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*in*

Sulas L. (ed.).
Legumes for Mediterranean forage crops, pastures and alternative uses

Zaragoza : CIHEAM
Cahiers Options Méditerranéennes; n. 45

2000
pages 439-443

# The introduction of an annual pasture legume into a tree cropping system

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**Summary** - In Italy fields of vineyards and olive trees offer a potential to the introduction of an herbaceous crop into the tree system. This may have several advantages, but the presence of a canopy is particularly worth of interest in hilly lands where soils are prone to erosion. Here we suggest the use of annual pasture legumes. At this purpose 28 genotypes of *Medicago polymorpha* were evaluated in Perugia from 1995 to 1999 for soil cover, canopy growth, cold tolerance, biomass production, flowering time, seed yield, hardseededness and stand regeneration in autumn. Entries differed enormously for most of the characters considered, thus allowing a broad choice, depending on the need of the system.

**Key-words**: orchards, vineyards, olive tree crop, *Medicago polymorpha*, soil erosion

***Résumé*** - *En Italie, les vignes et les oliveraies pourraient être améliorées en introduisant des cultures herbacées dans le système de culture. Cette association présente plusieurs avantages mais le principal reste la protection des sols contre l'érosion en zones de relief. Afin de tester l'intérêt des légumineuses annuelles, 29 génotypes de* Medicago polymorpha *ont été testés à Perugia de 1995 à 1999 pour leur capacité à couvrir le sol, le développement de leur feuillage, la tolérance au froid, la production de phytomasse, la période de floraison, la production de graines, le taux de graines dures et la régénération en automne. Les résultats obtenus sont très contrastés pour la plupart de ces critères, ce qui fournit un large éventail de choix en fonction des exigences du système de culture concerné. Les résultats concernant la tolérance au froid et le degré de couverture du sol sont présentés.*

***Mots-clès:*** *fruticulture,* Medicago polymorpha, *erosion*

## Introduction

In Italy the agricultural mechanisation in the sixties eased the frequencies of soil ploughing. Nowadays an increasing number of scientists are suggesting that even in true Mediterranean conditions the soil protected by a grass canopy is often at an advantage. As a matter of fact, the basic principles of rainfed Mediterranean agriculture rely upon techniques capable to ensure most of the rainfall water to the main crop. The year of fallow in herbaceous specie, for example, partly replenish the water content of the soil. The soil during fallow is managed through several shallow ploughing to avoid a direct consumption of water and nutrients by weeds, lower their seed population in the soil and reduce water evaporation. The frequent ploughing in tree crops has the same objectives.

At present the management of soils is primarily a cost, and the cost of energy, for instance, is dramatically increasing. In addition, several small farmers are approaching organic farming, seeking with attention at sustainable systems. In hilly lands, where most of vineyards and olive trees are located, soils are prone to erosion. Farmers become aware that eroded soils would cause a reduction of yields (less total water content in the profile), with consequent possible change of crops and, eventually, be left partially abandoned. The presence of a grass canopy is now seen as a compromise, where a little reduction of yields is accepted provided they be maintained with time.

The advantages of protecting the soil by a grass canopy would appear only in the long period: organic residues would slowly increase the soil organic matter and this, in turn, improve infiltration and storage of water by time (Pagliai and Sequi, 1983). The passage of machine over a layer of grass (for treatments, harvesting, pruning, etc.) can be greatly improved (Gril and Cauler, 1985; Scienza *et al.*, 1988), particularly so in clay, wet soils. The increasing organic content will also benefit the soil structure, thus preventing soil compaction.

However, nowadays all benefits will be measured against the losses of yields due to plant competition. In this respect a key factor will be the choice of a suitable species to be used. The idea to use an annual pasture legume resides in the following considerations. Firstly being a legume is much less competitive than a grass against the main crop, because independent for nitrogen source. Secondly using annual species their life cycle will not overlap with that of the tree crop: the legume crop will be present when the tree species is dormant (or close to it), thus protecting the soils during the rainy season, exactly when they are very much exposed to erosion; the legume will be present as dormant seeds and dry residues during the summer, thus providing a sort of mulching which may reduce the losses of water evaporation from the soil. The seed dormancy, then, will ensure a spontaneous regeneration the following autumn without the need of resowing. After all that, the high quality biomass of the legume crop (as fresh forage and/or pods and seeds) could be a great opportunity for grazing animals.

The demand of protecting the soil is strongly emerging. Actually many farmers are reducing the number of ploughing, letting the soil be covered by the natural flora, mowing it at intervals and/or controlling it by herbicides. Experimentation are currently conducted with the objective to understand the most suitable agronomic practices to reduce competition between herbaceous species and the main crop. The use of the native flora is at no cost of seeding, but it may well comprise grasses and several dangerous perennial weeds which during the summer could strongly compete for water. The tentative of introducing Australian varieties of pasture legumes have in some cases failed due to a poor adaptation to the Italian environmental conditions. Cold winter temperatures seem to be the most important factor impeding a straightforward use of available seed in the market. A need of new varieties is therefore an important condition for a successful introduction of annual pasture legumes in vineyards and olive tree crops (Russi and Lorenzetti, 1999).

## Materials and Methods

Twenty-eight lines of *M. polymorpha* singled out in 1995/96 from 19 populations from central and southern Italy (Russi and Lorenzetti, 1999) were evaluated in dense stands in Perugia from 1996/97 to 1999/2000. Seeds were manually scarified and sown at a rate of 27 kg $ha^{-1}$ on 1st October 1996. The experimental design was a randomised complete block with 4 replications. During the evaluation period several characters were recorded. Here we report only the results relative of cold tolerance (0= no damages, 1=tolerant - 5 susceptible) and soil cover (%). Seed production in 1998/99 was prevented by glyphosate. Prior to analysis percentages were transformed to angular values.

## Results and discussion

The evaluation site generally offers a good opportunity of screening for tolerance to cold temperatures. In 1996/97, the year of establishment, tolerance to cold was assessed after consistent drops in temperatures (in December 1996 temperatures below 0 °C were recorded in 10 days, with the lowest minimum of -13°C; and in April 1997, during flowering, frosts occurred in 6 days, with a minimum of -4°C). The most tolerant lines in winter (Fig. 1a) were TarVT_05, SFCLT_06 and SMaGR_28 (P>0.05). The total mean score in spring was significantly lower than in the winter (0.87 *vs.* 2.94, respectively, P<0.05) and no damages at all were observed in PriGR_18, SapSA_07 and the three lines from Tarquinia (TarVT); very low scores were also registered in the lines found tolerant during the winter, but a significant interaction 'Genotypes x Season' was due to the behaviour of some entries which resulted quite susceptible in winter and tolerant in spring (BisTE_16 and PriGR_17).

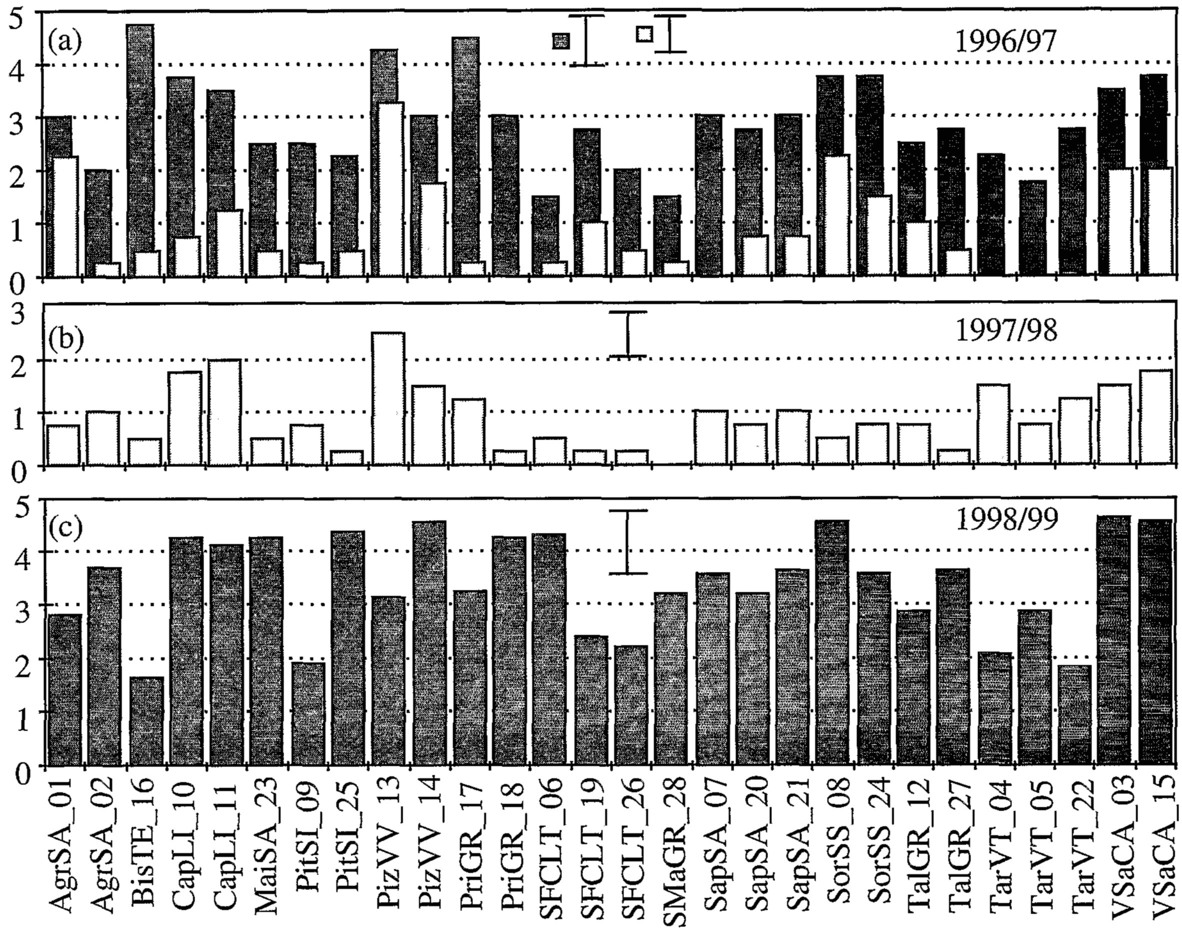


Figure 1: Cold tolerance in 28 lines *of M. polymorpha* from 1996/97 to 1998/99 during winter (solid) and/or spring (dashed). Bars are LSD at P<0.05.

It must be stated however that the low winter temperature caused damages to leaves which have in no cases ended with the death of plants, even in plots with relatively high scores. Dealing with a self-pollinated species the frost in spring may have caused a reduction of seed production due to pollen injuries. The screening carried out the previous season during the germplasm evaluation (Russi and Lorenzetti, 1999) seemed to be quite effective. In spring 1998 the entries confirmed the results of the previous year (Fig. 1b), but in 1998/99 almost all of them were so heavily damaged (Fig. 1c) to endanger seed yield. The winter of the third year was extremely cold, with as many as 64 frost days from December to February. However the damages were probably more the consequence of a quick drop in temperatures at the end of November, when plants were still actively vegetating, rather than to a long period of cold. In fact, in November weather conditions were unusually suitable for good plant growth, but it followed a rapid decrease of temperatures (the daily minimum dropped from 15°C to 0°C in few days). That the damages were associated to a particular physiological state of the plants is confirmed by the observation that in each plot they occurred only in the middle of it, where plants were taller and more succulent. This indicates how important can be the management of the pasture during mild, wet autumns; particularly in years of self-regeneration, when germination takes place earlier in September. In such circumstances mowing or grazing could have a role in maintaining the height of the vegetation lower and plants physiologically less prone to damages.

In year 1 (establishment) and 2 (first regeneration) mean soil covers were constantly increasing throughout the growing season, reaching their maximum in spring (Fig. 2 a, b). In year 3 and 4 similar high values were already recorded early in the autumn (Fig. 2 c, d) due to a dense seedling population. High values of soil cover were strongly associated with the size of the soft seeds present in the soil seed bank (P<0.05). Low cover attitude of BisTE_16 in the years 2-4 was the consequence of low values of hardseededness recorded at the end of the summer 1997 which, exposing the genotype to a series of false breaks, caused a depletion of the soil seed population. Interesting lines were PitSI_25 and TalGR_27, which showed high values of soil cover also in year 2, a critical year for hardseeded medics, and year 4, when the regeneration had to rely upon seed produced in year 1 and 2 only.

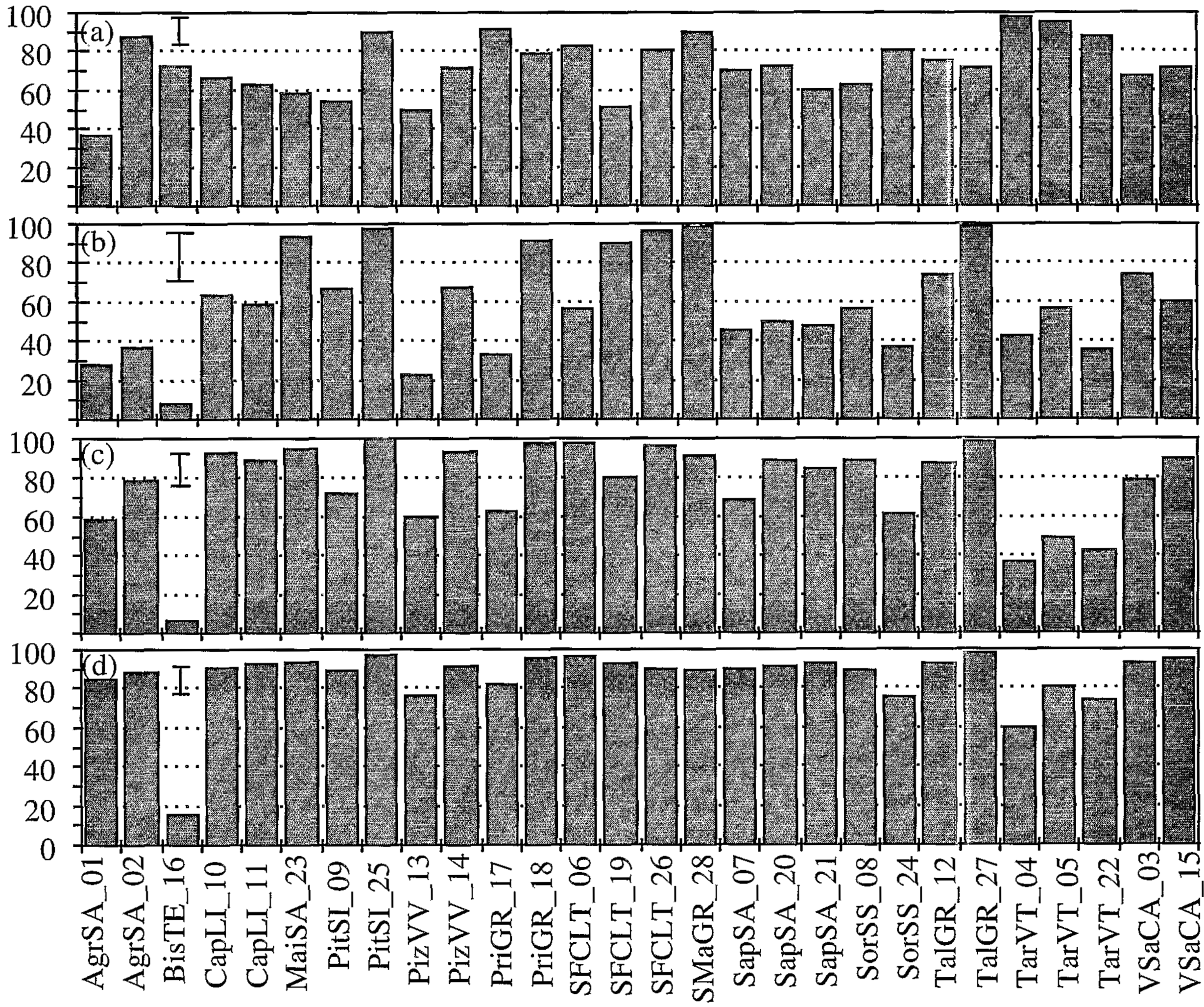


Figure 2: Soil cover (%) in 28 lines of *M. polymorpha* from 1996/97 (a) to 1999/2000(d). Bars are LSD at P<0.05.

## Conclusions

In many areas of central Italy *M. polimorpha* is a suitable species to introduce in a tree cropping system, provided that varieties be cold tolerant. The exploitation of natural variability present in local germplasm is the quickest way to reach the objective. Suitable varieties should also be early flowering and capable to produce large quantity of seeds with lower hardness. To ensure an optimum soil cover year by year, or site by site, could be wise to establish populations based on mixture of hard and soft seeded genotypes.

## Acknowledgements

Research funded by Regione Lazio, Ispettorato Provinciale Agricoltura di Rieti.

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