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# Burr medic: An annual legume in Mediterranean sheep systems

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**SUMMARY** – The introduction of self-regenerating species in Mediterranean forage systems is an important tool for sustainable production, due to their high adaptation to grazing and high seed production. In order to assess the suitability of *Medicago polymorpha* L. (burr medic) for dairy sheep systems, under rainfed Mediterranean conditions, its forage availability and quality were tested under grazing in a three year trial (1997-2000) carried out on an area of 6 hectares belonging to an organic dairy sheep system, mainly based on forage legumes. Three hectares of burr medic, one in the year of sowing (BM) and two in the first (BM1) and second (BM2) year of regeneration, were rotationally grazed throughout the year by 24 Sarda dairy ewes. The grazing started when average dry matter availability was, at least, 1 t/ha. In late spring BM and BM1 were rested during the flowering stage to assure reseeding. Dry matter availability was, on average, 1.5 t/ha during winter and 4.2 t/ha during spring. The spread of weeds was higher in BM1 and in BM2 (29% and 51% of the total dry matter on offer, respectively) than in BM (8%). The crude protein level in the green forage ranged between 25%, in winter and 21%, in spring. The pod production was high and assured a large seed bank and, in the meantime, represented an important feed resource during the dry season due to its quality. Milk yield, during the grazing period, ranged between 1,610 g/ewe/day in winter and 1,510 g/ewe/day in spring. The burr medic, in the Mediterranean environment and under this grazing management, represents sustainable forage thanks to its good herbage yield, high quality and long persistence. It also allows good animal performance.

**Key words:** Dairy sheep, grazing, self-regenerating legumes, forage quality.

***RESUME –*** *"*Medicago polymorpha *: Une luzerne annuelle pour les systèmes ovins méditerranéens". L'introduction dans les systèmes fourragers méditerranéens d'espèces capables d'autoréensemencement représente un outil intéressant pour assurer une production durable grâce à leur bonne adaptation au pâturage et à la production élevée de semences. Dans le but d'évaluer les avantages* de Medicago polymorpha *L. pour les systèmes ovins laitiers, dans les milieux méditerranéens non irrigués, la disponibilité et la qualité de cette plante fourragère ont été étudiées, en conditions de pâturage, pendant trois années d'essai (1997-2000), sur une superficie de 6 hectares à l'intérieur d'un système biologique de brebis essentiellement basé sur l'utilisation de légumineuses. Trois hectares de* M. polymorpha*, un en année de semis (BM), et un en première (BM1) et un en seconde (BM2) année de réensemencement, ont été utilisés en pâturage tournant pendant toute l'année par 24 brebis laitières de race sarde. La période de pâturage débutait lorsque la disponibilité moyenne de matière sèche était d'environ 1 t/ha. En fin de printemps BM et BM1 ont été mis en défens pendant la floraison pour assurer le réensemencement. La disponibilité en matière sèche a été, en moyenne, de 1.5 t/ha pendant l'hiver et 4.2 t/ha au printemps. La proportion d'adventices a été plus importante en BM1 et en BM2 (29% et 51% sur le total de matière sèche offerte, respectivement) plutôt qu'en BM (8%). La protéine brute dans le fourrage vert variait entre 25%, en hiver, et 21%, au printemps. La production de gousses, très élevée, a assuré une importante réserve de semence et, en même temps, les gousses ont représenté, par leur bonne qualité, une importante ressource alimentaire pendant la saison sèche. La production de lait, pendant la période de pâturage, a varié entre 1610 g/brebis/jour, en hiver, et 1510 g/brebis/jour, au printemps.* M. polymorpha*, utilisée en milieu méditerranéen et en pâturage rotatif, garantit une ressource fourragère soutenue et soutenable grâce à sa production d'herbe élevée en quantité et en qualité et à sa bonne persistance. Elle assure aussi de bonnes performances animales*

***Mots-clés :*** *Brebis laitière, pâturage, légumineuse annuelle, réensemencement, qualité du fourrage.*

## Introduction

Forage legumes have been suggested as important components of low input, sustainable systems for livestock production and in the last years their importance is increasing principally because of their ability to fix atmospheric nitrogen biologically. Then, they represent an important tool in organic agriculture. These species can also be envisaged as colonizers in order to restore marginal lands

from degradation and erosion (Porqueddu and Sulas, 1998). Moreover, legumes are important in farming systems because of their higher nutritive value than other forages due to high crude protein and digestibility. The introduction of self-regenerating legume pastures in rotation with short-term winter forage crops represents an evolution of the traditional cereal farming system (Fois *et al*., 1996) that could become a low input or biological system thanks to the strongly persistence of the seed bank. *Medicago polymorpha* L. (burr medic) is a self-regenerating species, native of Mediterranean area, well adapted to sub-acid-alkaline soils (Loi *et al*., 1995), characterised by high quality forage in winter-spring period (Sitzia *et al*., 2000) and also in summer due to the high pod production that could be grazed by ewes (Fois *et al*., 2000a), and also allows a persistence of the species.

The aim of this experiment was to test the sustainability of a dairy sheep forage system under Mediterranean conditions and with 50% of the surface cultivated with burr medic.

## Materials and methods

The trial was carried out in the years 1997-2000 at the Bonassai Research Station (NW Sardinia Italy, 41° N latitude), on flat clay calcareous soil, with pH 7.5, low N and $P_2O_5$ and adequate $K_2O$ contents. The climate of the area is Mediterranean with an average annual rainfall of 590 mm. Three one-hectare paddocks, of *Medicago polymorpha* L. cv. Anglona, belonging to an organic 6 ha farming system trial (Fois *et al.* 2000b), were rotationally grazed by 24 Sarda dairy ewes (45±0.8 kg live weight). Every year the paddocks consisted in burr medic in the year of sowing (BM, sowed in October at seeding rates of 40 kg/ha), burr medic in the first year of regeneration (BM1) and burr medic in the second year of regeneration (BM2). Each autumn the swards were fertilized with 92 kg/ha of $P_2O_5$. In spring the BM and BM1 were rested to allow a self-reseeding at the beginning and in the middle of the flowering stage, respectively.

### Sward measurements

At the beginning of the grazing period sward height (SH, weighted plate), dry matter availability (DMA, cutting twelve 0.5 $m^2$ quadrats per hectare) and its partitioning (burr medic-weeds) were measured. The quality of total herbage on offer was assessed for dry matter (DM), crude protein (CP) and neutral detergent fibre (NDF), acid-detergent fibre (ADF) and acid-detergent lignin (ADL) content (AOAC, 1990). Pod and stubble availability (6 quadrats of 0.25 $m^2$ per hectare) and their chemical composition were measured in June when pods were fully mature in the BM and BM1.

### Animal measurements

The ewes, all belonging to the Sarda breed, were machine-milked twice daily. Grazing season started in autumn and was restricted to 8 hours per day during winter when the ewes were housed overnight receiving hay (500 g/head/day) and peas (230 g/head/day) as supplements. Live weight (LW) and body condition score (BCS) were measured monthly; milk yields were weighted daily and individual milk yield, its fat and protein (N x 6.38) contents by infra-red method (milko-scan) were measured monthly. Milk urea was measured, on bulk milk, during 1999-2000 (differential pH-metry).

## Results and discussion

The average rainfall was 482, 564 and 650 mm in 1997/98, 1998/99 and 1999/00 respectively, and it resulted similar to the thirty years average rainfall of the site. Seasonal rainfall distribution was 44% in autumn, 22% in winter, 27% in spring and 7% in summer.

In BM the sward grazing management started on average 135 days after the sowing, in BM1 and BM2 67 and 33 days after the seed germination, respectively. SH at the first utilization were 17.8±4.20, 10.7±1.90 and 9.3±0.08 cm corresponding to DMA of 2.1±0.37, 1.5±0.09 and 1.2±0.11 t/ha, respectively in BM, BM1 and BM2. The sward height increased during the grazing season, and it was linearly correlated with DMA as reported by Sitzia *et al* (2000).

The spreading of not sowed species, mainly represented by thistles and grasses, on average was higher in BM1 and in BM2 (29% and 51% of the DMA, respectively) than in BM (8%). This was probably due to the 1-2 years accumulation of N in the soil; this raise of N was in favour of species adapted to high fertility (Piano and Talamucci, 1996). The herbage mass increased from autumn to spring following the typical Mediterranean pattern growth rate (Table 1). The herbage allowance ranged between 4.3 and 9.4 kg/head/day and it was relatively high throughout all the experiment and did not represent a limit to intake at pasture (Freer *et al.*, 1997).

Table 1. Three years average (means±*s.e.*) sward height (SH), dry matter availability (DMA), weed mass and number of grazing days (GD) of the burr medic on offer in autumn (A), winter (W) and spring (Sp)

| | | BM | | | BM1 | | | BM2 | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | A | W | Sp | A | W | Sp | A | W | Sp |
| SH | cm | - | 12.9 | 19.7 | 12.3 | 10.6 | 24.7 | 10.4 | 8.2 | 25.2 |
| | | | *0.82* | *0.84* | *0.66* | *0.56* | *1.70* | *0.51* | *0.65* | *1.97* |
| DMA | t/ha | - | 2.0 | 4.2 | 1.5 | 1.9 | 4.7 | 1.6 | 1.5 | 4.3 |
| | | | *0.13* | *0.26* | *0.06* | *0.11* | *0.25* | *0.09* | *0.14* | *0.29* |
| Not sowed species | t/ha | - | 0.2 | 0.4 | 0.2 | 0.4 | 1.5 | 1.0 | 0.6 | 2.2 |
| | | | *0.03* | *0.07* | *0.06* | *0.05* | *0.17* | *0.08* | *0.07* | *0.21* |
| GD | n | - | 9 | 14 | 5 | 19 | 21 | 21 | 14 | 10 |

The chemical composition of the forage was good throughout the years, and it was characterized by high CP level and low NDF content. In BM the quality was higher than in BM1 and BM2 because of the less incidence of weed. In spring, when the species switched into the reproductive stage, there was a quality decay particularly in BM and BM1 (Table 2).

Table 2. Three years average (means±*s.e.*) chemical composition of the dry matter availability (DMA): CP, NDF and ADL in autumn (A), winter (W) and spring (Sp)

| | | BM | | | BM1 | | | BM2 | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | A | W | Sp | A | W | Sp | A | W | Sp |
| CP | %DM | - | 29.6 | 25.6 | 29.5 | 25.5 | 18.5 | 21.9 | 23.0 | 20.3 |
| | | | *1.20* | *1.81* | *1.73* | *0.84* | *1.92* | *1.12* | *1.52* | *1.59* |
| NDF | %DM | - | 33.0 | 37.8 | 39.5 | 37.6 | 47.8 | 44.1 | 48.9 | 45.2 |
| | | | *0.95* | *2.29* | *0.36* | *1.17* | *3.26* | *0.86* | *2.56* | *1.39* |
| ADF | %DM | - | 20.9 | 24.4 | 25.5 | 23.9 | 31.4 | 28.6 | 30.1 | 25.8 |
| | | | *0.90* | *1.70* | *0.33* | *0.62* | *2.78* | *0.83* | *1.88* | *0.25* |
| ADL | %DM | - | 5.0 | 5.3 | 7.2 | 7.0 | 6.6 | 7.4 | 7.9 | 4.4 |
| | | | *1.38* | *0.62* | *0.17* | *0.74* | *1.05* | *0.46* | *0.53* | *0.73* |

The burr medic pods and stubbles showed an interesting chemical composition (Table 3), and their DMA allowed maintaining the animals during the summer without compromising the seed bank. In fact, considering the pod consumption of 1200 g DM/head/day (Fois *et al.*, 2000a), after 60 days of grazing, BM and BM1 reseeding capacity was not affected (data not shown).

Table 3. Three years average (means±*s.e.*) dry matter availability and chemical composition of pods and stubble

| | DMA t/ha | DM (%) | CP (% DM) | NDF (% DM) | ADF (% DM) | ADL (% DM) |
|---|---|---|---|---|---|---|
| Pods | 2.3 | 91.6 | 21.8 | 54.2 | 37.4 | 10.6 |
| | *0.60* | *0.92* | *0.74* | *2.78* | *2.17* | *0.93* |
| Stubble | 6.8 | 84.5 | 10.4 | 61.2 | 44.9 | 9.6 |
| | *0.52* | *3.43* | *0.89* | *3.71* | *2.93* | *0.01* |

## Animal performances

Live weight (LW) and body condition score (BCS) results are shown in Fig. 1. The three-year average for LW and BCS were 48.2±0.90 kg and 2.73±0.02, respectively. The BCS reached a minimum during the first month of lactation (2.59±0.03) and the maximum value in May (2.84±0.02).

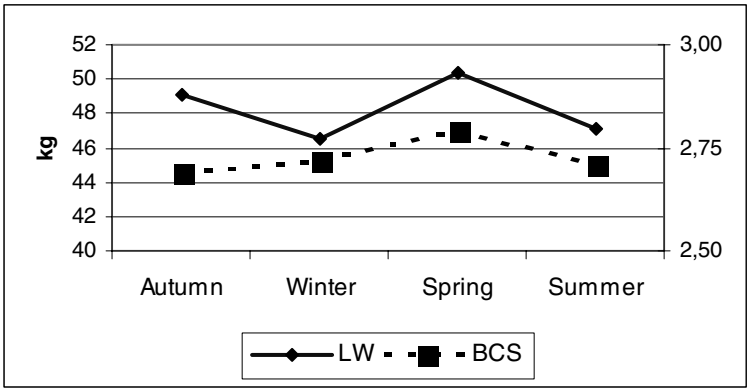


Fig. 1. Average live weight (kg, LW) and body condition score (BCS) measured in the flock during the three years trial.

Average milk yield, during the grazing period in the burr medic, ranged between 1,610±0.03 g/ewe/day, in winter and 1,510±0.02 g/ewe/day, in spring. The three year average milk production in the studied system resulted 237±12 kg/head, fat and protein content resulted 6.35%±0.52 and 5.67%±0.29, respectively. Milk urea of the burr medic in bulk milk was 59±2.21 mg/100 ml (range 51–68 mg/100 ml) these values being in good agreement with results found by Molle *et al*. (2002). They found that ewes grazing on burr medic produced more milk (+10%) than ewes grazing on annual ryegrass but with higher milk urea (58 vs 41 mg/100 ml). Cannas (2002) suggests that urea level, in sheep milk, higher than 60 mg/100 ml is associated to an excess of protein intake, poor health status and higher energy cost to eliminate the crude protein in excess. Nevertheless, no particular health problems were recorded in the organic flock during the three years study.

The annual pattern of sheep energy requirements [French Feed Units: UFL (INRA, 1988)] and the energy derived from pasture are reported in Fig. 2. The pasture covered almost all the total energy requirements of the animals, in particular it covered more than 90% in spring and summer, whereas about 73% during autumn and winter.

The annual feeding pattern of the flock at pasture shows that during the lambing and the first period of lactation burr medic represents about 61% of the total energy derived from pasture, and 67% in summer during the dry period (Fig. 3).

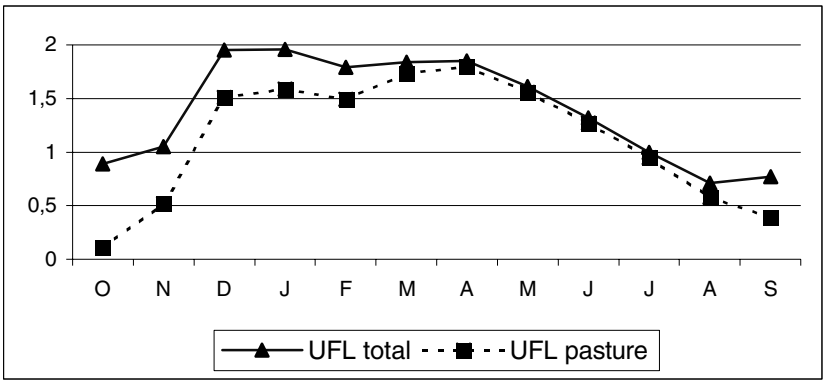


Fig 2. Annual average ewe energy requirements (UFL) and energy from pasture (UFL) calculated in the organic farming system.

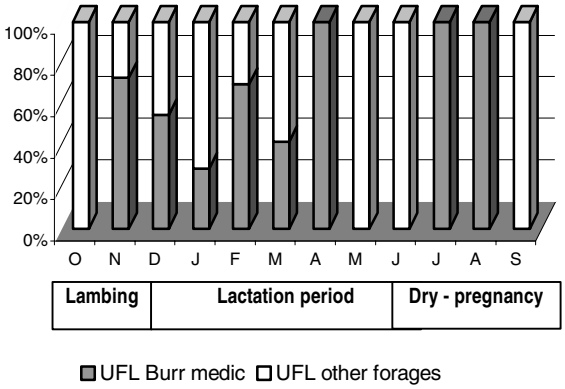


Fig. 3. Annual feeding pattern of the flock at pasture (% of UFL).

## Conclusions

The burr medic, in the Mediterranean environment and under this grazing management, represents a forage that, due to its good herbage yield, high quality and long persistence, could improve the system sustainability. One of the main problems is represented by thistles spreading due to the high burr medic nitrogen fixation, in particular on BM1 and BM2. Seeding the burr medic in mixture with a non legume forage could be a tool to reduce nitrogen accumulation in the soil and, also to improve the nutritional value of the herbage grazed by animals.

In order to assure the self-regeneration, that is a crucial aspect for self-reseeding species persistence and for the system sustainability, the burr medic in the year of sowing has to be rested in spring when the sward reach the pick production, but at the meantime the high quality pod and stubble represent an important feed resource for grazing ewes during summer.

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