seed sown directly in the plastic pots, trays and plastic potting bags was also high (90,90 and 92%, respectively). The results were similar using either commercial potting mix or washed river sand. Germination was complete after 10 days.

A difference in initial seedling establishment was noted (Fig. 1). Four weeks after sowing, the height of seedlings in the plastic potting bags was 10 cm in contrast to 5 cm for seedlings in plastic pots. Seedlings which had been transplanted from Petri dishes into plastic pots were about the same height (5-7 cm) as directly sown plants. However, they appeared less vigorous, probably due to root damage during transplanting as discussed earlier.

The emergence of seedlings of P. *australis* sown in seed trays began after 8 days, with 90% emergence being recorded after 12 days. Six weeks after sowing the seedlings had reached an average height of 5 cm (Fig. 1 ), and they were transplanted into 7 cm x 17 cm plastic bags filled with a 50:50 mixture of potting mix and sand. Survival of transplanted seedlings using this method was 99% in contrast to 40% survival of seedlings transplanted from Petri dishes.

Plant height measurements at 16 and 20 weeks are also shown in Fig. 1. Seedlings grown from seed sown directly into plastic bags were significantly taller (50 cm) than seedlings grown in pots or pre-germinated in Petri dishes. The mean height of seedlings raised initially in germination trays and transplanted to 7 cm x 17 cm bags after 6 weeks (43 cm) was insignificantly different from those sown directly into similar sized bags.

The most advanced seedlings after 20 weeks (ie. 4 weeks after all seedlings were transplanted and grown on in 40 cm pots) were those which had been sown directly in plastic bags (130 cm), while seedlings which had previously been raised in seedling trays were of a similar size to those sown directly into plastic pots (105 cm). Plants which were germinated in Petri dishes generally remained stunted (85 cm).

Seed that was not separated from flower parts and was sown in seed germination trays at the same time as cleaned seed failed to germinate after 21 days. The main problem with germination appeared to be a lack of wetting of the seed within the matt of floret parts.

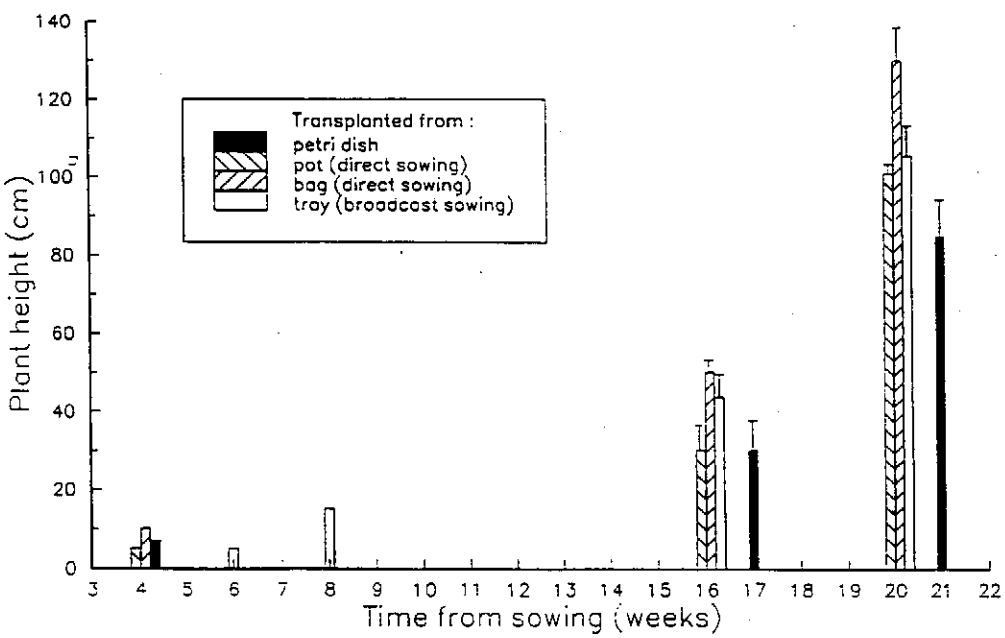


**Figure 1:** Seedling growth of *Phragmites australis* in different containers. (Error bars indicate standard deviation of mean).

## DISCUSSION

In our study, seed germination of P. *australis* on filter paper or in sand, potting mix or a mixture of these media was between 90% and 100% without stratification. The need for seed stratification in Europe and North America may be an ecotypic adaptation to the seasonal extremes. The possibility that this difference in germination was due to genotypic specialisation was discounted when subsequent research on cleaned *Phragmites australis* seed collected from diverse locations in Australia (including coastal and inland N.S.W., Victoria and South Australia) germinated at similar rates to the test samples without the requirement for stratification.

A blender is a simple and effective means for the separation of large quantities of seed from their husks. Cleaning of this seed with a simulated gravity table produced a high quality seed sample with excellent germination.

In this study we have demonstrated good seed germination and seedling growth with different temperatures. This apparent wide tolerance of P. *australis* suggests that in Australia it can be economically propagated for commercial purposes in any season in a glasshouse with heating.

The best results were achieved when seeds were sown in plastic potting bags. Seedlings reached 50 cm in height after 16 weeks whereas seedlings growing in plastic pots were only 30 cm high after the same period. A restriction of root volume is the likely explanation for the poorer seedling growth in these pots. If seedlings are to be propagated after germination in Petri dishes, this should be done as soon as possible after germination; the longer the roots develop the greater the damage. The main use for the Petri dish technique is to provide a rapid, simple estimate of seed viability.

Propagation from seed is considered the most economical and least labour-intensive method of large-scale propagation of P. *australis;* because of the tolerance limits and the adaptability of seed to germination and growth in glasshouses. A vigorous seedling of about 50 cm for direct planting into a constructed wetland can be produced within 16 weeks provided cleaned seed is sown into adequately sized containers.

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