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Forage chicory:
A valuable crop for Mediterranean environments

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RESUME – *"La chicorée fourragère : Une précieuse culture pour les milieux méditerranéens". La chicorée (*Cichorium intybus L.*) est une espèce spontanée connue depuis l'antiquité et utilisée comme légume, café et herbe médicinale mais elle est une culture fourragère relativement nouvelle. Un essai a été commencé en Sardaigne pour évaluer le niveau productif et la qualité d'un écotype local et de deux variétés commerciales de chicorée soumises à deux différentes fréquences de fauche. Les résultats préliminaires ont montré que cette espèce est très productive et utilisable dans les milieux secs de la Sardaigne. Pour ces intéressantes caractéristiques la chicorée fourragère représente une culture prometteuse en complémentation et / ou comme alternative aux fourragères traditionnels. Des essais à long terme s'avèrent nécessaires pour confirmer ses performances et pour évaluer le germoplasme local.*

Mots-clés : Cichorium intybus *L., rythme de croissance, production fourragère, composition chimique.*

Introduction

Chicory (*Cichorium intybus* L.), a perennial herb of the Asteraceae family, has a long history and utilisation (Nieddu *et al.*, 1999), in many parts of the world : for salad, coffee additive or substitute and medicinal uses. The plant roots contain large quantities of inulin, a polysaccharide alternative to sucrose and high carbohydrate concentrations of roots can be used for ethanol production by direct fermentation.

Although its natural distribution in many countries of Europe and also in Italy (Pignatti, 1982), forage chicory is a relatively new forage crop. In fact, much of the breeding for improved forage characteristics has been done in New Zealand, where the variety Puna has been developed under grazing conditions (Hume *et al.*, 1995). Other chicory varieties are being developed and evaluated in New Zealand and other countries.

Forage chicory is suited to be grown on well-drained or moderately drained soils with medium to high fertility and a pH of 5.5 or greater. Chicory has good seedling vigour and a relatively deep taproot which provides tolerance to drought and high uptake of mineral elements.

Chicory produces leafy growth which, if managed properly, is similar in nutritive value to lucerne (Moloney and Milne, 1993), but the mineral content is superior copper and zinc. Liveweight gains can be as high as those obtained with perennial ryegrass/white clover mixtures. Its forage is highly palatable to livestock. Recently, forage chicory is being studied for its bioactive compounds, such as tannins (Piluzza, personal communication) or sesquiterpene lactones, which can reduce nematode infection in animals.

Chicory is usually grazed, but can also be used to improve the quality of a silage mixture. For optimum performance and persistence, it should be rotationally strip grazed, or machine harvested (Li *et al.*, 1997). In New Zealand, optimum harvest height is 30 – 45 cm, leaving a stubble height of 5 cm. A rest period of 25-30 days between harvests is required.

Due to these important attributes, forage chicory can be considered as an interesting or additional alternative to the traditional grass and legume forages.

In Sardinia, chicory is a common component of native flora; seed of wild chicory plants, growing as weeds in forage legume crops, after seed harvesting is used, sometimes, as a component of forage mixtures. The mixture of a local ecotype of chicory plus *Trifolium alexandrinum* is being very appreciated by shepherds for dairy sheep grazing.

Considering the interesting characteristics of forage chicory and in order to evaluate the possibility of its use under rainfed Sardinian conditions, a research work was started in Sardinia by the CNR Centre for Mediterranean Pastures.

The main objectives of this trial were to test adaptation capacity, growth rates, forage production and quality of three accessions of forage chicory and to define its possible role within Mediterranean forage farming systems.

The first year results are reported in this paper.

Materials and methods

The experiment was carried out in North-Sardinia (Italy) on flat clay-loam calcareous soil, pH 7.5 with low N and P_2O_5 content and adequate K_2O content. The climate of the area is semi-arid Mediterranean, with mild winters and average annual rainfall of 547 mm. Plots of the local ecotype Accalai, the commercial population Marrubiu and the New Zealand variety Puna were established in October 1999 at a sowing rate of 8 kg ha^{-1} of viable seed. Fertilisation was applied with 100 kg ha^{-1} of P_2O_5 at sowing while 100 kg ha^{-1} of N were subdivided in two applications (40 and 60 kg ha^{-1} of N respectively in autumn and early spring). Two management treatments were compared: simulated grazing (SG) by cutting every 28 days and undisturbed herbage accumulation (U) until the only cutting in late spring. Growth rates were determined according to the Corrall and Fenlon methodology (1978) slightly modified. The following data were collected: seedling establishment (no. m^{-2}), growth rates (kg ha^{-1} d^{-1} of DM), dry matter yield. Crude protein, neutral detergent fibre, acid detergent fibre, acid detergent lignin, ether extract and ashes of forage subsamples were determined.

Results and discussion

The total annual rainfall from September to August was 480 mm in the year 1999-2000, but, only 79 mm were recorded from January to April corresponding to 40% of mean values. Unusual rains of about 70 mm were recorded in June.

Emergence was regular and about 130 plants m^{-2} were recorded at the first cutting in the three accessions.

DM production

The amount of available dry matter allowing the first cutting was reached on February 2nd and 29th, and on March 29th, respectively for Accalai, Marrubiu and Puna. After the first cutting, weed contribution has been negligible. The examined materials showed a different winter growth capacity, being Accalai more productive with 0.6 t $ha^{-1}$of available dry matter after 116 days from sowing. The last cutting of the regrowths was made on July 4th for both treatments.

The growth rate trend of the seasonal yield (Fig. 1) showed a high peak value of Accalai in June, corresponding to more than 170 kg $ha^{-1}d^{-1}$ of dry matter. Spring peaks are very common for the vegetation of Mediterranean natural pastures, mainly based on annual species.

Marrubiu and Puna showed a different trend, Puna having the lower growth rates. In general, the length of the vegetative period in forage chicory resulted higher than that of conventional forage crops in the same area (data not shown). In fact, chicory enabled to fully exploit late rains in June and its yield is less affected by the drought periods, presumably, for the deep root systems.

Very huge dry matter yields (Fig. 2) were reached in two of the three accessions of chicory, confirming previous data obtained outside the Mediterranean countries. The forage production under cutting is about a half than that of the undisturbed plots, except for Accalai, where the yields of both treatments are similar because of its higher growth rates; it was almost surprising that the undisturbed plots of Accalai have produced only 17% more than the five times cut plots. Puna resulted the less productive under both treatments. The first year forage yields were relevant, considering the weather

trend (rainfall lower than average values and its irregular distribution), and also in comparison to those of other forages grown in the same area. The deep root system and the long growth cycle with a late flowering are important attributes to explain the success of these forage chicory accessions in Sardinia.

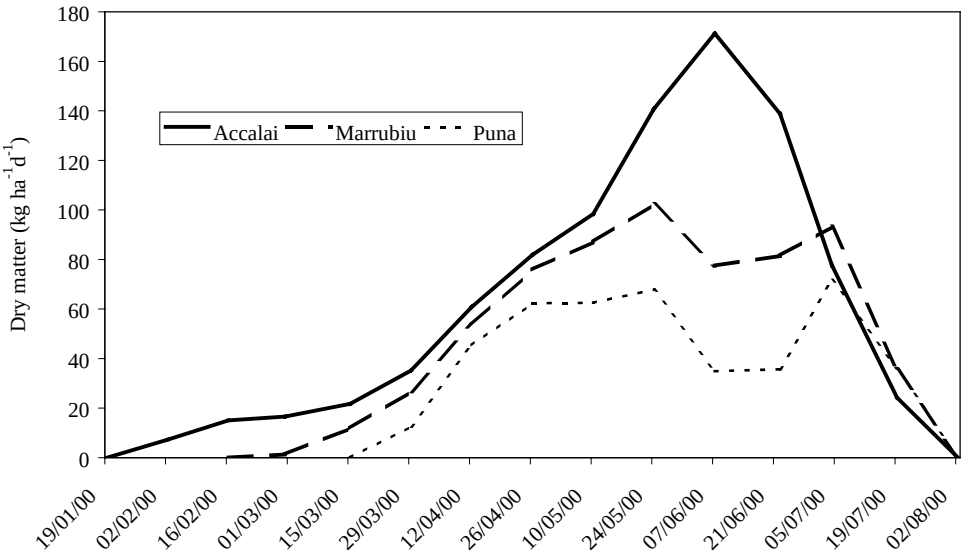

Fig. 1. “Corrall” seasonal yield trends of forage chicory.

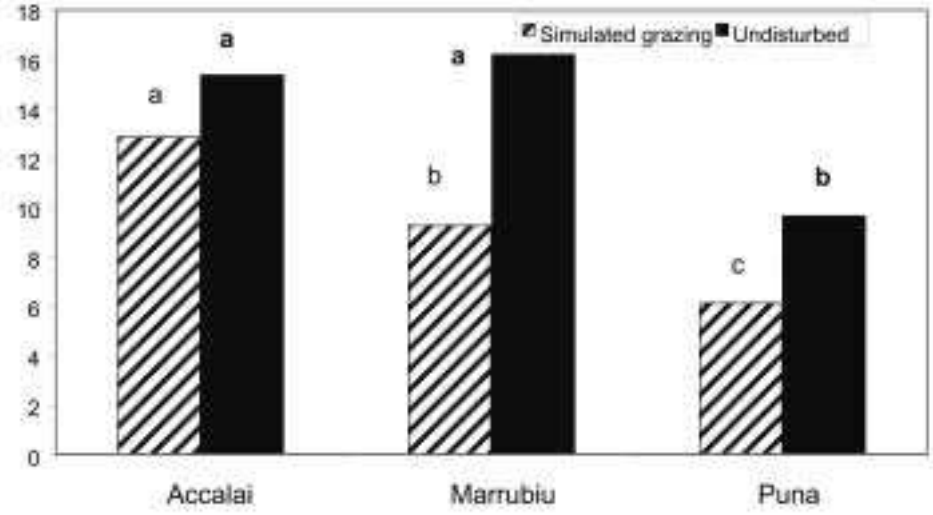

Fig. 2. Cumulative dry matter yield (t ha^{-1}).

Forage chemical composition

The percentages of dry matter were low during the season, except in the last cutting. In the cut plots, crude protein contents (Table 1) are not very high but stable without sharp decrement in late spring, while the amounts of neutral detergent fibre were moderate.

Table 1. Crude protein and neutral detergent fibre contents (% of DM) of the chicory forage

Month / Treatment		Crude protein			Neutral detergent fibre		
		Accalai	Marrubiu	Puna	Accalai	Marrubiu	Puna
Feb.	SG	22.1	-	-	29.9	-	-
Feb.	SG	21.4	18.3	-	25.8	24.4	-
Mar.	SG	21.4	24.8	24.3	28.6	34.2	32.3
Apr.	SG	18.5	19.5	21.5	35.1	36.6	36.9
May	SG	11.7	13.8	15.6	40.7	43.0	40.3
May	U	8.9	8.5	9.5	45.8	49.9	44.2

The comparison of both treatments at the same date showed differences, crude protein and neutral detergent fibre contents being more favourable under repeated cutting. Moreover, higher amounts of crude protein per hectare were produced in the cut plots than in the undisturbed ones, despite the lower dry matter yields.

Stand regeneration and persistence. In autumn 2000 and 2001, plants of Puna and Marrubiu were able to regrow and to persist, overcoming summer drought, even if their stand densities were reduced. However, Accalai proved to be an annual plant suggested that its sowing is required each year.

Conclusions

On the basis of the first year results, forage chicory appears to be a very interesting fodder crop for introduction in Sardinian forage systems. The high growth rates and yields, the favourable forage composition, the deep root system, the late flowering and good adaptation capacity are remarkable attributes of this species. Forage chicory can be regarded as an additional or alternative to the traditional grass and legume forages. Long-term trials are required to confirm its performances and local germplasm should be explored.

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