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Effect of component ratios and management of an annual ryegrass/burr medic mixture on the forage quality

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Abstract. A trial was carried out to evaluate the benefits of grass-legume mixtures in terms of sward establishment, dry matter yield, self-reseeding ability and unsown species control. In this paper we present the aspects related with the forage quality. Two annual self-reseeding species coming from Sardinian candivars *Lolium rigidum* Gaudin NURRA (L) and *Medicago polymorpha* Anglona (P) were used. The trial was carried out in Sardinia (Italy) comparing two pure stands (L100P0 and L0P100) and three mixtures (L75P25, L50P50 and L25P75), where 100 represented the standard dense sowing rate of each component in pure stand. Two different cutting treatments were compared: two cuts *vs* three cuts. Crude protein, NDF and ADF of the different treatments were determined. Mixtures assure a more seasonally-balanced quality of forage respect to the pure stands; two cuts achieve a higher CP content. Results are important for defining suitable strategies at farm level, in terms of grazing techniques.

Keywords. Annual self reseeding species – Mixtures – Forage quality.

Effet des ratios de composition et de la gestion d'un mélange ray-grass et medicago annuel sur la qualité du fourrage

Résumé. *Un essai a été réalisé pour évaluer les avantages de mélanges graminées-légumineuses en termes de mis en place du gazon, du rendement en matière sèche, du réensemencement naturel et de la capacité de contrôler les espèces non semées. Dans cet article nous présentons les aspects liés à la qualité du fourrage. Deux espèces annuelles à réensemencement naturel, candivars* Lolium rigidum *Gaudin Nurra (L) et* Medicago polymorpha *L. Anglona (P) provenant de la Sardaigne, ont été mis en place pour étudier les effets des différents rapports de mélange et de la coupe sur la qualité du fourrage. Le test a été effectué en Sardaigne (Italie) comparant deux* (L100P0 et L0P100) *semis purs et trois mélanges* (L75P25, L50P50 et L25P75) *où 100 représente la densité agronomique standard pour la culture de chaque espèce en pur. Deux différent traitements de coupe ont étés comparés: deux coupes* vs *trois coupes. La teneur en protéines brutes, NDF et ADF a été déterminée sur des échantillons de fourrage. Les mélanges fournissent un fourrage de meilleure qualité par rapport aux semis en pur; une teneur plus élevée en CP est assurée avec deux coupes. Les résultats sont importants pour définir les stratégies les plus optimales de production de fourrage au niveau des exploitations, en termes de valeur nutritive et les techniques de pâturage.*

Mots-clés. *Espèces annuelles à réensemencement naturel – Mélange – Qualité du fourrage.*

I – Introduction

Native and improved pastures and mixtures of annual legumes with winter cereals, used as short annual forage production, represent the most important feed resources for extensive or semi-extensive Mediterranean farming systems. The higher the forage quality, the more efficient is the forage consumption by grazers, so the availability of good quality fodder is ever more a pressing pre-requisite to better manage the livestock farming and its economy. Almost 8% of protein is necessary in the feed rations to meet the protein requirements of ruminants (Qamar *et al.*, 1999). So, it is very important to ensure a minimum level of protein in the rations based on

the association of forage legumes with grasses; as well as it's relevant the stage at which forage plants are utilized. Two Sardinian candivars of annual self-reseeding species, *Lolium rigidum* Gaudin Nurra and *Medicago polymorpha* Anglona were selected by CNR-ISPAAM in Sardinia. Both species are widespread in the Sardinian pasturelands and have a potential important role in the qualitative and productive improvement of marginal pastures of Mediterranean areas (Franca *et al.*, 1998; Sulas and Sitzia, 2004).

II – Materials and methods

The trial was carried out under rainfed conditions in the North-West Sardinia at the Ottava research station (80 m a.s.l. 40°46'28",66 N, 8°29'17",88 E). The climate is typical of the central Mediterranean basin with long-term average annual rainfall of 540 mm and mean annual temperature of 16.2°C. The soil is clay-loam calcareous, with pH 7.5, low N and P_2O_5 content and adequate K_2O content. The species used in the experiment were *L. rigidum* Gaudin Nurra (L) and *M. polymorpha* Anglona (P). Five plots of 20 m^2 each (5m x 4m) were sown in autumn 2002 in a split-plot randomized block design with four replicates. The plots included two pure stands (L100P0 and L0P100) and three mixtures (L75P25, L50P50 and L25P75) where 100 represented the standard dense sowing rate of each component in pure stand (25 kg ha^{-1} and 20 kg ha^{-1} for L and M, respectively). The five plots were compared with a commercial mixture, constituted by Australian varieties of annual legumes as *M. truncatula* 'Paraggio', *M. rugosa* 'Sapo' and *Trifolium brachycalycinum* 'Clare' (M100) well suited for sub-alkaline/alkaline soils. After the late winter cut, each plot was splitted in order to apply two cutting treatments in relation to the burr medic phenological stage: two cuts T1= Early Flowering (EF) and Pod Maturing (PM) *vs* three cuts, T2= Early Flowering (EF), Full Flowering (FF) and Pod Maturing (PM). Before sowing all plots were fertilized with 36 kg ha^{-1} of N and 92 kg ha^{-1} of P_2O_5. No weeding was applied. Plots were mowed at 5 cm above ground. Forage quality was evaluated by drying samples of biomass in oven at 80°C for 48 h, then milling the samples for chemical traits determination. Total N was determinate using Kjeldahl method and crude protein (CP) was calculated by multiplying the N content by 6.25. Neutral and acid detergent fibres (NDF and ADF), were determined by te Van Soest (1994) procedure. Total digestible nutrients (TDN), digestible dry matter (DDM), dry matter intake (DMI), relative feed value (RFV) and net energy for lactation (Ne_l) were estimated according to the following equations adapted from Horrocks and Vallentine (1999): TDN=(-1.291xADF)+101.35, DMI=120/%NDF dry matter basis, DDM=88.9-(0.779x%ADF) dry matter basis, RFV=%DDMx%DMIx0.775, NE_l= (1.044-(0.0119x%ADF))x2.205.

III – Results and discussion

Significant differences for all quality parameters both between thesis and between treatments were observed. The potential yield of CP, NDF and ADF for the different phenological phases and treatments is summarized in Table 1.

Values at EF are common for T1 and T2. In general, mixtures give better responses than pure stands for CP production, especially for L25P75.

On average, annual CP was higher in T2 than T1 while NDF and ADF contents were higher in T1 than T2 due to the lower cut frequency and also for the drop of quality of the grass component CP annual production ranged from 533 kg in L100P0 to 1308 kg in L25P75 for T1. The CP content was higher in pure stands than mixtures, with L0P100>M100 (Fig.1). A similar range was observed for T2.

A positive interaction mixture x phenological stage of utilization was observed. The TDN concentrations were higher than those found for vetch and oats in pure stand or in mixtures by Carr *et al.* 2004 and Lithourgidis *et al.* 2006 (Table 2).

Table 1. CP, NDF, ADF production (kg ha^{-1}) in the pure stands, the grass-legume mixtures and the commercial legume mixture in relation to the phenological stage of utilization

	Crude protein (kg ha^{-1})				Neutral detergent fiber (kg ha^{-1})				Acid detergent fiber (kg ha^{-1})			
Thesis	**T1=T2**	**T1**	**T2**		**T1=T2**	**T1**	**T2**		**T1=T2**	**T1**	**T2**	
	EF	**PM**	**FF**	**PM**	**EF**	**PM**	**FF**	**PM**	**EF**	**PM**	**FF**	**PM**
L_0P_{100}	358^{c}	639^{c}	550^{c}	223^{nc}	293^{a}	2206^{ab}	444^{a}	727^{a}	176^{a}	1471^{ab}	277^{ab}	464^{a}
$L_{25}P_{75}$	448^{d}	860^{d}	481^{c}	292^{nc}	528^{b}	3047^{bc}	741^{c}	1523^{b}	311^{c}	1833^{bc}	397^{bc}	974^{b}
$L_{50}P_{50}$	270^{b}	583^{bc}	332^{b}	275^{nc}	484^{b}	3827^{c}	655^{ab}	1624^{b}	238^{b}	2172^{c}	337^{abc}	814^{b}
$L_{75}P_{25}$	256^{b}	551^{abc}	444^{bc}	241^{nc}	322^{a}	3614^{c}	691^{c}	1930^{b}	166^{a}	1848^{bc}	373^{bc}	1108^{b}
$L_{100}P_0$	105^{a}	428^{ab}	167^{a}	276^{nc}	355^{a}	2908^{bc}	447^{a}	1824^{b}	174^{a}	1762^{bc}	428^{c}	965^{b}
M_{100}	296^{bc}	366^{a}	499^{c}	257^{nc}	296^{a}	1603^{a}	647^{ab}	768^{a}	174^{a}	1133^{a}	223^{a}	269^{a}

EF = early flowering; FF = full flowering; PM = pod maturing; for EF: T1 = T2.
Different letters in a column mean significant differences at P≤0.05.

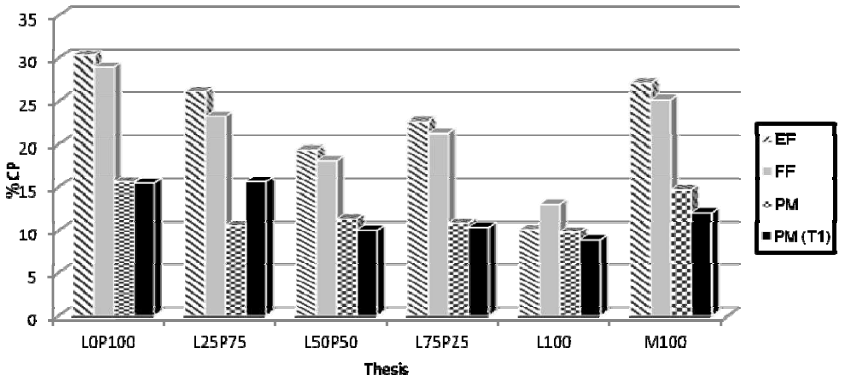

Fig. 1. CP content (%) in the pure stands, the grass-legume mixtures and the commercial legume mixture for the different phenological stages. EF = early flowering; FF = full flowering; PM = pods maturing; for EF: T1 = T2.

Table 2. TDN, DMI, DDM content in the pure stands, the grass-legume mixtures and the commercial legume mixture in relation to the phenological stage of utilization

	Total digestible nutrients %				Dry matter intake %				Digestible dry matter %			
Thesis	**T1 = T2**	**T1**	**T2**		**T1 = T2**	**T1**	**T2**		**T1 = T2**	**T1**	**T2**	
	EF	**PM**	**FF**	**PM**	**EF**	**PM**	**FF**	**PM**	**EF**	**PM**	**FF**	**PM**
L_0P_{100}	82.1	55.5	82.6	59.5	4.9	2.3	5.1	2.4	77.3	61.2	77.6	63.6
$L_{25}P_{75}$	78.0	58.4	76.7	56.0	3.9	2.2	3.4	2.0	74.8	63.0	74.3	61.5
$L_{50}P_{50}$	78.5	53.3	76.0	58.1	3.5	1.8	3.2	1.8	75.1	59.9	73.6	62.8
$L_{75}P_{25}$	82.5	56.7	76.8	56.0	4.2	1.8	3.4	2.0	77.5	62.0	74.1	61.5
$L_{100}P_0$	79.9	54.4	78.8	57.3	3.5	2.0	3.4	1.8	75.9	60.6	75.1	62.3
M_{100}	80.8	53.3	73.5	64.0	4.4	2.3	3.7	2.6	76.5	59.9	72.1	66.4

EF = early flowering; FF = full flowering; PM = pod maturing; for EF: T1 = T2.

Being the TDN negatively related with ADF, as ADF increases animals are less capable to utilize the forage. Relative Feed Value provides a fast interpretation to evaluate the forage quality because it combines potential intake and digestibility (Table 3). Forage with RFV >151 is classified as "first-class" (Horrocks and Vallentine, 1999) as shown at EF and at FF cuts. L0P100 reached the highest RFV, above 33% more than M100 confirming the high quality of *M. polymorpha* Anglona. Also NE_l its an important factor formulating a balanced diet and it is a more comprehensive measure of energy than TDN. For all treatments, NE_l was higher than NE_l described for vetch and triticale or oat in pure stands or in mixture (Lithourgidis *et al.* 2006). Average NE_l PM T2 treatments is higher (about 10%) than T1 treatments.

Table 3. RFV value and Net energy for lactation in the pure stands, the grass-legume mixtures and the commercial legume mixture in relation to the phenological stage of utilization

	Relative feed value N°				Net energy for lactation Mcal kg^{-1}			
Thesis	**T1=T2**	**T1**	**T2**		**T1=T2**	**T1**	**T2**	
	EF	**PM**	**FF**	**PM**	**EF**	**PM**	**FF**	**PM**
L_0P_{100}	291	107	305	116	1.912	1.369	1.920	1.451
$L_{25}P_{75}$	226	106	193	95	1.828	1.429	1.801	1.381
$L_{50}P_{50}$	202	85	180	88	1.837	1.326	1.788	1.423
$L_{75}P_{25}$	254	85	196	94	1.918	1.394	1.804	1.380
$L_{100}P_0$	208	94	201	89	1.865	1.347	1.844	1.408
M_{100}	263	106	206	136	1.885	1.326	1.737	1.543

EF = early flowering; FF = full flowering; PM = pod maturing; for EF: T1 = T2.

IV – Conclusions

In the search for solutions able to maximize the environmental resources such as water, nutrients and light to productivity aims, the mixtures are an important alternative to the pure stands. The positive grass/legume interaction on the efficiency dynamics of Nitrogen as mutual stimulatory effects on the N acquisition is important for sustainable agricultural systems (Nyfeler 2011). The results show that mixtures with *M. polymorpha* and *L. rigidum*, besides to forage production (data not showed) assure a more seasonally-balanced quality of forage with respect to the pure stands. Positive effects are obtained thanks to the different complementary functionality of the two species ensuring appreciated CP productions in winter when the legume components exhibit slow of growth rate and in late spring, when the grass quality drops quickly.

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