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Adaptation of Australian self-reseeding forage legumes to three environments of Sardinia

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Abstract. The important role of annual self-reseeding legumes is well known and their use in livestock systems is consistent with low input agriculture trend. Australian commercial varieties of self-reseeding legumes mainly derive from Mediterranean basin germplasm. They have been selected for environmental conditions of southern Australia where they are cultivated. Each year a large amount of seed of Australian varieties is imported to southern Europe. Therefore it is necessary to investigate their adaptation and yield capacity to local environmental conditions. A two years trial was performed in three Sardinian sites with different pedoclimatic characteristics, with the aim to compare the agronomic performances of Australian self-reseeding legume varieties belonging to *Biserrula*, *Ornithopus*, *Medicago* and *Trifolium* genera. Earliness of flowering, forage yield and variety persistence in the second year were evaluated. Varieties of *Trifolium* spp. had the best productive performances, coupled with the highest persistence in subterranean clovers. Varieties of *Biserrula* and *Ornithopus* spp. proved to be not well adapted to the three sites and showed low herbage mass production.

Keywords. Self reseeding legumes – Forage yield – Persistence – *Trifolium* spp.

Adaptation de légumineuses fourragères auto-réensemençantes australiennes à trois environnements de la Sardaigne

Résumé. *Le rôle important des légumineuses annuelles auto-réensemençantes est bien connu et leur utilisation dans les systèmes d'èlevage est compatible avec une agriculture à faible input. Les variétés commerciales de légumineuses auto-réensemençantes australiennes dérivent principalement de matériel génétique du bassin méditerranéen. Elles ont été sélectionnèes pour le milieu du sud de l'Australie. Tous les ans une grande quantité de semences de variétés australiennes est importée dans l'Europe du Sud, par conséquent c'est nécessaire de vérifier leur capacité d'adaptation et de production de fourrage dans les environnements locales. Une expériméntation de deux ans a été réalisée dans trois localités sardes avec différentes caractéristiques pédoclimatiques, dans le but de déterminer la réponse agronomique des variétés australiennes de légumineuses auto-réensemençantes appartenant aux genres* Biserrula, Ornithopus, Medicago *et Trifolium. La phénologie, la production fourragère, et persistance dans la deuxième année ont été évalues. Les variétés du genre* Trifolium *spp. ont montré la meilleure réponse productive, et la plus élevée persistance pour le trèfle souterrain. Bien différent a été la réponse des genres* Biserrula *et* Ornithopus *spp. dans les trois localités, avec une production fourragère réduite.*

Mots-clés. *Légumineuses auto-réensemençantes – Production de fourrage – Persistance* – Trifolium *spp.*

I – Introduction

The benefits of forage legumes, as nitrogen fixation capacity, high nutritive value and voluntary feed intake, are well known and economically exploited in animal production systems (Rochon *et al.*, 2004; Frame, 2005). The use of annual self-reseeding legumes is consistent with low input agriculture trend. Their ability to produce a variable quantity of hard seed allows them to persist

several years without annual sowing, reducing costs for soil cultivation and seed purchase. This peculiarity is exploited in short (1 or 2 years) and long (3-6 years) crop rotation systems such as performed in many Australian farms (Nichols *et al*., 2007). Despite most of annual self-reseeding legumes have their origin in Mediterranean basin, Australian commercial varieties, that have been selected to mach the needs of Australian agriculture, sometimes proved to be unsuitable for local pasture improvement (Sulas, 2005). Therefore the aim of this work is to assess in different locations of Sardinia (Italy) some agronomic performances of several annual self-reseeding legume cultivars imported from Australia.

II – Materials and methods

The trial was carried out from October to June in 2009/10 and 2010/11 in 3 different locations of Sardinia, Bolotana, Olmedo and Ussana. The pedo-climatic characteristics of experimental site and their meteorological condition during the trial period are showed in Table 1 (meteorological data were provided by Sardinia Environmental Agency, ARPAS). Bolotana has a sub acid soil whereas Olmedo and Ussana have a sub alkaline soil. The latter has the highest values of assimilable phosphorus and exchangeable potassium. Seventeen Australian genotypes were compared: *Biserrula pelecinus* L. Casbah and Mauro, *Medicago polymorpha* L. Cavalier, *M. sphaerocarpus* Bertol. Orion, *Ornithopus compressus* L. Santorini, *O. sativus* Brot. Cadiz and Margurita, *Trifolium dasyurum* L. Sothis, *T. glanduliferum* Boiss. Prima, *T. hirtum* All. Hykon, *T. michelianum* Savi Paradana, *T. resupinatum* L. Prolific and Turbo Plus, *T. subterraneum* L. Antas and Denmark, *T. spumosum* L. Bartolo, *T. vesiculosum* Savi Zulu. The sown in each location was in October 2009. The adopted experimental design was a randomised block with 3 replications and 10 m^2 plots size. All species were inoculated with their specific rhizobia. In the two years total dry matter (DM) production of each variety was evaluated by cutting two 0.5 m^2 samples per plot at vegetative and full flowering stage. Fresh forage was completely dried in an oven-dryer at the temperature of 65°C. Moreover, to asses species earliness, the number of days between sowing and the first open flower were recorded. All data were analysed by ANOVA procedure using forage species and location as fixed effect (SAS, 2002).

Table 1. Main pedo-climatic characteristics of the three experimental locations

	Bolotana		**Olmedo**		**Ussana**	
Lat, Long	40°16'N, 8°58'E		40°40'N, 8°22'E		39°10'N, 3°20'E	
Altitude (m a.s.l.)	200		40		150	
Texture	sandy clay loam		sandy clay loam		sandy loam	
pH	6.1		7.8		7.9	
Organic C (g kg^{-1})	10.0		9.5		7.3	
Total N (g kg^{-1})	0.7		0.9		0.8	
Assimilable P (mg kg^{-1})	3.5		7.3		18.6	
Exchangeable K (mg kg^{-1})	141.6		81.7		204	
Climate	**Climatic mean**	**2009-11**	**Climatic mean**	**2009-11**	**Climatic mean**	**2009-11**
Min temperature (°C)	9.4	9.9	11.5	9.4	10.7	9.9
Max temperature (°C)	23.5	24.9	20.4	21.2	22.8	22.7
Rainfall (mm)	580	480	582	774	434	540

III – Results and discussion

During the years of the trial temperatures didn't differ from long term values and Bolotana showed the highest maximum temperatures (Table 1). Annual rainfall was above climatic mean in both Olmedo and Ussana and below in Bolotana. Overall genotypes belonging to *Trifolium* genus had the highest DM production in both years whereas *Biserrula* and *Ornithopus* spp. had the lowest (4.2 *vs* 1.6 and 1.1 t ha^{-1} in the first year, 1.3 *vs* 0.5 and 0.3 t ha^{-1} in the second year for *Trifolium*, *Biserrula* and *Ornithopus* spp respectively, P<0.05). In the first year, in Olmedo and Ussana, *T. vesiculosum* Zulu and *T. resupinatum* Turbo Plus and Prolific had the best performances, with more than 8 t ha^{-1} of DM production (Table 2). In Bolotana the Australian species had the lowest productions with a maximum of 4.8 t ha^{-1} in *T. vesiculosum* Zulu. In the second year *T. subterraneum* Antas showed the highest forage production in all sites, but *T. vesiculosum* Zulu, *T. michelianum* Paradana, *T subterraneum* Denmark in Ussana and *T. hirtum* Hykon and *T. subterraneum* Denmark in Olmedo produced over 2 t ha^{-1} of DM. Subterranean clovers performed well in all locations, confirming previous results obtained in Sardinia (Porqueddu *et al.*, 2010). Despite the species with high level of hardseedness had not relevant yield in the second year, *B. pelecinus* Casbah and Mauro produced in Ussana 2.1 and 1.2 t ha^{-1} respectively.

Table 2. Total dry matter (DM) production in the first and second year at the three locations Bolotana (BO), Olmedo (OL) and Ussana (US)

	DM yield 2009-10				DM yield 2010-11			
	BO	OL	US	spxlo LSD=	BO	OL	US	spxlo LSD=
Specie and cultivar	**t ha^{-1}**	**t ha^{-1}**	**t ha^{-1}**	**1.9 t ha^{-1}**	**t ha^{-1}**	**t ha^{-1}**	**t ha^{-1}**	**0.8 t ha^{-1}**
B. pelecinus Casbah	0.0e	1.8de	3.5de	*	0.0c	0.0f	2.1bc	*
B. pelecinus Mauro	0.0e	2.2de	2.0ef	*	0.0c	0.0f	1.2c-e	*
M. polymorpha Cavalier	0.2e	5.2c	4.5bd	*	0.0c	0.0f	0.0f	ns
M. sphaerocarpus Orion	0.2e	3.7dc	5.7b	*	0.1c	0.0f	0.0f	ns
O. compressus Santorini	0.4e	0.4e	1.7f	ns	0.0c	0.0f	0.0f	ns
O. sativus Cadiz	1.1de	1.7de	1.7f	ns	0.1c	0.5ef	0.7d-f	ns
O. sativus Margurita	1.1de	0.2e	1.1f	ns	0.2c	0.3f	0.9d-f	ns
T. dasyurum Sothis	1.0de	5.8c	4.7b-d	*	0.0c	1.3c-e	0.0f	*
T. glanduliferum Prima	3.4a-c	4.0dc	3.9cd	ns	0.1c	1.0c-f	0.8d-f	*
T. hirtum Hykon	1.2c-e	4.6c	3.5de	*	0.4c	2.4b	1.5cd	*
T. michelianum Paradana	3.2a-d	4.8c	3.8cd	ns	0.1c	1.9bc	3.0b	*
T. resupinatum Prolific	1.3c-e	9.3a	5.6bc	*	0.1c	0.7d-f	0.9d-f	*
T. resupinatum Turbo Plus	3.9ab	6.2bc	8.1a	*	0.0c	0.8d-f	0.4ef	*
T. subterraneum Antas	2.2b-e	5.2c	3.9cd	*	2.0a	5.0a	4.8a	*
T. subterraneum Denmark	1.3c-e	1.6de	1.4f	ns	1.5b	2.4b	2.6b	*
T. spumosum Bartolo	1.0de	5.1c	4.9b-d	*	0.0c	0.0f	0.0f	ns
T. vesiculosum Zulu	4.8a	8.2ab	8.1a	*	0.5c	1.6bd	2.5b	*
Average	1.5	4.1	4.0		0.3	1.1	1.3	
		P				P		
Specie		<0.001				<0.001		
Location		<0.002				<0.002		
Specie x location		<0.001				<0.001		

In the column of locations means followed by the same letter are not different at P = 0.05 (Duncan's test).
In the rows interaction specie x location least significant difference (spxlo LSD) is calculated at P = 0.05 (Duncan's test); * = significant; ns = not significant.

However in both years 11 species showed significantly interactions with the locations in forage production (Table 2). Flowering time highlighted wide differences of earliness in the studied species ranging from 118 to 196 days in *M. polymorpha* Cavalier in Bolotana and *T. resupinatum* Turbo Plus in Ussana, respectively (Fig. 1).

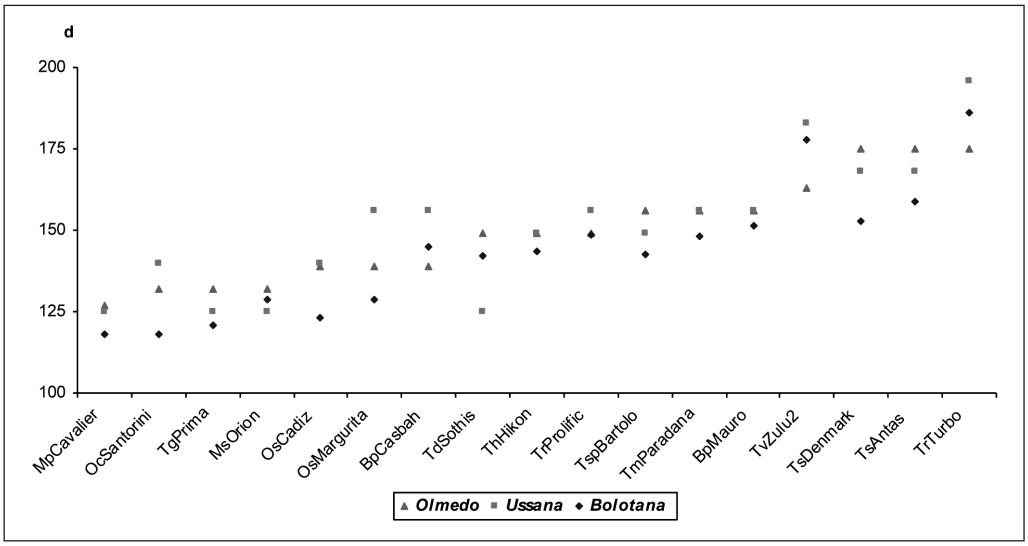

Fig. 1. Days between sowing and the first open flower of the forage species in the three locations.

IV – Conclusions

The different pedo-climatic characteristics of the locations strongly influenced the performances of the Australian species. Some species showed high level of hardseedness, up than 90% (data not shown), that could permit the regrowth in the subsequent years, adapting to ley farming systems. However the different behaviour of these species in such different environmental conditions allows a wide range of varieties choice for pasture establishment in the Mediterranean farming system. More studies should be necessary, in various pedo-climatic environments, to evaluate the suitability to grazing pressure with different animal species.

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