Attributes of Biserrula pelecinus L. (biserrula): A new pasture legume for sustainable farming on acidic sandy soils in Mediterranean environments

Carr S.J., Loi A., Howieson J.H., Porqueddu C.

in

Etienne M. (ed.).
Dynamics and sustainability of Mediterranean pastoral systems

Zaragoza : CIHEAM
Cahiers Options Méditerranéennes; n. 39

1999
pages 87-90

Attributes of *Biserrula pelecinus* L. (biserrula): A new pasture legume for sustainable farming on acidic sandy soils in Mediterranean environments

S.J. Carr*/, A. Loi*, J.H. Howieson*/** and C. Porqueddu*****
*CLIMA, The University of Western Australia, Nedlands WA 6907, Australia
**Department of Agriculture WA, South Perth WA 6151, Australia
***CNR, Centro di Studio sui Pascoli Mediterranei, Via Enrico De Nicola, 07100 Sassari, Italy

SUMMARY - Agricultural systems in Mediterranean southern Australia rely heavily on annual pasture legumes grown in rotation with cereals. Historically, Trifolium and Medicago have been the dominant genera, yet many soils are too acidic for the long-term persistence of these genera, and their rhizobial microsymbionts. Serradella, a species symbiotic with acid soil tolerant Bradyrhizobia offers an alternate for acid soils, yet adoption by Australian farmers has been hampered by the expensive seed processing needed for serradella. In this paper, we discuss *Biserrula pelecinus*, a monotypic genus endemic to the mediterranean basin with unique root-nodule bacteria. The agronomic adaptation of biserrula, and the ease of seed harvesting and processing compared with current pasture species, we believe are highly desirable attributes.

Key words: Biserrula, dry matter production, seed yield, rooting depth.

RESUME *- "Caractéristiques de* B. pelecinus *L., une nouvelle légumineuse à pâturer pour agriculture durable sur sols sablonneux acides en condition méditerranéenne". Les systèmes agricoles de l'Australie méridionale méditerranéenne comptent beaucoup sur les légumineuses annuelles pour pâturage cultivées en rotation avec des céréales. Du point de vue historique, les genres Trifolium et Medicago ont dominé, mais de nombreux sols sont trop acides pour une persistance à long terme de ces espèces et de leurs rhizobiums symbiotes. Ornithopus compressus, une espèce vivant en symbiose avec un Bradyrhizobium tolérant les sols acides, offre une alternative pour ce type de sols, mais son utilisation de la part des agriculteurs australiens a été freinée par le coût élevé du processus de production des graines de O. compressus. Dans ce travail, nous examinerons* Biserrula pelecinus, *un genre monospécifique endémique dans le Bassin Méditerranéen avec un rhizobium particulier. Nous croyons que l'adaptation agronomique de Biserrula ainsi qu'une récolte facile des graines par rapport aux espèces les plus communes sont des attributs très souhaitables.*

Mots-clés *: Biserrula, production de substance sèche, production de graines, profondeur des racines.*

Introduction

Annual pasture legumes grown in rotation with cereal crops are integral to the success of farming systems in Mediterranean Australia (Puckridge and French, 1983). Subterranean clover (*Trifolium subterranean*) and several species of annual medics (e.g. *M. polymorpha*, *M. littoralis* and *M. truncatula*) tend to dominate. Sub clover and medics are excellent pasture species, however several major problems relating to sustainability are evident. Farming systems in Mediterranean regions of Australia require greater pasture legume diversity to address sustainability issues such as soil erosion, acidification and secondary salinisation. Conventional pasture legumes require vacuum harvesting, which is environmentally damaging, current species have shallow root systems which restrict water and nutrient exploitation, and soil acidification is affecting the survival and persistence of pasture legume species, and their associated root-nodule bacteria. Our research aims to develop species adapted to acid soils, have deep rooting habit, and that are easily harvested and processed. In this manuscript, we discuss some of the agronomic traits of *Biserrula pelecinus*, an example of a species with potential for acidic sandy soils.

Materials and methods

Pasture legume germplasm, and their associated root nodule bacteria sourced primarily from sandy textured, infertile acidic soils in Greece and Sardinia (Howieson and Loi, 1994) have been evaluated in Western Australia (Table 1). For simplicity, vegetative (Table 2) and seed yields (Table 3) for a single genotype of biserrula, MOR99 (100 days to first flower in Perth WA); pink serradella, ZAF5 (105); yellow serradella, cv Paros or cv Santorini (90 and 100 respectively) and subterranean clover, cv Dalkeith or Trikkala (98 and 112 respectively) are presented. All trials were ungrazed, with basal fertiliser rates and management practices (eg insecticide sprays) based upon sub clover recommendations for the particular region. Maximum rooting depth was determined at three sites (Table 4). The technique involves collection of incremental soil samples (10 cm) with stainless steel tubing which are then gently washed out over a 2 mm grid to determine the maximum depth of root penetration (Carr *et al.*, 1991).

Table 1. Trial location (annual rainfall), soil type description, soil pH and species evaluated (B: biserrula; S: sub clover; P: pink serradella; Y: yellow serradella)

Location (rainfall)	Soil type description	pHt[1]	pHs[2]	Species
Binnu (300)	Deep yellow earth, >2 m	5.1	4.5	BSPY
Northan (450)	Grey duplex, 40 cm sand/clay	4.4	4.2	BSY
Woodanilling (500)	Gravelly loam	5.2	ns	BSP
Pinjarra (800)	Deep sand, >2 m sand	4.9	4.3	BSPY
Jingalup (550)	Gritty grey duplex 60 cm sand/clay	4.5	4.1	BSY

pHt[1] topsoil (0-10 cm) and pHs[2] sub soil (20-30 cm) measured in 1:5 0.01M $CaCl_2$

Results and discussion

Vegetative yield

Vegetative yield of ungrazed pastures of biserrula varied from 1.5 to 7.5 t ha^{-1} (Table 2). These yields compared favourably with the range in yields of pink serradella (0.7 to 8.1 t ha^{-1}), yellow serradella (0.6 to 7 t ha^{-1}) and sub clover (2.6 to 5.1 t ha^{-1}). Maximum yields were achieved at the Pinjarra site, which has the highest average annual rainfall. Generally, the 1995 season in Western Australia was favourable, with most regions receiving above average rainfall, that was well distributed during the growing season (>80% falling during the growing season, May until October). Vegetative yields were therefore at the higher end of long term expectation.

Table 2 . Dry matter production (t ha^{-1}) of biserrula and comparative species

Location	Sample date	Biserrula	Yellow serradella	Pink serradella	Sub clover
Binnu	29/8/95	1.5	1.8[1]	2.3	ns[3]
Northan	6/10/95	6.7	7.0	ns[3]	5.1
Woodanilling	10/10/95	4.0	ns[3]	3.8	2.7[2]
Pinjarra	13/10/95	7.5	ns[3]	8.1	5.2[2]
Jingalup	30/10/95	4.8	6.1[1]	ns[3]	2.6

[1] Santorini serradella, not Paros
[2] Trikkala sub clover, not Dalkeith
[3] ns: not sampled

Seed yield and seed reserves

Biserrula is capable of prolific seed production, with total seed yields of 762, 773 and 1513 kg ha^{-1} for Woodanilling, Northam and Jingalup respectively (Table 3). These seed yields were equivalent to the

seed yield of pink serradella (772 kg ha^{-1}) at Woodanilling and yellow serradella (1757 kg ha^{-1}) at Jingalup respectively. At the Northam site, which experienced a drier spring than the Woodanilling and Jingalup sites, the biserrula seed yield of 773 kg ha^{-1} outyielded yellow serradella (292 kg ha^{-1}) considerably. Sub clover yields ranged between 104 and 918 kg ha^{-1}. At all sites, in considering the number of potentially germinable units (seed number produced ha^{-1}) biserrula performance was superior to the control species and the seed bank established during 1995 would be expected to ensure survival of the species for many years. Recent observations at the beginning of the 1997 growing season confirms excellent regeneration of biserrula.

Table 3. Seed yield and number of potential germinable units (seeds ha^{-1}) of biserrula and other species

Species	Jingalup		Northam		Woodanilling	
	Kg ha^{-1}	Germ units	Kg ha^{-1}	Germ units	Kg ha^{-1}	Germ units
Biserrula	1513	$1.16*10^9$	773	$5.95*10^8$	762	$5.86*10^8$
Yellow serradella	1757†	$7.64*10^8$	292	$1.27*10^8$	ns	ns
Pink serradella	ns	ns	ns	ns	772	$5.94*10^8$
Sub clover	103	$8.58*10^6$	918	$7.65*10^7$	553	$4.61*10^7$

† Santorini serradella, not Paros at Jingalup

Rooting depth

Biserrula was the deepest rooting legume at all sites, with root development observed at 1.15 and 1.2 m below the soil surface at Binnu and Pinjarra respectively (Table 4). This was 20% deeper than the maximum rooting depth of pink serradella at both sites, and 20%-60% deeper than sub clover at Binnu and Pinjarra respectively. At the Jingalup site, biserrula (0.7 m) was clearly much deeper rooting than sub clover (0.25 cm), although an impenetrable clay layer at 60 to 70 cm below the soil surface prevented sampling to the maximum depth using our sampling technique. Nevertheless we observed both biserrula and serradella roots were able to penetrate this clay layer.

Table 4. Maximum rooting depth (m below soil surface) at three sites

Species	Binnu 25/8/95	Pinjarra 26/9/95	Jingalup 28/9/95
Biserrula	1.15	1.2	0.70
Pink serradella	0.95	1.0	0.60[2]
Sub clover	0.70	0.9[1]	0.25

[1] Trikkala, not Dalkeith at Pinjarra site
[2] Yellow serradella cv Santorini, not pink serradella at Jingalup

Indeterminance

Depending upon location, biserrula remained green and continued growing and flowering for between two and four weeks after the senescence of sub clover (both Dalkeith and Trikkala). There was little difference between biserrula and pink serradella in the loss of green vegetative material, both tending to be more indeterminate than Paros serradella, although the difference was less obvious in the later maturing Santorini. The indeterminate nature and deep rooting habit of biserrula are highly desirable traits for a Mediterranean pasture species. For instance, biserrula MOR99 originates from Morocco, in a rainfall region of 450mm. Under the favourable seasonal conditions at Pinjarra (annual rainfall 800 mm) in which 7.5 t ha^{-1} biomass was harvested in mid October, biserrula was still able to set a reasonable seed bank (data not shown).

Conclusions

Biserrula displayed broad soil type adaptation, particularly on the sandy surfaced duplex soils on which sub clover performance is often sub optimal (Ewing *et al.*, 1992). The deep rooted habit of biserrula compared with conventional pasture legumes is an excellent attribute and offers an exciting prospect to complement the current range of pasture legumes available in the Mediterranean environment. The ability of biserrula to utilise water and nutrients from deeper in the soil profile extends the period of green feed late in spring which is important in Mediterranean farming systems, and confirms observations in Sardinia, of biserrula remaining green after the senescence of other pasture species (Loi *et al.*, 1995). An added advantage of the extended growth period of biserrula is the potential to address the issues of rising ground water, secondary salinisation and eutrophication of rivers and waterways. The agronomic adaptation of biserrula associated to the ease of seed harvesting and processing compared with current pasture species justify the interest to continue the evaluation programme to set up the first commercial variety.

References

Carr, S.J., Ritchie, G.S.P. and Porter, W.M. (1991). A soil test for aluminium toxicity in acidic subsoils of yellow earths in Western Australia. *Aust. J. Agric. Res.*, 42: 875-892.

Ewing, M.A., Bathgate, A.D., French, R.J. and Revell, C.K. (1992). The role of crop and pasture legumes in rotations on duplex soils. *Aust. J. Exp Agric.*, 32: 971-979.

Howieson, J.G. and Loi, A. (1994). The distribution and preliminary evaluation of alternative pasture legumes and their associated root-nodule bacteria collected from acid soils of Greece (Serifos), Morocco, Sardinia and Corsica. *Agricoltura Mediterranea*, 124: 170-186.

Loi, A., Carr, S.J. and Porqueddu, C. (1995). *Alternative pasture legumes and rhizobia collection in Sardinia. May-July 1995*. CLIMA Occasional publication No. 6, Sept 1995.

Puckridge, D.W. and French, R.J. (1983). The annual legume pasture in cereal ley farming systems of southern Australia: A review. *Agric. Ecosystems and Environ.*, 9: 229-267.