

UNDERSTANDING C₃ AND C₄ NATIVE GRASS SPECIES

Plants use sunlight and carbon dioxide to make sugars which fuel their growth; this is photosynthesis. Sunlight is harnessed for energy by the same process in all plants, but carbon dioxide can be taken up by different means in different groups of plants.¹ Two pathways, the C₃ and C₄ pathways for the uptake of carbon dioxide, have evolved in the grasses. Not only do these differ in the chemical reactions that incorporate carbon dioxide into organic molecules and in the structures in which photosynthesis occurs, they lead to marked differences in the distribution and growth patterns of C₃ and C₄ grasses.²

Only 1% of plants use the C₄ pathway and more than 60% of these are grasses. Among the Australian grasses, some 65% of native species are C₄. They are most numerous in the Northern Territory, northern Queensland and the

warm-season grasses. They brown off in winter in southern Australia. And C₃ grasses, also known as cool-season grasses, have their period of active growth in autumn and spring. While many brown off over summer, they remain green all winter.

At the time of European arrival, native grasslands were a mix of mainly perennial, warm- and cool-season grasses. In South Australia, the drought tolerant and often tall-growing warm-season grasses were dominant over the smaller cool-season grasses. While stock flourished on the diversity of year-round feed, the C₄ summer-green species in particular were soon eaten out and to this day remain largely absent in the landscape.³ These mostly perennial warm-season grasses have a far wider adaptive range and respond more rapidly to summer rain than the frequently

Autumn **WINTER** Spring

Grasses establishing and
or actively growing



Perennial native COOL

	wet
	season grasses
	dry

Spring **SUMMER** Autumn

Grasses establishing and
or actively growing



Perennial native HOT

	moist
	season grasses
	dry

Kimberley, where they can make up more than 90% of the grass species. On the other hand, C₃ grasses are most numerous in the south-eastern and south-western corners of Australia. These distribution patterns relate particularly to temperature and rainfall. In general, C₄ species are more common in areas with a warmer, wetter, growing season and often with a drier cold season than are C₃ grasses. Conversely, fewer C₃ species are found in areas with high January average maximum temperature and more in areas of high spring rainfall.²

The biochemical and structural differences between the C₃ and C₄ pathways mean that the optimum temperature for photosynthesis is higher in C₄ than in C₃ plants. As a result, C₄ grasses tend to have their period of active growth in summer and so are also known as summer-active or

annual cool-season grasses that replaced them. As a group, the C₄ grasses not only can have value in extending the availability of useful forage, but their active summer growth (when the annual cool-season grasses are dead) reduces deep drainage to water tables, a factor contributing to dryland salinity, and protects against erosion.⁴

Just as C₃ and C₄ grasses are actively growing at different seasons, their seed germinates most reliably over different temperature ranges. C₃ grasses germinate best over a temperature range of 15–25 °C while C₄ grasses germinate best over the range 25–35 °C. Choice of sowing time largely depends on the rainfall distribution at the site and the species to be sown. In South Australia, C₃ grass seed should be sown in autumn and C₄ grass seed from spring to early summer to catch the growing conditions that suit each best.

CHECKLIST



The Genera listed here **particularly refer to South Australia**.⁵ A bracketed Latin name identifies the one species in that genus in S.A. The common name listed is the generally accepted name for that genus. The various species can be found in Grasses of South Australia.⁶



GENERA	COMMON NAME	GENERA	COMMON NAME
<i>Agrostis (venusta)</i>	Graceful bent	<i>Aristida</i>	Wire-grass
<i>Amphibromus</i>	Swamp wallaby-grass	<i>Astrebala</i>	Mitchell grass
<i>Amphipogon</i>	Grey-beard grass	<i>Bothriochloa</i>	Blue & Red-leg grass
<i>Austrodanthonia</i>	see <i>Rytidosperma</i> ⁷	<i>Brachiaria</i>	Armgrass
<i>Austrofestuca (littoralis)</i>	Coast fescue	<i>Brachyachne (ciliaris)</i>	Hairy native couch
<i>Austrostipa</i>	Spear-grass	<i>Chloris</i>	Windmill-grass
<i>Bromus (arenarius)</i>	Sand brome	<i>Chrysopogon (fallax)</i>	Golden-beard grass
<i>Deyeuxia</i>	Bent-grass	<i>Cymbopogon</i>	Lemon-scented grass & Silky-heads
<i>Dichelachne</i>	Plume-grass	<i>Cynodon (dactylon var. pulchellus)</i>	Couch-grass
<i>Echinopogon</i>	Hedgehog & Rough-bearded grass	<i>Dactyloctenium (radulans)</i>	Button grass
<i>Elymus</i>	Wheat-grass	<i>Dichanthium</i>	Blue-grass
<i>Elytrophorus (spicatus)</i>	Spike-grass	<i>Digitaria</i>	Spider grass
<i>Festuca (benthamiana)</i>	Fescue	<i>Distichlis (distichophylla)</i>	Emu or Salt-grass
<i>Glyceria (australis)</i>	Australian sweet-grass	<i>Echinochloa</i>	Channel millet
<i>Isachne (globosa)</i>	Swamp millet	<i>Enneapogon</i>	Bottle-washers
<i>Joycea</i>	see <i>Rytidosperma</i> ⁷	<i>Enteropogon</i>	Umbrella-grass & Curly windmill-grass
<i>Lachnagrostis</i>	Blown grass	<i>Eragrostis</i>	Lovegrass
<i>Microlaena (stipoides)</i>	Weeping rice-grass	<i>Eriachne</i>	Wanderrie
<i>Monachather (paradoxus)</i>	Bandicoot grass	<i>Eriochloa</i>	Cupgrass
<i>Neurachne*</i>	Mulga-grass	<i>Eulalia (aurea)</i>	Sugar-grass
<i>Notodanthonia</i>	see <i>Rytidosperma</i> ⁷	<i>Hemarthria (uncinata)</i>	Mat grass
<i>Pentapogon (quadrifidus)</i>	Five-awned spear-grass	<i>Imperata (cylindrica)</i>	Kunai grass
<i>Phragmites</i>	Common reed	<i>Iseilema</i>	Flinders-grass
<i>Poa</i>	Poa / tussock grass	<i>Leptochloa</i>	Umbrella cane-grass & Beetle-grass
<i>Polypogon (tenellus)</i>	Beard-grass	<i>Neurachne (munroi)</i>	Window mulga-grass
<i>Puccinellia (stricta)</i>	Saltmarsh-grass	<i>Oxychloris (scariosa)</i>	Winged chloris
<i>Rytidosperma</i>	Wallaby-grass	<i>Panicum</i>	Panic & Native millet
<i>Tetrarrhena</i>	Rice-grass	<i>Paractaenum</i>	Barbed-wire grass
<i>Thyridolepis</i>	Mulga-grass	<i>Paraneurachne (muelleri)</i>	Northern mulga-grass
<i>Whalleya (proluta)</i>	Coolah grass	<i>Perotis (rara)</i>	Comet grass
		<i>Pseudoraphis (spinescens)</i>	Spiny mud-grass
		<i>Setaria</i>	Pigeon-grass & Paspalidium
		<i>Spinifex (hirsutus)</i>	Rolling spinifex
		<i>Sporobolus</i>	Dropseed
		<i>Themeda</i>	Kangaroo grass
		<i>Tragus (australianus)</i>	Burr-grass
		<i>Triodia</i>	Spinifex & Porcupine grass
		<i>Tripogon (loliiformis)</i>	Five-minute grass
		<i>Triraphis (mollis)</i>	Purple heads
		<i>Uranthoecium (truncatum)</i>	Flat-stem grass
		<i>Yakirra (australiensis)</i>	Bunch panic
		<i>Zoysia (macrantha)</i>	Manila grass
		<i>Zygochloa (paradoxa)</i>	Sandhill cane-grass

**Neurachne* has two C3 and one C4 species in South Australia.

Produced as a Species Information Sheet by the Native Grass Resources Group Inc., October 1999. Revised August 2012. Concept & checklist revision: Robert Myers. Explanation: Ellen Bennett. Design: Katherine Timotheou.



Native Grass
Resources Group Inc

www.nativegrassgroup.asn.au

References:

- J.R. Anderson & J. Beardall *Molecular Activities of Plant Cells: An introduction to plant biochemistry*. Blackwell Scientific Publications, Oxford & Melbourne, 1991.
- R. Sinclair, 'Ecophysiology of grasses' in *Flora of Australia, Vol 43, Poaceae 1, Introduction and Atlas*, Australian Biological Resources Study/CSIRO, Canberra, 2002, pp.133-7.
- J. Reeseigh, P. Foster & R.J. Myers, *Native Grass Strategy for South Australia 2: Management of native grasses and grassy ecosystems for sustainable production and biodiversity conservation*. Rural Solutions SA, Adelaide, 2009.
- B. Johnston, D. Garden, S. Ellis and C. Clifton, *Hill Country Native Grasslands: Better management for healthy catchments*. Murray-Darling Basin Commission, Canberra, 2004.
- W.R. Barker, R.M. Barker, J.P. Jessop & H.P. Vonow (Eds) *Census of South Australian Vascular Plants, 5th Edition*, Botanic Gardens of Adelaide & State Herbarium, 2005.
- J. Jessop, G.R.M. Dashorst & F.M. James, *Grasses of South Australia: An illustrated guide to the native and naturalised species*, Wakefield Press, Adelaide, 2006.
- The Council of Heads of Australasian Herbaria in 2011 accepted the 2010 reclassification of *Austrodanthonia*, *Joycea* and *Notodanthonia* to *Rytidosperma* by an international team of botanists (H.P. Linder et al. *Annals of the Missouri Botanical Garden*, 97(3), 2010, pp. 306-364.)