Differences in intrinsic water-use efficiency between four *Austrodanthonia* species

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Abstract: *A common garden experiment was used to examine the genotypic variation in intrinsic water-use efficiency ($\Delta^{13}C$) among 28 wild populations of four Austrodanthonia species. No significant differences were found in $\Delta^{13}C$ among Austrodanthonia bipartita, A. caespitosa, A. fulva, and A. setacea. The mean value of $\Delta^{13}C$ for Austrodanthonia was high (25.8 %) suggesting low efficiencies but variation between populations was sufficient to provide useful sources for future breeding programs.*

Key words: *Water-use efficiency, native grasses*

Introduction

Wallaby grasses (*Austrodanthonia* spp.) are important native pasture species in both temperate and low rainfall areas. Plant growth may be limited by water and breeding for enhanced water-use efficiency (WUE) may offer one mechanism to improve forage production in not only semi-arid areas but also in the marginal croplands of southern NSW where climate change is expected to have significant negative impacts. Estimation of carbon isotope discrimination ($\Delta^{13}C$) has been used to screen large numbers of plants in order to examine differences in water-use (Chen *et al.* 2007). A higher value of $\Delta^{13}C$ indicates higher discrimination and therefore less carbon fixed per unit of water lost (low water use efficiency). Native plants may be expected to have high water use efficiency but there is limited data to support this notion.

Methods

Twenty eight natural populations of *Austrodanthonia* spp. collected from central western NSW (Waters *et al.* 2009) were examined for differences in $\Delta^{13}C$. Eight hundred seedlings of parent plants were grown in a common garden study for a period of three months and harvested in late December 2004. For each plant, leaf material was separated and dried to constant weight and $\Delta^{13}C$ determined following the methods of Farquhar *et al.* (1989). An analysis of variance was used to examine the main effects of species and population on $\Delta^{13}C$.

Results and discussion

There were no significant differences in $\Delta^{13}C$ among species *Austrodanthonia bipartita, A. caespitosa, A. fulva,* and *A. setacea*. The mean value of $\Delta^{13}C$ for *Austrodanthonia* was 25.8 % but the variation in values was high. Predicted values (s.e) ranged from 23.1% (0.64) to 28.3% (0.64) and suggest low relative WUE (Table 1). Between the four *Austrodanthonia* species, population had a significant ($P<0.001$) effect on variation in $\Delta^{13}C$ but was largely associated with differences in chromosome number (Figure 1) and not related to environment. This suggests $\Delta^{13}C$ is a trait not under selection. Characteristics such as $\Delta^{13}C$ are complex, being responsive to many adaptive characters. For example, WUE can be influenced by leaf area and photosynthetic capacity. Bolger *et al.* (2005) reported the relative leaf water content of *Austrodanthonia caespitosa* to be high compared to other related species and that these differences were associated with a large amount of cuticular wax found with *A. caespitosa*. In this way *A. caespitosa* may have a mechanism for greater dehydration avoidance and an increased capacity for drought avoidance without the need for increased water-use efficiency. Alternatively, the collection area may represent environments that are more mesic and have not allowed for the selection of water-use efficient plant genotypes.

Table 1. Predicted values (s.e) for $\Delta^{13}C$ in four species of *Austrodanthonia*

Species	$\Delta^{13}C$	
	Maximum,	**minimum**
A. bipartita	24.5 (0.89),	28.3 (0.64)
A. caespitosa	24.9 (0.90),	26.9 (0.89)
A. fulva	23.1 (0.89),	26.4 (0.53)
A. setacea	23.7 (0.64),	27.3 (0.89)

It follows that populations sampled from more arid environments may reveal a different finding.

Conclusions

Intrinsic water-use efficiency may not be a trait under selection in *Austrodanthonia.* However, the considerable variation found in this trait may provide useful sources of variation for plant breeding and selection.

References

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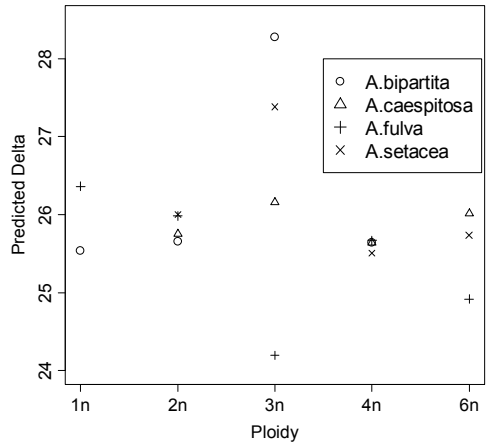

Figure 1. Relationships between chromosome number and predicted mean $\Delta^{13}C$ of four *Austrodanthonia* species for a range of chromosome number (ploidy).