Phalaris cultivars

Monaro Farming Systems Winter Field Day
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CSIRO Canberra
Outline

1. Introduction

2. Cultivar types

3. Two recent cultivars bred for persistence factors
   - Holdfast GT (Grazing tolerance)
   - Advanced AT (Acid soil tolerance)

4. Canberra genotype x management study
Phalaris aquatica in Australia

- Proven deep-rooted perennial grass for sheep and beef industries of southern Australia
- Sown on 2+ M ha Australia-wide (2011 survey)
  Domestic seed market ~400 t /yr
- Good autumn-winter-spring production, partially dormant in summer
- Excellent drought survival
- Role in sustainability
- Few pests and diseases
- Occasionally toxic to livestock
Dormant buds for summer survival
CSIRO phalaris program breeding history

Advances: seedling vigour, autumn-winter yield, lower alkaloids, harvestable seed & seed quality, reduced establishment costs, adaptation to dry areas, adaptation to skeletal and acidic soils.
Grouping phalaris cultivars

Winter activity

Seed retention

Summer dormancy

Al, acid soil tolerance
# Phalaris cultivars in Australia

<table>
<thead>
<tr>
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<th>Semi-winter dormant</th>
<th>Winter-active type</th>
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</thead>
<tbody>
<tr>
<td><strong>Older cultivars</strong></td>
<td>Australian type</td>
<td>General purpose</td>
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<tr>
<td>(pre-2005)</td>
<td>Australian Uneta*</td>
<td>Sirosa Holdfast*</td>
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<tr>
<td></td>
<td>Australian II*</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Grazier*, etc</td>
<td></td>
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<tr>
<td></td>
<td>Maru</td>
<td></td>
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<tr>
<td><strong>Since 2005</strong></td>
<td>Fosterville</td>
<td>Holdfast GT*</td>
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<td></td>
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<td>Lawson*</td>
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<td></td>
<td></td>
<td>Stockman?</td>
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</table>

* Seed-retaining cultivar
Semi-winter dormant cultivar: Australian, Uneta, Australian II, Fosterville, ...

- Reputation for high persistence
- Tolerant of heavy continuous grazing
- Smaller seedlings, less productive in autumn/winter than winter-active cultivars
- More spreading
- Higher content of tryptamine alkaloids
General purpose winter-active cultivar:  
Sirosa, Holdfast, Holdfast GT, Lawson

Best used in well-fertilized, highly productive pastures

Best managed rotationally/strategic rests for optimum productivity and persistence

BUT

Holdfast GT much more tolerant of high continuous grazing pressure
Winter-active cultivars for marginal and acidic soils:
Landmaster, Advanced AT

**Landmaster**
Bred for shallow, fairly acidic and infertile soils on mid and upper slopes where recharge occurring

**Advanced AT**
Most Al-tolerant phalaris cultivar for strongly acid soils

Best managed rotationally/strategic rests for optimum productivity and persistence
Winter yield comparison

Swards in September of Year 2
(Mean of sites at Tamworth, Yass, Hamilton)

Herbage DM (kg/ha)
Yield comparison 1991-94
Balmoral, Western Victoria (615 mm)

Source: Anderson et al. 1999

Persistence Index:
- Australian
- Sirosa
- Porto
- Currie
- Demeter
- Triumph
- Melik sel.
- Ellett
- KV
- Brumby

Yield (DM t/ha)

- Perennial ryegrass
- Tall fescue
- Cocksfoot
- Phalaris

Winter-active phalaris

Source: Anderson et al. 1999
Higher spreading ability of Australian
Canberra grazing trial 1990-98

Mean rotationally and set stocked
Rotationally stocked

Basal area (%)

Year


Australian
Holdfast
Sirosa
Perla Ret.
AUSTRALIAN  1420 kg/ha phal, 1850 kg/ha total DM

ADVANCED AT
1960 kg/ha phalaris, 2280 kg/ha total DM
Background to persistence issues

1. **Pressure to intensify management**
   - profitable
   - internationally competitive
   - efficient use of land & pasture resources

2. **Fertiliser, increased stocking rates**
   - **Pressure on persistence of perennial grasses**

3. **Concern for >25 years over persistence of perennials**
   - MLA Key programs
   - Feedbase Investment Plan

Derived from ABARE data   (Source: Mullen, 2007)
Stresses affecting persistence

Advanced AT

Factors that influence pasture plant persistence

- Drought
- Frost
- Temperature
- Rainfall distribution (e.g., winter vs summer rainfall)
- pH (acid v. alkaline, Al-, Mn-toxicity)
- Salinity
- Texture
- Fertility
- Grazing pressure (stocking rate / insect attack)
- Plant grazing tolerance (e.g., cocksfoot – pulled out cv. Australian phalaris vs winter-active)
- Rest periods (e.g., continuous vs rotational grazing)
- Palatability (e.g., good = overgrazed poor = undergrazed)
- Fungal, bacterial and viral diseases, pests (root & shoot diseases, insects, grubs, nematodes)
- Interspecies, plant competition

climate x soil x grazing x disease x competition

single stress
double stress
multiple stress
Holdfast GT

A winter-active cultivar with improved persistence under grazing
Winter Activity vs. Persistence under grazing pressure

Winter yield
In Year 2
Mean of 3 sites
(kg/ha)

Winter-active cultivars

Sirolan
Sirosa
AT98
Holdfast
Landmaster
Atlas PG

Holdfast GT

Parental families

Expected position

LSD (5%)

Basal frequency in year 5; %
(Mean of W Vic & S. Tablelands sites)
Improved acid soil tolerance – Advanced AT
Soil acidity and phalaris

Soil pH\textsubscript{Ca} < 4.5 common
Progress in breeding for Al tolerance

- **Sirosa** *(1974)*
- **Holdfast** *(1990)*
- **Landmaster** *(1996)*

- **AT98** *(source of the new AT cultivar)*

Tolerance of 100 μM Al in nutrient solution

Phalaris aquatica × arundinacea × aquatica
Establishment
Seedling growth, Rye Park

Soil
0-10: $\text{pH}_{\text{Ca}}$ 3.9, Exch. Al 26%
10-30cm: $\text{pH}_{\text{Ca}}$ 4.0, Exch. Al 35%
Benefit of Al tolerance at establishment

- Persistence in Year 2 at Chiltern (%)
- Root DM in nutrient solution (g x 10^-4)

Correlation: $r=0.97$ (P<0.01)

Species:
- Australian II
- Sirosa
- Holdfast
- Landmaster
- AT98

Location:
- Chiltern
- Yass
- Sutton
- Beechworth

Note: The image includes photographs of the selected locations and species.
Acid soil tolerance x moisture interaction

Dick’s Ck (2\textsuperscript{nd} year basal frequency)

Soil 0-40 cm: $\text{pH}_{\text{Ca}}$ 4.1, Exch. Al 43%

Sown Aug 2004
Winter-spring 292 mm

Sown Aug 2005
Winter-spring 498 mm
Effect of drought
Aug. 2006-sown trials in 2007 (mean of 4 sites)

<table>
<thead>
<tr>
<th>Site</th>
<th>pH Ca</th>
<th>Exch. Al %</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>4.0-4.3</td>
<td>21-52</td>
</tr>
<tr>
<td>2</td>
<td>4.1-4.1</td>
<td>17-46</td>
</tr>
<tr>
<td>3</td>
<td>4.0-4.1</td>
<td>38-58</td>
</tr>
<tr>
<td>4</td>
<td>4.2-4.6</td>
<td>12-22</td>
</tr>
</tbody>
</table>

Frequency in autumn of 2\textsuperscript{nd} year

- Advanced AT
- Landmaster
- Sirosa
- Holdfast
- Australian II
- Kasbah cocksfoot
- Fraydo tall fescue
- KV-type ryegrass

LSD (5%)
Advanced AT trials: conclusions

Higher Al tolerance in Advanced AT of most benefit in assuring establishment in acid soils in response to moisture availability

Landmaster has useful Al tolerance but Advanced AT superior

- when establishing under drought
- in soils with layers of pH<4.2 and 30-50% exch. Al in the top 50 cm

Parallel effects on longer-term persistence generally smaller than at establishment

*Note: Advanced AT is very erect and should be rotationally grazed for good persistence
Role of genetics and management:
Canberra 2009-2013
Structure of experiment

**Genotype:**

- 16 phalaris genotypes
  - differing in growth habit, growth pattern, stress tolerance

**Environment:**

- soil fertility & drought
  - low P / high P

**Management:**

- grazing management
  - rotational vs. continuous at high and low P
- grazing pressure
  - 13.5 vs 18 dse/ha at high P
Long-term $P \times$ stocking rate experiment
Dr Richard Simpson

Timeline:

Pre-treatment phase
- 2007: sown May (+100 kg/ha single super on low P plots)
- 2008: grazed intermittently, fertility treatments maintained

Experimental phase
- 2009: mid-June grazing treatments commenced
- 2013: early June grazing treatments ended

Recovery phase (grazing exclusion)
- Jun-Aug 2013 assess winter production
- Sep-Oct 2013 assess spring production
Management treatments

High P Olsen 22
- Continuous stocking
  - 18 sheep/ha (4 per 0.222 ha)
  - 14.8 m
- Rotational stocking
  - 18 sheep/ha (4 per 0.222 ha)
  - 7.4 m

Low P (no super) Olsen 4
- Continuous stocking
  - 13.5 sheep/ha (3 per 0.222 ha)
  - 14.8 m
- Continuous stocking
  - 9 sheep/ha (6 per 0.666 ha)
  - 7.4 m
- Rotational stocking
  - 9 sheep/ha (3 per 0.333 ha)
Soil pHCa 0-20cm 4.2-4.6
Total herbage DM

- HPRS
- HPCS
- LPRS
- LPCS
- HPCS13.5

Days:
- Jul09
- Jan10
- Jul10
- Jan11
- Jul11
- Jan12
- Jul12
- Jan13
Total herbage DM – High P

- HPRS
- HPCS
- HPCS13.5

Days
Jul09 Jan10 Jul10 Jan11 Jul11 Jan12 Jul12 Jan13

Total herbage DM (kg/ha)
Botanical composition

- **High P Rotational 18/ha**
- **Low P Rotational 9/ha**
- **High P Continuous 13.5/ha**
- **High P Continuous 18/ha**

- Composition (%)

- Days

- Days

- Composition (%)

- Composition (%)

Legend:
- Black: Broadleaf weeds
- Gray: Clover
- Light gray: Other grass
- White: Phalaris

Month: July, January
Grazing management effects
(average all phalaris lines)

Culvenor and Simpson (2015) Grass and Forage Science
High P, 18 sheep/ha, continuous stocking

- Holdfast GT
- Advanced AT
- Sirosa
- Holdfast
- Landmaster
- Australian

Basal frequency (%)

LSD between cvv
LSD2 within cvv

Frequency (%)

2009 2010 2011 2012 2013 2014
0 10 20 30 40 50 60 70 80 90 100

Graph showing changes in basal frequency (%) over years for different species.
High P, 18 sheep/ha, rotational stocking

![Graph showing basal frequency (%)](image)

- Holdfast GT
- Advanced AT
- Sirosa
- Holdfast
- Landmaster
- Australian

- LSD between cvv
- LSD2 within cvv
High P, 13.5 sheep/ha, continuous stocking

[Graph showing basal frequency (%)]

- Holdfast GT
- Advanced AT
- Sirosa
- Holdfast
- Landmaster
- Australian

LSD between cvv
LSD2 within cvv

2009 2010 2011 2012 2013

0
10
20
30
40
50
60
70
80
90
100
Low P, 9 sheep/ha, continuous stocking
Low P, 9 sheep/ha, rotational stocking

![Graph showing basal frequency (%)](image_url)

- Holdfast GT
- Advanced AT
- Sirosa
- Holdfast
- Landmaster
- Australian

Legend:
- **LSD  between cvv**
- **LSD2 within cvv**
Recovery period (exclusion from grazing)

Aim: To observe the growth potential of surviving phalaris after 4 years of treatment
- combines survival and vigour

Winter: 7 June to 28 August

Spring: 2 September to 30 October
Recovery period – winter

General views

High P
Rotational
18/ha

Low P
Rotational
9/ha

High P
Continuous
13.5/ha

Low P
Continuous
9/ha
Recovery: High P, 18 sheep/ha, continuous stocking
**Recovery period**

**Fertility treatment effects**

Winter + Spring

<table>
<thead>
<tr>
<th>Treatment</th>
<th>DM kg/ha</th>
<th></th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Phalaris</td>
<td>Total</td>
</tr>
<tr>
<td>High P</td>
<td>2740</td>
<td>5040</td>
<td></td>
</tr>
<tr>
<td>Low P</td>
<td>750</td>
<td>2700</td>
<td></td>
</tr>
<tr>
<td><em>lsd (P=0.05)</em></td>
<td>188</td>
<td>121</td>
<td></td>
</tr>
</tbody>
</table>
Recovery: High P, 18 sheep/ha, continuous stocking

Winter

Less persistent than GT

Lower vigour cf. GT

Spring

Total DM (kg/ha)
Recovery: High P, 13.5 sheep/ha, continuous stocking
Recovery: High P, 18 sheep/ha, rotational stocking
Summary

• Phalaris was more resilient after drought/overgrazing and much more productive at high than at low soil fertility

• Rotational stocking enhanced persistence during a period of drought and low herbage mass

• Reducing stocking rate under continuous stocking also protected phalaris persistence

• Holdfast GT was more tolerant of close continuous stocking than other winter-active cultivars

• The other winter-active cultivars clearly benefitted from rotational stocking at high grazing pressure

• Australian was best able to cope with grazing pressure under low soil fertility
Conclusions

• Perennial grass persistence is protected by Managing grazing.

  OPTIONS: lower stocking rate (*high cost*)
  or rotational stocking (*less convenience*)

• Genotypes that can resist Environmental and/or grazing stresses further protect perennial grass density when management options are limited.

  e.g. *in droughts when multiple stresses occur*

• Long term persistence and continuing productivity is ensured by combining G and M
Thank you