Australian breeding of persistent perennial ryegrass without endophyte

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Out of the four perennial grasses cocksfoot, perennial ryegrass, phalaris and tall fescue, perennial ryegrass would be highest selling species sold in Australia. Perennial ryegrass has been popular due to its ease of establishment, management and good forage quality. Perennial ryegrass is also a commonly used species in New Zealand and Europe for forage and north America for turf. A majority of the perennial ryegrasses used in Australia are bred in those countries and then marketed in Australia. There are over 6 million ha of perennial ryegrass based pastures in Australia (Reed 1996). The majority of the perennial ryegrass material used in overseas breeding programs is based on germplasm originally collected from northern European or southern Mediterranean germplasm regions. However there has been little work done with north African based material which has summer dormancy characteristics which may be of significant value in the hotter, drier climate of Australia. Currently available perennial ryegrass cultivars are generally suited to an annual rainfall of >650 mm. With climate change, the predictions are that annual rainfall will decrease and temperatures will increase. If this occurs, then unless a far greater effort is placed on breeding cultivars better suited to Australia's environment we are likely to see a the current perennial ryegrass zone shrink as a result of poor ryegrass persistence.

Perennial ryegrass plants can contain endophyte. Endophyte is a fungus that often occurs in perennial ryegrass as well as some other perennial grasses. The natural form of endophyte often causes the syndrome known as 'ryegrass staggers'. The affects on livestock and subsequent costs to producers are significant. New Zealand research has selected novel endophytes existing in nature and inserted these into ryegrass plants to retain positive effects of insect resistance and reduce negative animal effects. One of the major claims about endophyte is that endophyte is required in a variety for it to be persistent. Some Australian trials have demonstrated that Australian bred perennial ryegrass is potentially better adapted to some regions than perennial ryegrass bred overseas. As a result of these trials the evidence is mounting that an important consideration when selecting a cultivar should first be how well adapted is it to the region and use that the farmer requires and then after that endophyte issues should be considered.

One advantages that perennial ryegrass has as a species is its diversity in heading dates or maturity. It begins to head from 6 October to the 27 November. This difference in the heading dates can be used to select the right variety for a specific location and may also help with persistence. Perennial ryegrass usually has a spring dry matter (DM) production peak of nearly 60% of its annual DM production close to its heading date. Allowing perennial ryegrass to head can help increase persistence. To take advantage of this peak it is important to match the right heading date in the right environment. Early heading perennial ryegrass varieties which are based on the Australian Kangaroo Valley germplasm such as Boomer, Roper and Fitzroy, have the DM production peak in late winter/early spring, so these varieties are best suited to early country rather than late country. These early varieties still need adequate rainfall to persist. The mid heading varieties are your 'all rounder' that can be used in most locations including dry and wet. Examples of these are Camel, Avalon and Victorian. Late heading varieties are best suited to high rainfall, late country that holds moisture into early summer. This is usually on flats or on the southern slide of slopes. All late heading varieties are bred overseas and include Platinum, Banquet II and Bealey.

Medea was one of the most persistent perennial ryegrass variety ever introduced into the

Australian market, Medea, had low endophyte (Table 1). Medea had the ability to go dormant in summer, giving it greater persistence than the non-summer dormant varieties. Currently there are no summer dormant perennial ryegrasses available in Australia. Anthony Leddin, Valley seeds plant breeder, through his award of the 2009 Young Scientist of the Year for Meat and Livestock by MLA is developing summer dormant perennial ryegrasses with low endophyte that will persist longer than any variety available in Australia. Leading advocate of Australian pasture research, Dr Kevin Reed, states in one of his papers that 'Algerian derived lines of perennial ryegrass (with low endophyte) may become a valuable genetic resource for the development of safe, persistent cultivars' (Reed *et al.* 1987).

In trials at various locations in Australia, it has been demonstrated that the key to persistence of a plant is breeding with germplasm suited to Australia in Australia. New Zealand breeding in perennial ryegrass has gone down the path of selecting for novel endophytes to try and increase persistence and have no side effects on animals. Most New Zealand perennial ryegrasses have begun with European germplasm material selected from central Europe followed by material selected from southern Europe. Australian breeding has gone down a different pathway. Many varieties developed in Australia have used Victorian or Kangaroo Valley perennial ryegrass as their base. These plants were adapted to the Australian environment from the original seed brought over from England over 100 years. It has been shown to be very persistent and hardy in Australian conditions and some varieties even persist without endophyte. Results from a trial at Balmoral in Western Victoria, with an annual rainfall of less than 600 mm, less than what is recommended to maintain perennial ryegrass stands, show that the persistency of perennial ryegrass bred in Australia without endophyte was greater than those bred in New Zealand with endophyte (Table 1) and both had a similar heading date. This may have also been due to the varieties being able to go dormant in the summer. Persistency is important not only due to the extra cost that is involved in having to resow pastures but also when desirable plants die these are usually replaced with weeds. There is a time and economic cost in controlling weeds and the weeds also place more pressure on existing desirable plants within the pasture for moisture and nutrients.

A good example of the breeding with Australian germplasm for persistency is the program from Valley seeds in the development of Camel perennial ryegrass, a nil endophyte variety. It was selected from Victorian perennial ryegrass plants that were surviving at St Arnard, which has an annual rainfall of 550 mm and had also survived the 1982 drought. Hamilton is on the border of a marginal environment for perennial ryegrass to grow. This is the location where Valley Seeds carry out certified seed production of its Australian bred perennial ryegrass. These paddocks are selected for production of certified seed on the basis that there is less than 1 in $10m^2$ of another ryegrass. Certified seed paddocks of Camel ryegrass with nil endophyte in this region have persisted well beyond the three year period of certified seed production and even through the 2006 drought.

The results from the trial in Yarck, a site that has an early finish to the season (Table 2) suggest that Australian bred or background based material to have greater persistence than material bred in New Zealand, in a tough

Table 1. Persistency trial Balmoral Western Victoria, DPI Hamilton in 1991 and 1995.

Species	Cultivar/ecotype	Plant density 1991 (no/m^2)	Plant density 1995 (no./m^2)	% density
Perennial ryegrass	Medea material (LE)	801	73	9.1
Perennial ryegrass	Brumby (Vic x Medea)(LE)	753	31	4.1
Perennial ryegrass	Kangaroo Valley (SE)	486	16	3.3
Perennial ryegrass	Ellett (SE)	1111	40	3.6

Note: LE = Low endophyte, SE = Standard endophyte. LSD for Plant density (no./m^2) in 1995 ($P = 0.05$) = 16.6.

Table 2. Plot density (%) on 7/7/10 at perennial ryegrass trial, Yarck central Victoria, Sown 18/4/08.

Entry	Den070710		Endophyte	Type	Breeding
Camel	96.25	Equivalent to each other	Nil		Australia (Valley Seeds)
Victorian	94.5		High	Wild	Australian Ecotype
Fitzroy	94.25		High	Wild	Australia
Boomer	93.75		Nil		Australia (Valley Seeds)
Prolong	92.75		Nil		Australia (Valley Seeds)
Avalon	92.5		High	Wild	Australia
Kangaroo Valley	92.25		High	Wild	Australian Ecotype
Meridian AR1	90		High	AR`	New Zealand (Kangaroo Valley cross)
Roper	88.5		Nil		Australia (Valley Seeds)
Arrow AR1	88		HIgh	AR1	New Zealand
Bolton	87.75		High	Wild	Australia
Commando	87.6		High	AR1	New Zealand
Platinum	87		Low	Wild	New Zealand
Samson	86		High	Wild	New Zealand
Kingston	85.75		High	Wild	New Zealand
Bealey	85.5		High	NEA2	New Zealand
Banquet II	85		High	Endo5	New Zealand
Revolution	85.5		High	AR1	New Zealand
Alto AR1	84.25		High	AR1	New Zealand
Matrix	84		HIgh	Wild	New Zealand
PG one 50	83.5		High	AR1	New Zealand
Extreme AR1	83.25		High	AR1	New Zealand
NZ – LP9904	82.5		Nil		New Zealand
Trial Mean	88.5				
LSD (5%)	5.8				
% CV	4.6				

Australian environment. This may be due to a number of factors including:

- Adaptation of the parental material to the Australian environment of over 100 years
- The appropriate heading date, early and mid heading would be more suitable to most Australian environments than late heading when it comes to persistence.
- It is possible for nil or low endophyte material to persistence in the absence of insect pests as long as it has strong genetics for persistence.

References

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