**A comparison of the emergence of octoploid and tetraploid *Phalaris aquatica* seedlings**

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## ABSTRACT

The induction of polyploidy is a means of increasing seed size and thereby improving the establishment success of small-seeded pasture species. Two glasshouse experiments were conducted to compare the emergence of octoploid and tetraploid *Phalaris aquatica* seedlings from sowing depths of 5, 15, 25 and 35 mm in a heavy, setting soil. The first experiment compared the original octoploid with its tetraploid parent population and the second compared two more recently selected populations of both ploidy levels. In both experiments the octoploid seedlings emerged significantly better than the tetraploid seedlings, especially from the two deeper sowings. The new octoploid population is under evaluation at a field site near Rye Park, N.S.W.

**Key words**

Phalaris, polyploidy, seedling emergence.

## INTRODUCTION

Establishment is a difficult phase in the agronomy of small-seeded pasture grasses. The phalaris cultivar Australian (*Phalaris aquatica* L.) is a valuable pasture grass in south-eastern Australia being able to maintain stand density under grazing. However, it has low seedling vigour causing establishment problems. A successful approach to improving seedling vigour has been the induction of polyploidy (2). This approach was used in the development of an octoploid form of *P. aquatica* (2n=8x=56), based on plants derived from a cross of the tetraploid cvv. Australian and Uneta. A field trial to compare the octoploid and parent tetraploid populations showed the superior emergence of the octoploid, but population numbers of the octoploid declined dramatically over the first summer (1); it was suspected that this inviability was due to chromosomal imbalance in plants of the original octoploid. On the assumption that the persistent plants in this trial were a more chromosomally stable subset of the original octoploid, a new population was derived by intercrossing 32 survivors.

A glasshouse experiment was designed to examine in a more controlled environment the relative success of emergence from variable sowing depths of the two octoploid and the parent tetraploid populations. Separate comparisons were made between the original octoploid and its tetraploid parent, and between the new octoploid and the tetraploid cultivar Australian II.

## MATERIALS AND METHODS

The development of the original octoploid population by nitrous oxide treatment and its evaluation in a grazing trial was described in Kelman et al. (1). Thirty-two surviving plants from this trial were intercrossed to form the new octoploid population. An approximately equal number of seeds of each plant was bulked to constitute the new octoploid. A sample of topsoil from a site adjacent to the field experiment was collected. The soil is a yellow podsolic on a poorly drained lower slope. The bulk density of this soil was found to be 1.23 g/cc. Plastic pots (1.7 L) were divided in half using thin plastic sheeting and filled with the appropriate weight of soil to achieve the same bulk density that was measured in the field.

**Experiment 1.** This experiment compared the Australian ? Uneta tetraploid with the original octoploid. The tetraploid population was made up of single seeds from each of a random sample of 25 families from the 42 families tested by Oram (3) in the development of the cv. Australian II. The seed was sown at 4 depths: 5, 15, 25 and 35 mm below the surface. Twenty-five seeds of each ploidy treatment were sown in each half-pot area. There were 4 replicates of each ploidy ? sowing depth combination, making a total of

32 pots. A spare pot was used to determine the volume of water needed to completely wet the soil profile. Each pot was then watered with this volume. During the course of the experiment the soil surface was kept moist with a mister, applied each morning. Germination tests confirmed the viability of the seed used in the experiment.

Emergence counts were made 25 days after sowing when it was judged that emergence was complete from the deepest sowings. Seedling height was measured from the soil surface to the tip of the coleoptile. Seedlings were cut at ground level and weighed immediately. Emergence counts were arc-sine transformed.

**Experiment 2**. The cultivar Australian II, a tetraploid derived from the cross of Australian and Uneta, was compared with the new octoploid population described earlier. The tetraploid population was made up of a sample of seed from each of the 9 families used to produce Australian II (3). This experiment was conducted in the same way as Experiment 1 and was run concurrently in the same glasshouse.

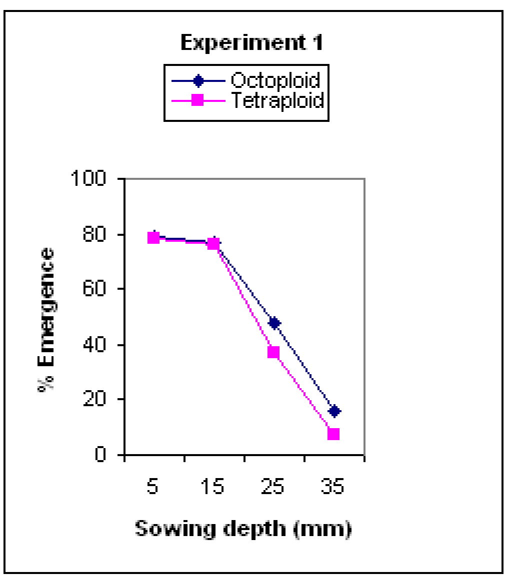
In both experiments the design was a split-plot with the sowing depths assigned to main plots and the two ploidy levels assigned to sub-plots.

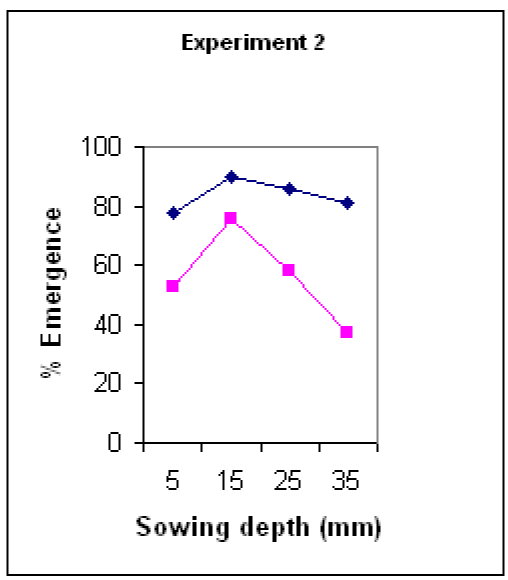
**RESULTS**

**Experiment 1.**

There was a significant reduction in the percent emergence (averaged over ploidy levels), from 77% at 15 mm to 42% at 25 mm and 12% at 35 mm sowing depth. Percent emergence of the octoploid was higher than that of the tetraploid (P = 0.05) and this was most evident at the two deeper sowing depths (Fig 1a). There was no significant effect of sowing depth on the average seedling fresh weight but the octoploid seedlings were more than twice as heavy and also 33% taller than the tetraploid seedlings (P < 0.001), the height difference again being most marked at the deeper sowing depths (data not shown).

Fig. 1a Fig. 1b




**Experiment 2**

The comparison of the tetraploid (Australian II) with the new octoploid was complicated by the relatively poor emergence of the populations at the shallow 5 mm sowing depth (Fig 1b). Although precautions were taken to maintain soil moisture at the surface, it may not have been sufficient to prevent some seed mortality. However, the effect of sowing depth was significant when the 5 mm treatment was excluded. The percentage emergence of the new octoploid was higher than the tetraploid at all depths and the difference was again most notable at the two deeper sowings. The seedling fresh weight of the octoploid was more than twice that of the tetraploid and was also 30% taller than the tetraploid ($P < 0.001$).

## DISCUSSION

The sowing depth of small seeded grasses is an important consideration in their successful establishment. In both comparisons in this study the octoploid *Phalaris aquatica* had better emergence from the deeper sowings than did the tetraploid type. The seedlings of the octoploid were also more vigorous as judged from seedling weight and height than the tetraploid. These characteristics are likely to favour the octoploid in competition with other sward components at establishment.

Superior emergence from the deeper sowings was evident in the new populations of both the tetraploid and octoploid types (Fig. 1b) compared to their respective original populations (Fig. 1a). Although the parents of the populations in Experiment 2 were selections of better-adapted genotypes - based on survival in the case of the octoploid, and on progeny performance for persistence in the case of the tetraploid (3) - some of this difference may be attributed to effects on vigour arising from the difference in the age of the seed used in the two experiments.

In Experiment 2 seedling emergence from the shallowest sowing was poorer than from the 15mm sowing. This was unexpected, but the result suggests a favourable option of sowing the larger seeded phalaris slightly deeper than is recommended for the tetraploid types, thus reducing the risk of poor establishment through soil surface drying.

The superior seedling emergence from depth of the octoploid was also suggested in a field trial, where post-sowing rains had silted the planting furrows (1). However, in this trial the stand density of the octoploid was severely reduced over the summer compared with the tetraploid. A recent comparison of the new octoploid with Australian II in July 1999 in a field trial at Rye Park, NSW, confirmed the improved emergence of this octoploid population. Under favourable moisture conditions for establishment, the mean seedling number per metre of row over three replicates for the octoploid was 24, compared to 20 for Australian II ($P = 0.05$). Furthermore, measurements of percent presence made in September 2000 in this trial showed no significant difference between Australian II (91.8% presence) and the octoploid (91.1% presence).

## CONCLUSION

The glasshouse experiment demonstrated the capacity of the octoploid phalaris to emerge successfully from deep sowings. This has been confirmed in field trials. The persistence of the octoploid population under sheep grazing at Rye Park, NSW, will be followed with great interest.

## REFERENCES

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