

Phoenix, Venture and Matador – new birdsfoot trefoil cultivars for permanent pasture applications in eastern Australia

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Abstract. Three birdsfoot trefoil (*Lotus corniculatus*) cultivars have been developed for the high rainfall permanent pasture zone. The cultivars Phoenix and Venture were bred at Glen Innes by recurrent selection for seed yield components under the low latitude/short day-length conditions of northern New South Wales. The cultivar Matador was bred at Canberra for prostrate growth habit. Data are presented that show the three cultivars are strongly contrasting in vegetative morphology and growth habit, and they express high seed-yield components and favourable agronomic performance when grown under low latitude/short day-length conditions. With commercialisation, they are expected to contribute an alternative perennial legume for a diversity of grazing applications, and expansion of the area of grazing lands based on deep-rooted perennials.

Introduction

Birdsfoot trefoil is a perennial legume with promise for low fertility acidic soils in recharge landscapes in the high rainfall zone of eastern Australia (Ayres *et al.* 2006). Birdsfoot trefoil is especially well adapted to high rainfall (>600 mm average annual rainfall, AAR) permanent pastures in northern New South Wales (NSW), and elsewhere in low lying poorly drained soils where lucerne fails to persist (Dear *et al.* 2008). Based on climate modelling, the potential zone of adaptation of birdsfoot trefoil is comparable to the white clover (*Trifolium repens*) zone.

However, in the low latitude (28–32°S) section of this zone where birdsfoot trefoil has greatest application (Ayres *et al.* 2006), flowering of existing cultivars is limited by lack of adaptation to short day-length (Ayres *et al.* 2007). Consequently, existing birdsfoot trefoil cultivars do not flower with sufficient intensity to set seed, develop a seed-bank and trigger the mechanisms of seedling recruitment to sustain persistence.

A breeding program (Ayres *et al.* 2008) was undertaken to develop birdsfoot trefoil cultivars adapted to high rainfall (650–1,000 mm AAR) permanent pasture applications, including low latitude/short photoperiod environments to expand the area sown to deep-rooted perennial pasture in the upper catchment of the Murray-Darling basin. The present paper describes the characteristics of the three birdsfoot trefoil cultivars: Phoenix, Venture and Matador developed by the breeding program.

Methods

The three birdsfoot trefoil cultivars were developed by conventional breeding processes that are fully described in Ayres *et al.* (2008). The three cultivars have provisional Plant Breeders Rights protection.

In brief, Phoenix and Venture were bred concurrently at Glen Innes (29° 42'S) from two germplasm sources: a narrow germplasm base (cv. Grasslands Goldie) and a broad germplasm base (49 lines from world-sourced low latitude origins). The selection strategy with the narrow base comprised two cycles of recurrent selection for flowering prolificacy resulting in 22 elite parental plants that were allocated to two morphological groups ('Goldie erect', 'Goldie semi-erect'). With the broad germplasm base, a single round of selection for flowering prolificacy resulted in 17 elite parental plants that were allocated to two morphological groups ('LL erect', 'LL semi-erect'). A final polycross stage separately recombined 'erect' and 'semi-erect' genotypes from the narrow and broad germplasm bases to produce the nucleus populations of Venture and Phoenix respectively. These were progressed through F1 and F2 generations to produce Venture and Phoenix.

Matador was developed at Canberra (35° 06'S) by pair-crossing four erect breeding lines with six prostrate accessions. The progeny were taken through two rounds of recurrent selection for the 'Spanish phenotype' (prostrate dense habit, grey-green leaf, pale yellow flowers characteristic of one of the parent accessions) and progressed through F1 and F2 generations to produce Matador.

Data are presented for vegetative growth characteristics (Table 1) from plants in pots at Glen Innes, and seed yield components (Table 2) from spaced plants grown at two field sites (Glen Innes, 848 mm AAR; Inverell 758 mm AAR) in northern NSW.

Results and discussion

Vegetative characteristics and seasonal herbage growth

Relative to the commercial cultivar Grasslands Goldie, Phoenix is medium-leafed, fine-stemmed and high yielding in both warm-season and cool-season herbage growth. Venture is large-leafed, medium in stem thickness, vigorous in warm-season growth and intermediate in cool-season growth. Matador is small-leafed, thick-stemmed (with short internodes) and low in cool-season growth; Matador has greater leaf density than Phoenix, Venture and Goldie and is more prostrate in growth habit at the pre-flowering stage (Table 1).

Flowering and seed-set characters

Phoenix, Venture and Matador are earlier flowering and more prolific in flowering intensity than Goldie when grown under the short day-length conditions of northern NSW (Table 2). Phoenix is some seven days earlier in flowering maturity than Goldie, while Venture and Matador are intermediate between Phoenix and Goldie. At both sites, Goldie produced a large number of stems, but few of these were flowering stems. Phoenix and Venture, in comparison, produced a greater number of flowering stems and umbels/flowering stem than Goldie. For example, at Glen Innes, while only three per cent of Goldie stems were flowering stems, flowering stems as a proportion of total stems for Phoenix, Venture and Matador were 49%, 24% and 35%, respectively. At Inverell, while Goldie produced more flowering stems than at Glen Innes (19% cf. 3%) (because of less cloud cover and correspondingly higher photoperiod), Phoenix, Venture and Matador produced 51%, 62% and 43% flowering stems, respectively. Matador produced

Table 1. Vegetative and growth characteristics of 'Phoenix', 'Venture' and 'Matador' birdsfoot trefoil in comparison with cv. Grasslands Goldie. Means with different letters in the same column are significantly different ($P \leq 0.05$)

Cultivar	Leaf area ^A (mm ²)	Stem thickness ^A (mm)	Internode length ^A (mm)	Leaf:Stem ratio	Summer growth ^B (g DM/plant)	Winter growth ^B (g DM/plant)
Goldie	97 b	1.06 c	17.2 c	1.57	9.5 b	8.8 c
Phoenix	88 b	1.12 c	20.5 b	1.47	14.9 a	20.0 a
Venture	111 a	1.22 b	22.5 a	1.58	14.7 a	14.0 b
Matador	68 c	1.35 a	13.1 d	1.68	14.4 a	6.6 c

^AMeasurements undertaken on autumn vegetative growth of plants in pots at Glen Innes; F2 populations of Phoenix, Venture and Matador and commercial seed of Goldie

^BSeasonal herbage growth (g DM/plant) undertaken on plants in pots at Glen Innes

Table 2. Seed yield components of 'Phoenix', 'Venture' and 'Matador' birdsfoot trefoil in comparison with cv. Grasslands Goldie measured on spaced plants in mixed sward culture at two field sites in northern NSW. Plants were propagated from F2 plants of Phoenix, Venture and Matador and commercial seed of Goldie. Means with different letters in the same column are significantly different ($P \leq 0.05$)

Cultivar	Glen Innes			Inverell		
	Stems ^A	Flowering Stems ^B	Umbels /Stem ^C	Stems ^A	Flowering Stems ^B	Umbels /Stem ^C
Goldie	19.0 a	0.6 c	0.6 c	18.6 ab	3.5 c	1.9 c
Phoenix	11.3 b	5.5 a	3.0 a	13.1 c	6.7 b	3.1 b
Venture	12.1 b	2.9 b	2.0 b	16.4 b	10.2 a	4.3 a
Matador	10.1 b	3.5 b	1.1 c	21.0 a	9.0 a	3.0 b

^ANumber of stems arising from crown

^BNumber of flowering stems

^CNumber of umbels per flowering stem

more flowering stems than Goldie at both sites and more umbels/flowering stem than Goldie at the Inverell site, but not at the Glen Innes site.

In pollination tunnels at Glen Innes, seed production in the three consecutive years 2005, 2006 and 2008 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 correlated characters 'prolific flowering' and 'early maturity' evidently confer potential for high seed production capability that is expected to be even greater where commercial seed production takes place in high latitude/long day-length environments like western Victoria, Tasmania or New Zealand.

In conclusion, Phoenix, Venture and Matador present a pioneer suite of locally adapted birdsfoot trefoil cultivars for grazing applications in the high rainfall zone. They uniquely possess strong regeneration mechanisms for persistence under the short photoperiod conditions that prevail where latitude <32°S. No other birdsfoot trefoil cultivar developed internationally for low latitude applications has this capability. This potentially extends the northern limit of this valuable temperate perennial legume to at least 28°S – the NSW/Queensland border. Together with cultivars being developed for lower rainfall Mediterranean environments in southern Australia (Real *et al.* 2005), birdsfoot trefoil offers potential to greatly expand the area of grazing lands based on deep-rooted perennials.

Acknowledgements

Prior investment in studies that determined breeding objectives and assemblage of germplasm was partially provided by Meat and Livestock Australia, the New South Wales government 'Acid Soil Action Program' and the Grains Research and Development Corporation. Cultivar development was partially funded by the CRC for Plant-based Management of Dryland Salinity. The technical support of Emma Wilson, Regina Knight, Gordon Tilley (NSW Department of Primary Industries); and Phillip Veness and Scott McDonald (CSIRO) is gratefully acknowledged.

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