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Searching for new annual legumes suitable for pasture establishment in Southern Europe

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Abstract. The high plant biodiversity of Mediterranean basin, shaped from both the millennial agro-pastoral activity and the pedo-climatic variability, has produced a natural selection of pasture species, suitable for several uses in farming systems. Many of the recently released Australian annual legumes varieties are not always suitable for pasture establishment in southern Europe, mainly because of their early flowering and high hardseededness, which affect the persistence capability. In order to clarify the low persistence of the Australian varieties and to identify new interesting materials for the Mediterranean forage scene, ten accessions of *Lotus ornithopodioides*, *Ornithopus compressus*, *O. sativus*, *Trifolium hirtum*, *T. mutabilis* and *T. spumosum* were compared in North-Sardinia. These accessions, were evaluated for bio-agronomic traits as vigour, phenology, seed production and hardseedness breakdown. Results revealed the potential suitability of many of tested materials for both Mediterranean pasture improvement purposes and multifunctional uses.

Keywords. Persistence – Hardseededness – Annual legumes – Pasture establishment.

Recherche des nouvelles légumineuses annuelles adaptées à l'établissement de pâturages dans l'Europe du Sud

Résumé. *La grande biodiversité de la communauté végétale du bassin méditerranéen, façonnée par la millénaire activité agro-pastorale et par la variabilité pédo-climatique, a produit une sélection naturelle des espèces, adapté à plusieurs buts dans les systèmes agricoles. La plupart des variétés australiennes des légumineuses annuelles, disponibles sur le marché, ne sont pas toujours adaptées à l'établissement de pâturages dans le sud de l'Europe, principalement en raison de leur précoce floraison et de la haute dureté des semences, qui affectent la capacité de persistance. En conditions semi-arides Méditerranéennes, les traits distinctifs du idéotype des légumineuses annuelles sont la capacité de persistance et la gestion durable des cultures. Dans ce contexte et afin d'identifier matériaux potentiellement intéressants pour les systemes fourragèrs méditerranéens, treize différentes accessions de* Lotus ornithopodioides, Ornithopus compressus, O. sativus, Trifolium hirtum, T. mutabilis *et* T. spumosum *ont été comparés dans l'essai expérimental avec plantes espacées réalisée dans le nord-Sardaigne. Ces accessions ont été comparés pour la vigueur, la phénologie et la dureté des semences. Les résultats ont révélé la pertinence potentielle de beaucoup des matériaux testés pour l'amélioration des pâturages Méditerranéens et les usages multifonctionnels.*

Mots-clés. *Persistance – Dureté des semences – Légumineuses annuelles – Établissement de pâturages.*

I – Introduction

The native flora of the Mediterranean basin represent a rich source of legumes' germplasm and their root-nodule bacteria, for purposes of cropping, pasture and forage (Howienson and Loi 1994; Loi *et al.*, 2005). This is due to the high biodiversity of vegetal community, shaped from both millennial agro-pastoral activities and pedo-climatic variability, which have produced a natural selection of species suitable for several aims. Subterranean clover and annuals medics played an important role in the Australian wheat belt area in supplying nitrogen and sustaining the animal productions in both ley-farming and phase-farming systems. In the last decade, the

high cost of seed production, the dependence from herbicides, the diffusion of new pests and diseases impacted on their popularity (Loi *et al.* 2005). In this contest, a second generation of legumes was released and introduced in the seed market by Australian researchers. In a recent multisite experiment in Sardinia, several of these new varieties showed difficult establishment and persistence and low forage productions. Despite good agronomic performances in the first year, the low autumn re-establishment of the sown varieties reduced the competitiveness against native species, depressing any attempt of pasture improvement (Porqueddu *et al*., 2010). This behaviour suggested their use in mixtures and highlighted the need to identify new pastures species more suitable to the local conditions. The existence of a variability in hardseededness among species in a mixture is a favourable trait, as advantages may be achieved combining seeds with different hard seeds levels and softening pattern for reducing inter- and intra-annual fluctuations (Porqueddu and González, 2006). For this aim, ten accessions of annual self-reseeding legumes, collected in different areas of Mediterranean basin, were compared for vigour, phenology and hardseededness in North-Sardinia.

II – Materials and methods

The trial was carried out in Surigheddu (North Sardinia, 40°35'38,21'N – 8°22'49,21'E, 26 m a.s.l.) at the Centre for the Conservation and Valorisation of Plant Biodiversity of the University of Sassari. The climate is typical of the central Mediterranean basin with long-term average annual rainfall of 540 mm and dry summer. The soil is calcareous alluvial, with a pH (water) of 6.9. Ten accessions of *Lotus ornithopodioides* (2), *Ornithopus compressus* (2), *O. sativus* (1), *Trifolium hirtum* (2), *T. mutabilis* (1), and *T. spumosum* (2) were compared in a completely randomized block experimental design with 3 replications. *Medicago polymorpha* Anglona, *T. subterraneum* Antas, *T. spumosum* Bartolo were used as tests. Preliminarily, seeds of all accessions were germinated in Petri dishes on tissue paper in a germinator at constant temperature (20°C). Seedlings were first transferred in Jiffy pots and after few months transplanted in spaced rows (0,6mx1.80m) on the December 7th, 2010. No herbicides were used, weeds having been controlled by mulching films. Data on plant vigour, cold damages, phenology and hardseededness were collected. Plant vigour and cold damages were estimated by assigning visual scores between 1 (low) and 5 (high). Phenology was recorded indicating the date at which each plant reached the following four phenological phases: 1st opened flower, 1st green pod, end of flowering and complete plant senescence. To investigate on hardseededness, 100 seeds for each accession were wrapped in fly-wire envelopes to form a strips. Three replicate strips were placed on the soil surface and then buried at 1 cm deep in a randomized block design. On 30th of July, 30th August and 30th September, the seeds were taken off and placed directly onto moist filter paper in Petri dishes at 20 °C for 20 days. Germinated and hard seeds were counted at in each of the three dates.

III – Results and discussion

In the period of the trial from transplantation to senescence (June), the total rainfall was 330 mm, mainly concentrated in December (50% of total rainfall) and the remaining one homogeneously distributed between March and June. No rainfall during the summer months occurred. *T. spumosum* WCT showed more vigorous plants than most of the accessions, but was not significantly different from the test variety *M. polymorpha* Anglona. *T. spumosum* Bartolo and most of the other native accessions formed a group of low vigor materials (Table 1). Cold damages were insignificant in *T. spumosum* WCT, but were more evident in less vigorous accessions. All accessions showed a high variability in phenology. Significant differences were found in all the observed phases; flowering began earlier in *T. spumosum* Bartolo (110 days from transplantation), which was significantly earlier than the other two *T. spumosum* WCT and VCD, with 124 and 130 days,

respectively. *O. sativus* Soft and *T. mutabilis* showed late flowering (142 and 170 days, respectively,) but the latter was very fast ending its reproductive cycle after only 43 days from the first flower appearance. In *T. subterraneum* Antas, *O. compressus* Pabarile, *L. ornithopodioides* LA, *O. compressus* GEH and *T. spumosum* Bartolo, the duration of the flowering cycle were longer than 70 days (70-84 day). *T. spumosum* VCD, *T. spumosum* WCT, *M. polymorpha* Anglona and *T. hirtum* NA completed the flowering between 60 and 64 days, *L. ornithopodioides* LB and *T. hirtum* NB between 56 and 59 days.

Table 1. Bio-agronomic traits of the accessions: plant vigour and cold damages (score 1-5) and phenology phases (days from, December 7th 2010)

	Vigour	Cold damage	1° flower open	1° pod green	End flowering	Senescence
T. subterraneum Antas	2.7^{cd}	3	133^{d}	141^{d}	200^{bc}	206^{bcd}
T. hirtum NA	2.4^{bc}	4	126^{bcd}	165^{e}	189^{ab}	194^{a}
T.hirtum NB	1.4^{ab}	4	128^{bcd}	165^{e}	187^{ab}	194^{a}
T. mutabilis	2.0^{abc}	4	172^{f}	194^{f}	215^{c}	216^{bcd}
T. spumosum Bartolo	2.0^{abc}	3	110^{a}	124^{a}	190^{ab}	194^{a}
T. spumosum WCT	4.0^{e}	2	124^{bcd}	138^{bcd}	190^{ab}	194^{a}
T. spumosum VCD	2.3^{bc}	3	130^{cd}	134^{bcd}	190^{ab}	194^{a}
O. compressus Pabarile	1.7^{abc}	3	130^{cd}	139^{cd}	202^{bc}	213^{bc}
O. compressus GEH	1.1^{a}	4	117^{ab}	136^{bcd}	190^{ab}	193^{a}
O. sativus Soft	1.7^{abc}	4	142^{e}	165^{e}	202^{bc}	210de
L. ornithopodioides LA	1.6^{ab}	4	119^{abc}	133^{bc}	203^{bc}	212^{e}
L. ornithopodioides LB	2.2^{abc}	3	127^{bcd}	132^{b}	183^{a}	193^{a}
M. polymorpha "Anglona"	3.7^{de}	3	120^{abc}	132^{b}	184^{a}	194^{a}

The pattern of hardseed breakdown (Fig. 1) was quite homogeneous for all of the accessions, except for *O. sativus* Soft, which showed to be clearly softseeded (95% soft seeds on 30th of July). For this reason, *O. sativus Soft* was excluded from the statistical analysis.

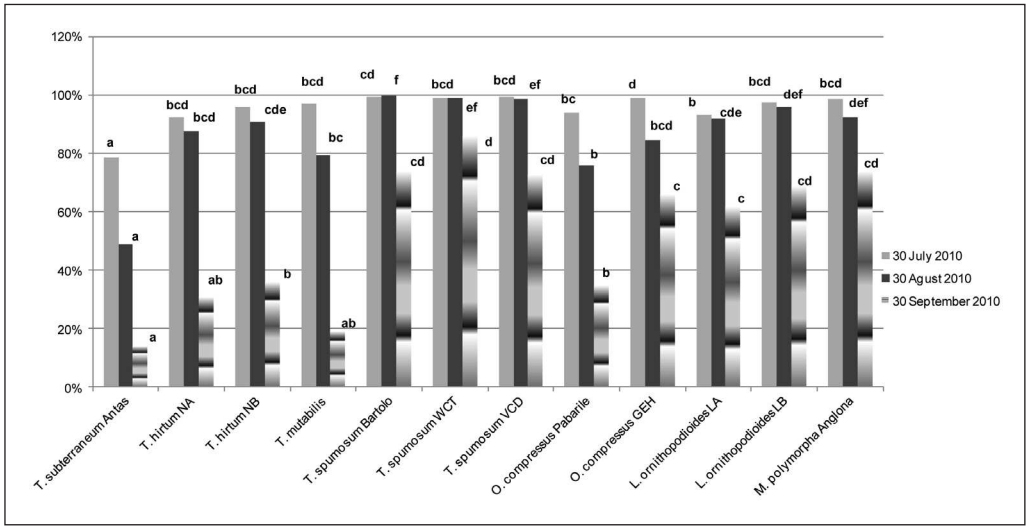

Fig. 1. Percentage of hard seeds at three different dates.

In the other accessions, hard seeds ratio exceeded 90% in early summer except for T. *subterraneum* Antas. In general, the percentage of hard seeds was stable in mid-summer. A slight decrease was observed in the two accessions of *O. compressus* and *T. mutabilis* while *T. subterraneum* Antas dropped from 80% to 50% hard seeds. Significant differences in hardseededness were also shown among accessions at the end of summer. *T. subterraneum* Antas, *T. mutabilis*, *T. hirtum* and *O. compressus* Pabarile, strongly reduced the hard seeds level up to 15%-35%. The remaining accessions maintained hard seed percentages between 60% (*L. ornithopodioides* LA) and 85% (*T. spumosum* WCT).

IV – Conclusions

The late flowering of a pasture crop in Mediterranean environments is a factor that promotes the extension of the grazing calendar and guarantees the lasting preservation of forage quality, as well as the regenerative capacity ensures the plant persistence. *O. sativus* Soft, which is late maturing and fully soft-seeded at the beginning of summer, satisfies both phenology and persistence requirements. However, it could be sensible to false breaks in case of summer rainfall. The same considerations are also valid for *T. mutabilis*. As regards *T. hirtum*, both genotypes showed interesting traits, with a flowering time similar to that of the well adapted tests. *T. spumosum* VCD and *O. compressus* Pabarile represented a promising alternatives to the commercial varieties of the same species, being late-maturing. Although the results are partial and site-specific, some accessions showed to be suitable for the inclusion in valorisation programs. In particular their erect habit that set heads on the top of the plants may avoid the use of suction harvesting (indispensable for the traditional pasture legumes as subterranean clovers and medics) making easier and cheaper the harvesting with conventional cereal harvesters.

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