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Forage species for long duration artificial mixtures characterised by different complexity

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SUMMARY – In marginal lands under Mediterranean climatic conditions it is very important to create long duration grasslands characterised by species adapted to the environment and with good and stable production. In an area of south Tuscany, on a public farm managed to maintain the local cow breed "Maremmana", a trial was carried out comparing three forage mixtures characterised by different composition over a four-year period. Data collection concerned the evolution of the sown species and weeds, the productivity and the quality of each mixtures studied. Best results were found in the most complex mixture, concerning DM production, forage quality and stability of a more balanced equilibrium among sown species.

Keywords: Dry matter yield, quality, mixtures, grasses, legumes.

RESUME – *"Espèces fourragères pour des mélanges artificiels de longue durée caractérisés par une complexité différente". Dans les milieux marginaux avec un climat méditerranéen, il est très important de réaliser des prairies de longue durée avec l'utilisation d'espèces bien adaptées aux conditions environnementales. Dans ce but une expérimentation a été menée dans la Toscane du Sud dans une exploitation qui, depuis quelques années, a mis au point un programme de conservation et de valorisation de la race bovine "Maremmana". Trois mélanges fourragers ont été comparés. Une évaluation de la composition botanique, de l'offre de matière sèche et de la qualité du fourrage a été faite. Les résultats ont mis en évidence la supériorité du mélange à plusieurs composantes aussi bien pour le rendement en matière sèche que pour la qualité et pour le maintien de l'équilibre entre les espèces semées.*

Mots-clés : *Production, qualité du fourrage, mélanges, graminées, légumineuses.*

Introduction

It is a matter of fact that in Mediterranean environments one of the most important problems of natural forage production is the strong irregularity of forage availability, with a surplus in spring and a remarkable gap during summer (Piano and Talamucci, 1996). Moreover, the soils are often characterised by a reduced fertility and the most of these areas present marginal conditions from the economical and social points of view. Nevertheless, due to their great diffusion, it is impossible to hypothesize for them a general abandon and an extensive system of animal husbandry can be a tool for their valorisation, provided that rough animal breeds or proper vegetal materials are used. To achieve such results, it is important to establish artificial grasslands that can reduce the productive gaps and contribute to territory protection (Porqueddu *et al.*, 2004). In these cases, to face the difficult environmental conditions, it is suggested the use of complex mixtures instead of simple ones (Franca *et al.*, 2007).

To produce useful data in these features for marginal Mediterranean lands, a research was carried out with the aims of identifying mixtures for grassland establishment characterised by a good and stable production and an acceptable quality of the forage.

Materials and methods

The experiment was carried out in an area in the South Tuscany in a public organic farm managed to maintain the local cow breed "Maremmana". The trial site was a clay-sandy soil (pH 7.8) with a

reduced presence of nutritive elements and organic matter. The climate was a Mediterranean type, with an annual average rainfall of 885 mm and an average temperature of 13.8°C.

Three mixtures of different complexity were compared as follows: mixture 1 (*Medicago sativa* 50% and *Festuca arundinacea* 50%), mixture 2 (*Dactylis glomerata* 30%, *Festuca arundinacea* 20%, *Medicago sativa* 30% and *Onobrychis viciifolia* 20%) and mixture 3 (*Festuca arundinacea* 30%, *Dactylis glomerata* 23%, *Lolium multiflorum* 17%, *Onobrychis viciifolia* 17.5%, *Medicago sativa* 5%, *Lotus corniculatus* 5% and *Trifolium repens* 2.5%). The seeding was executed in October 2003 with a rate of 60 kg ha^{-1} for each mixture. Basic dressing was constituted by 40:60:60 kg ha^{-1} of NPK and top dressing was performed only for the firsts two years using 700 kg ha^{-1} of poultry manure. The trial was arranged as a completely randomised blocks design with four replications and each plot was 500 m^2 wide. Data collection was ended on June 2007 and it concerned floristic composition according to Daget and Poissonet (1969), DM yield, performed with cut of sample areas during late spring (1 m^2) and quality of obtained forage samples. Data were analysed through ANOVA and means comparisons were executed through the Duncan test.

Results and discussion

Average specific contributions for every year for all sown species and weds encountered in the floristic analysis were calculated (Table 1).

Table 1. Annual average specific contributions (%) of sown species and weeds for each mixture

Species	2004	2005	2006	2007
Mixture 1				
Sown grasses	42 ab	42 ab	52 a	33 b
Sown legumes	5 b	12 ab	6 b	13 a
Other species	53 a	46 ab	42 b	54 a
Mixture 2				
Sown grasses	49 a	56 a	50 a	32 b
Sown legumes	12 ns	16 ns	14 ns	18 ns
Other species	39 ab	28 b	36 b	50 a
Mixture 3				
Sown grasses	52 a	48 ab	41 b	30 c
Sown legumes	26 ns	36 ns	32 ns	31 ns
Other species	22 b	16 b	27 ab	39 a

Values in the same row with the same letter do not differ significantly at p<0.05.

In the simplest mixture weeds were present in a remarkable way just from first year (53%) and they maintain high values also for the following years. *Medicago sativa* produced unsatisfactory results in all years, whereas *Festuca arundinacea* performed in a very good manner and only at the end of the trial period it showed a significant reduction of its presence. The mixture was so characterised by a low competitive vigour against intrusive species and the reason of that is in the very simple original composition that was not very suitable to difficult environments and in the different behaviour of the two used species. Mixture 2 performed in a very similar way to the former as grasses and weeds contributed strongly to botanical composition and legumes presented only a moderate contribution (15% in the average) without any significant variation among years. In the most complex mixture sown grasses were highly present after the establishment but after that they showed a continuous decrease, especially in the last two years. This permitted to weeds to increase their presence (39% at the end) but at a level not comparable to other mixtures. In this case legumes showed remarkable values (31% in the four years average) even if the percentage in the original composition was lower than other mixtures. We can state that at the end of the trial the composition was strongly changed, especially in mixtures 1 and 2, and in these cases weeds resulted particularly aggressive taking also into account the reduced presence of legumes. On the contrary, mixture 3

produced a more balanced composition and a more stable presence of sown species, overall at the end of the period of study in comparison to mixtures 1 and 2.

Table 2 reports data of percentage of presence (referred to the total of sown species) for each species present in different mixtures.

Table 2. Annual average percentage of presence of each sown species

Species	2004	2005	2006	2007
Mixture 1				
Festuca arundinacea	89 a	78 ab	90 a	72 b
Medicago sativa	11 b	22 ab	10 b	28 a
Mixture 2				
Dactylis glomerata	41 a	37 a	20 b	5 c
Festuca arundinacea	39 b	41 b	59 a	59 a
Medicago sativa	7 ns	8 ns	7 ns	10 ns
Onobrychis viciifolia	13 b	14 b	14 b	26 a
Mixture 3				
Dactylis glomerata	19 ab	24 a	14 bc	6 c
Festuca arundinacea	14 b	20 b	41 a	40 a
Lolium multiflorum	34 a	13 b	2 c	3 c
Medicago sativa	1 b	2 b	4 b	9 a
Trifolium repens	14 ab	20 a	17 a	7 b
Onobrychis viciifolia	8 b	8 b	14 ab	19 a
Lotus corniculatus	10 ab	13 ab	8 b	16 a

Values in the same row with the same letter do not differ significantly at p<0.05.

The simplest mixture was dominated by *Festuca arundinacea* which presented a good establishment and a high capacity to persist along years. The same behaviour was observed for this species in all mixtures in which it was present. *Dactylis glomerata*, though highly present in the original composition, showed behaviour rather opposite to *Festuca*, with a strong presence at the beginning and a high tendency to reduce its occurrence, especially in mixture 2. As expected, *Lolium multiflorum* was highly useful at the beginning for its fast soil cover. Among legumes, *Medicago sativa* produced results definitely lower than other species. Even if it is not easy to explain such performance, the reduced presence of this legume was replaced by *Trifolium repens*, which was suitable to fill the open spaces among tall grasses plants, and by *Lotus corniculatus*, that, thanks to its progressive germination, increased its presence throughout years and demonstrating its suitability for the constitution of complex mixtures. The same behaviour was observed for *Onobrychis viciifolia* which deserves a better utilisation in these kinds of resources.

The DM production was higher in mixture 1, where *Festuca arundinacea* dominated the canopy, and in mixture 3, where the great number of species involved permitted to obtain the best synergy from all the components (Table 3). On the contrary, the lower value of DM yield was that observed for mixture 2.

For all studied mixtures the DM yield was rather low and not comparable to those obtainable in more productive environments.

Qualitative analysis showed that some parameters are not significantly different among mixtures, such as crude fibre and ADF. On the contrary, significant differences were observed for the crude protein content, which was higher in more complex mixtures due to the greater presence of legumes. The mixtures showed a different behaviour concerning the NDF, which was lower in mixture 2, and in rate of lignin, which was in relation to the number of the components of the mixtures.

Table 3. Annual average values of productive and qualitative data for each mixture

	Mixture 1	Mixture 2	Mixture 3
DM production (t ha^{-1})	3.11 ab	2.58 b	3.46 a
Ash (%)	7.6 b	8.7 a	7.1 c
Crude protein (%)	6.4 b	7.6 ab	8.9 a
Crude fibre (%)	26.6 ns	25.4 ns	25.3 ns
NDF (%)	56.1 a	52.4 b	58.3 a
ADF (%)	39.2 ns	39.6 ns	39.9 ns
ADL (%)	6.1 c	7.3 b	8.3 a

Values in the same row with the same letter do not differ significantly at $p < 0.05$.

Conclusions

The four years trial permitted to study the suitability of some forage species to be used for the establishment of long duration artificial grasslands in a Mediterranean environment.

The higher soil cover obtained by the most complex mixture and the different vegetative rhythm contribute to enhance the competitive ability of this mixture against weeds. This was obtained both through species rapid in establishment such as *Lolium multiflorum*, and through species characterised by strong persistence, such as *Festuca arundinacea* or *Lotus corniculatus*. The result was a more balanced forage and a more equilibrated botanical composition, even at the end of the observation period. At the same time the most complex mixture was one of the more productive in terms of DM yield, even if the qualitative profile was not different from other mixtures in a remarkable way. This topic remains one of the more critical point from the moment that all the mixtures did not produce high level forage from the qualitative point of view.

Concerning single species, the experiment showed the strong suitability of *Festuca arundinacea* to these environments but, at the same time, its strong ability to the competition when well established can create some risks in maintaining a good balance among components in very simple mixtures, like that studied in this research, when one of the sown species presents some problems that reduce its presence. *Dactylis glomerata* showed behaviour rather opposite to *Festuca arundinacea* and this can suggest the increase of seeding rate for this particular species. Of a remarkable interest were the tested legumes which, with the only exception of lucerne, can be used with success in these marginal conditions and in situations characterised by low inputs and extensive systems of utilisation.

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