

Phoenix[Ⓢ], Venture[Ⓢ] and Matador[Ⓢ] – locally-adapted birdsfoot trefoil cultivars

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Introduction

Birdsfoot trefoil (*Lotus corniculatus* L.) is a perennial pasture legume with promise for low-fertility acidic soils in recharge landscapes in the high-rainfall zone of eastern Australia.

Birdsfoot trefoil is well adapted to high-rainfall (>750 mm average annual rainfall, AAR) permanent pasture applications, especially in summer-rainfall districts in northern NSW and elsewhere on problem soils where lucerne fails to persist. The zone of adaptation of birdsfoot trefoil is comparable to the white clover zone.

Recent breeding by NSW DPI in collaboration with CSIRO Plant Industry has developed a pioneer suite of locally-bred and locally-adapted cultivars (Phoenix[Ⓢ], Venture[Ⓢ], Matador[Ⓢ]) for grazing applications in the high rainfall zone.

These cultivars possess regeneration mechanisms for persistence under the short day length conditions of northern NSW with latitude less than 32°S. No other birdsfoot trefoil cultivars developed internationally for low-latitude applications have this unique capability.

This extends the northern limit of birdsfoot trefoil to at least 28°S – the NSW/Queensland border. Together with cultivars currently being developed for low-rainfall Mediterranean environments in southern Australia, birdsfoot trefoil has the potential to greatly expand the area of grazing lands in NSW based on deep-rooted perennials.

However, birdsfoot trefoil is sensitive to day length and photoperiod for the full expression of seed-



Figure 1. Birdsfoot trefoil showing the characteristic shape of the umbel (collection of pods) that gives the plant its common name

yield components. Without intensive flowering and prolific seed-set, sparse seed-bank development limits regeneration and persistence.

Description

Birdsfoot trefoil is a perennial legume with a deep tap-root similar to lucerne. Unlike lucerne, however, it also has an extensive lateral root system.

Birdsfoot trefoil is productive on infertile acidic soils where pH(CaCl₂) > 4.5. It is universally referred to as 'poor-land lucerne' because it does well on soils which are acidic or less fertile than those where lucerne thrives. Birdsfoot trefoil is 'bloat-safe' due to the presence of condensed tannins. Its nutritive value is similar to lucerne.

Birdsfoot trefoil is an out-crossing perennial legume – cross-pollination is effected by honey bees. Its mechanism for regeneration is natural reseeding. Prolific flowering is essential for favourable seed-yield components, seed-bank development, seedling recruitment and persistence.



Adaptation

From statewide evaluation studies undertaken by the authors across NSW, soils where birdsfoot trefoil has proven adaptation include self-mulching clay loams on the Northern Tablelands, red earths (derived from basalt) and red-brown earths on the North-West Slopes, and sandy clay loams on the North Coast and Southern Tablelands. It has broad adaptation across a wide range of soils with pH (CaCl₂) range 4.5–6.0 in Tablelands and Slopes environments in NSW.



Figure 2. The potential zone of adaptation (green shading) of birdsfoot trefoil (map supplied courtesy of Future Farm Industries CRC)

Again from this evaluation study, grasses with proven compatibility with birdsfoot trefoil include the cool season temperate perennials tall fescue and phalaris, the warm season native grass species *Bothriochloa*, *Dicanthium* and *Poa*, the winter-green native grasses *Austrodanthonia* and *Microlaena stipoides*, and the bunch-type subtropical grasses setaria and paspalum.

In Tablelands and Slopes environments, there is a significant potential role for birdsfoot trefoil to:

- provide an perennial legume alternative to lucerne on acidic soils and to white clover on low fertility native pasture country
- enhance green herbage mass, especially over summer
- increase the consumption and utilisation of low quality companion grasses.

Cultivars

The breeding program was undertaken to develop birdsfoot trefoil cultivars for high rainfall (750–1000 mm AAR) permanent pasture applications to expand the area sown to deep-rooted perennial pastures in the upper catchment of the Murray–Darling basin.

Phoenix and Venture were bred concurrently at Glen Innes, NSW from two germ plasm sources: a narrow germ plasm base (selections from an old stand of cv. Goldie) combined with a broad germ plasm base (accessed from low latitude origins). Recurrent selection was applied for flowering prolificacy under short day length conditions, growth vigour and vegetative uniformity.

Matador was developed at Canberra by pair-crossing erect breeding lines with prostrate accessions. The progeny were subjected to recurrent selection for the 'Spanish phenotype' (prostrate dense habit, grey-green leaf, pale yellow flowers).

All three cultivars are protected by plant breeder's rights (PBR[®]).

Phoenix

Phoenix is medium-leafed, fine-stemmed and high yielding in both warm season and cool season growth conditions.

Venture

Venture is large-leafed, medium in stem thickness, vigorous in warm season growth and intermediate in cool season growth.

Matador

Matador is small-leafed, thick-stemmed (with short internodes) and is low in cool season growth.

Matador has greater leaf density than Phoenix, Venture and Goldie and is more prostrate in growth habit while vegetative.



Figure 3. Three locally-adapted birdsfoot trefoil cultivars: Phoenix, Venture and Matador

Table 1. Characteristics of Phoenix, Venture and Matador in comparison with Goldie. Means with different letters in the same row are significantly different ($P \leq 0.05$)

	Goldie	Phoenix	Venture	Matador
Leaf size (mm ²)	97 b	88 b	111 a	68 c
Stem size (mm)	1.06 c	1.12 c	1.22 b	1.35 a
Growth				
– summer	9.5 b	14.9 a	14.7 a	14.4 a
– winter	8.8 c	20.0 a	14.0 b	6.6 c
(g DM/plant)				

Establishment and management

A local knowledge base of *Lotus* technology has been developed from a state-wide research program and co-learning phase undertaken by the authors. This has provided evidence that pasture development based on birdsfoot trefoil with appropriate companion grasses is both feasible and practical, and provides a stable and productive grazing system for sheep and cattle production.

Success with pasture development based on birdsfoot trefoil relies on the use of suitable cultural practices for successful establishment, and the implementation of sound management for the persistence of the birdsfoot trefoil component.



Figure 4. Established stand of birdsfoot trefoil (left) from broadcasting seed into native pasture compared with unimproved native pasture (right)

Sowing

Birdsfoot trefoil can be used to develop legume-based pastures either in a replacement pasture or in existing pasture.

For replacement pasture, cultural practices should be directed at achieving a weed-free seedbed and planting shallow (<1 cm) with a seeding rate of 1–3 kg seed/ha.

The optimal stand density of 20–25 plants/m² requires a seeding rate of 2–3 kg seed/ha.

An alternative approach is to use a lower seeding rate and apply management practices (such as a summer spell from grazing) that thicken up the population density in subsequent years.

For establishing birdsfoot trefoil into an existing sward, seed (inoculated and lime-coated) can be surface-broadcast following lead-in practices (grazing, slashing, herbicide) that reduce vegetation cover and foster soil-seed contact with moisture for effective germination.

Inoculum

Birdsfoot trefoil requires inoculating with the correct strain of *Rhizobium* bacteria (labelled '*Lotus corniculatus*' or '*birdsfoot trefoil*' inoculant) immediately before planting. The seed should also be lime-coated, especially if the soil is acidic or where seed is surface-broadcast with phosphate fertiliser.

Fertiliser

Fertiliser requirements vary according to soil type, previous fertiliser history and soil phosphate status.

In general, birdsfoot trefoil is broadly adapted to acidic low-fertility soils and may not require regular applications of P fertiliser for adaptation and persistence. However, birdsfoot trefoil-based pasture may respond in herbage growth to the application of P fertiliser. The appropriate fertiliser program is best determined by expert interpretation of a soil test.

Grazing

The presence and persistence of birdsfoot trefoil may benefit from the following strategic grazing practices.

- Light grazing during early-establishment will avoid dislodgement of seedlings.
- With sheep, continuous close-grazing is likely to reduce longevity to less than three years.
- With cattle, rotational grazing that provides a regular spell from defoliation of 4–6 weeks is likely to maintain the original birdsfoot trefoil population into the long-term (>10 years).
- While birdsfoot trefoil is vegetative in autumn–winter–spring, a handy 'available DM' benchmark is to spell from grazing until the sward is 'calf-height' and to subsequently graze down to 'ankle-height'.
- A spell from grazing to allow flowering and seed-set while birdsfoot trefoil is in reproductive mode (December/January) will develop a soil seed-bank and promote seedling recruitment for sustainability of the birdsfoot trefoil stand.



Figure 5. A pasture composed of birdsfoot trefoil and tall fescue at Glen Innes Research Station

Seed production

The breeding objective for Phoenix and Venture was 'flowering prolificacy' under the short day length conditions of northern NSW.

The outcome of the breeding program is that Phoenix, Venture and Matador are earlier-flowering and more prolific in flowering intensity than the industry standard Goldie and the seed production of Phoenix and Venture is much greater (Table 2). This is due to a greater number of flowering stems and umbels per flowering stem of Phoenix and Venture.

Table 2. Seed yield components of the cultivars Phoenix and Venture developed for low latitude environments. Means with different letters in the same row are significantly different ($P \leq 0.05$)

	Goldie	Phoenix	Venture	Matador
Maturity (days to flower)	131 a	122 b	120 b	131 a
Flowering stem ratio	0.20 c	0.68 a	0.67 a	0.31 b
Umbels per flowering stem	1.6 c	2.9 a	3.0 a	1.8 b
Seeds per plant	239 b	1939 a	1291 a	262 b

To fully exploit this genetic improvement in seed yield capability, management for seed production needs to implement cultural practices:

- for a weed-free seed crop
- for timeliness with preparation of the crop for intensive flowering (and optimal harvest date)
- for precision with harvesting and processing to achieve a high proportion of the potential seed yield.

A sowing rate of 3–5 kg/ha of basic seed that achieves a plant density of 40–50 plants/m² to out-compete weeds is indicated. Autumn planting can result in a seed crop in the first summer, although

yield of seed in a juvenile crop is less than in a mature crop due to the development of fewer stems from the crown of juvenile plants.

Under the day length conditions of northern NSW, the seed crop should be closed to grazing from the third week in November. Regrowth during this spell from grazing occurs in the form of reproductive stems, and flowers appear on the terminal points of the stems. A high yield of seed requires strategic placement of honey-bee hives, using up to five hives per hectare.

Under northern NSW conditions, Phoenix and Venture express full bloom between Christmas and New Year and Matador a few days later. The crop of umbel-bearing pods progressively develops and ripens through purple pod, brown pod and mature (bleached pod) stages in 30–35 days after full bloom.

Daily monitoring of crop development is essential to optimise timeliness with the harvest date. The optimal time of harvest is when 80 per cent of the pods are bleached, 10 per cent are immature (brown) and 10 per cent have already shattered.

Paddocks may be harvested by direct-heading but vegetative trash can be problematic to handle. The crop may alternatively be windrowed and 'turned' to expose the vegetative trash to aeration and drying. Mowing and windrowing in early morning (when temperature is low and humidity is high) may reduce the loss of seed. Processes that contribute to the dehydration of pods without causing pod-shatter will increase the yield of seed. A header adjusted to suit small seeds and fitted with a 'pick-up front' can be used to harvest the windrows.

In seed increase blocks at Glen Innes Research Station in northern NSW, seed production in three consecutive years was 622, 430 and 625 kg/ha for Phoenix; 525, 198 and 448 kg/ha for Venture; and 102, 165 and 113 kg/ha for Matador. The 1000-seed weight of cleaned seed retained by a 0.8 mm screen was 1.221 g for Phoenix, 1.246 g for Venture, and 0.686 g for Matador.

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Seed of Phoenix will be released by PGG Wrightson Seeds.

Warnings

Pasture improvement may be associated with an increase in the incidence of certain livestock health disorders. Livestock and production losses from some disorders are possible. Management may need to be modified to minimise risk. Consult your veterinarian or advisor when planning pasture improvement.

Legislation covering conservation of native vegetation may regulate some pasture improvement practices where existing pasture contains native species. However, birdsfoot trefoil has been assessed for weed risk status by the Future Farm Industries CRC and is rated to be of low or negligible weed risk, and is free to be promoted and released without specific management guidelines regarding weed potential.

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