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Effects of *Medicago polymorpha* L. cover cropping in Sardinia vineyards

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Summary - The influence of different soil management systems on vegetative and reproductive grape behaviour and wine quality was studied during 1995–1998 in Sardinia. Cover crop by *Medicago polymorpha* L., natural herbage covering and the herbicide+tillage technique were evaluated in irrigated vineyard. Natural covering affected grape yield and wine quality negatively. *M. polymorpha* established very well and showed satisfactory autumn re-establishment in the second and third years whereas burr medic covering decreased year by year. Differences in the occurrence of phenological phases were observed between vine and burr medic with no competition during the reproductive of the grape. Cover crop by burr medic determined vine vegetative and productive performance similar to that produced by the traditional management treatment and *M. polymorpha* induced better wine quality.

Key–words: grape, burr medic, cover crops, soil management techniques, wine quality

Résumé - *L'influence de différentes méthodes culturales sur le développement de la vigne et la qualité du vin ont été étudiés en Sardaigne depuis 1995. Trois techniques ont été comparées dans une vigne irriguée : semis de* Medicago polymorpha, *envahissement par les herbes naturelles, sarclage + désherbage. L'enherbement naturel réduit le rendement en raisins et la qualité du vin.* M. polymorpha *s'installe parfaitement et se régénère sans problème les deux automnes suivants, bien que la quantité de gousses diminue d'année en année. Le décalage entre les phases phénologiques de la vigne et de la luzerne annuelle évite la concurrence pendant la période reproductive du raisin. Les performances végétatives et productives de la vigne sont similaires entre la parcelle sarclée et celle semée en luzerne, par contre cette dernière induit une meilleure qualité du vin.*

Mots.clés: *raisin, luzerne annuelle, culture associée, protection des sols, qualité du vin*

Introduction

In Sardinia the grape has been from ancient time one of the main cultivated crops; however, its diffusion is influenced by economic and environmental conditions. In this island, as in other Mediterranean regions, berry growth occurs during summer, when high temperatures and low rainfall affect the ripening process and the wine quality. Many vineyards are also located in hilly areas where the slope increases the erosion risks. In recent years in Sardinia, in accordance with international demand and EU rules for cultivation systems with low environmental impact, new approaches in soil management systems have been evaluated. These methods, an alternative to the traditional use of herbicides in the rows and the tillage between the rows, include the sowing in the vineyard of annual self-reseeding cover crops, characterized by a short vegetative period and associated in a non competitive way with the grape.

Materials and methods

The trial was carried out in the period 1995-1998 in the southern Campidano lowland (Villasor, 30 km North of Cagliari, lat N 39°23'; E 8°56'), 22 m a.s.l.. Total average annual rainfall is 428 mm. The soil is alluvial with 50% stones and pH (water) = 5.3. The white berry cv Pinot bianco vines, grafted on 1003P, were nine years old and cultivated under the drip irrigation system. The vines planted 1.20 m x 2.70 m, were trellis trained and Guyot pruned. In October 1995, three plots of this vineyard, each of 1,000 m^2, were sown with *Medicago polymorpha* L. cv *Anglona* (Porqueddu et al., 1998) using 20 kg ha^{-1} of scarified seed. The seed was inoculated with *Rhizobium meliloti* collected from a local accession of *M. polymorpha*. The two other treatments were spontaneous soil cover, and the soil tillage technique between rows associated with herbicide use on rows as control. The experiment was designed as randomised plots with three replicates. The number of burr medic seedlings and regenerating seedlings were counted in 18 quadrats of 0.12 m^2 randomly placed in each plot. Herbage covering rate and weed presence was scored (min=1, max=9) monthly. Dry matter yields were estimated in 9 quadrats of 0.5 m^2 in each plot for the cover cropping treatments. The percentage of *M. polymorpha* was estimated by botanical separation. Burr medic seeds were collected from six subsamples (25 x 25 cm) in July. During the three years, the main phenological phases of the grape (bud burst, flowering, veraison and ripening) and legume (emergence, flowering, fruit set and senescence) were observed. Vegetative growth of the vine was measured by the weight of the dry pruning wood, and bud fertility and yield was also recorded. Data on grape yield were not collected in the first year because of *Plasmopara viticola* damage. In 1997 and 1998, from veraison to ripening three clusters for each plot were sampled every week and analyzed for the determination of biometric characters (weight and size of clusters and berries) and chemical components (pH, SST and total acidity). The whole yield of each thesis was microvinified and the wines so obtained were analyzed and evaluated by a panel test (scores from 1=min to 5=max).

Results and discussion

M. polymorpha established rapidly and a full soil covering was recorded in the successive winter and spring. The sward was cut before flowering at the beginning of March 1996. Burr medic pod and seed production were high reaching 12,600 m^{-2} and 61,000 m^{-2} respectively (Tab. 1). The successive autumn re-establishment was satisfactory (about 1,700 seedlings m^{-2}) but unusually high rainfall (150 mm) occurred in December 1996 brought about long waterlogging (about 30 days) which resulted in the death of the plants. Moreover, part of the seeds present in the soil seed bank germinated in January and about 100 new seedlings m^{-2} were counted.

Tab. 1 – *M. polymorpha*: dry matter production, seed bank and re-establishment.

Variable		1996	1997	1998
Dry matter yield	t ha^{-1}	4.4 (±0.1)	0.7 (±0.05)	3.7 (±0.2)
Pods m^{-2} (x 1,000)	no.	12.6 (±0.7)	10.8 (±0.6)	4.2 (±0.4)
Seeds m^{-2} (x 1,000)	no.	60.9 (±4.7)	40.3 (±2.7)	7.6 (±0.9)
Seedlings m^{-2}	no.	1,682 (±98)	2,056 (±163)	258 (±35)

The Standard Errors are reported in brackets

However, the successive spring covering and seed production were low. Seedling re-establishment was excellent in autumn 1997 but in the following seasons *M. polymorpha* showed an unsatisfactory competition towards the spontaneous species mainly represented by

annual grasses (*Avena* spp. and *Lolium rigidum* Gaudin) and composites (*Calendula* spp. and *Chrysantemum* spp.). A total of six cuts were made on burr medic and natural covering plots during the three years. With regard to botanical composition, burr medic incidence decreased from 93% to 20% during the trial.

Differences in the occurrence of phenological phases were observed between vine and burr medic with no overlapping from fruit set to ripening of the grape (Fig. 1). The Anglona variety was characterized by the complete senescence of the whole plant before mid June.

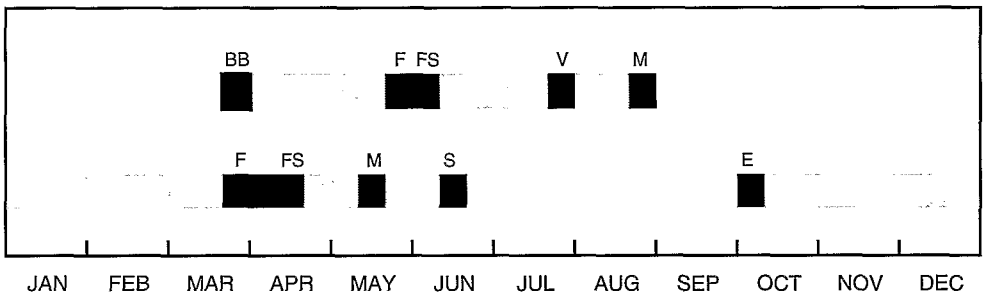


Fig. 1 Main phenological phases of the vine (above) and *M. polymorpha* in 1996:
BB (bud break), F (flowering), FS (fruit set), V (veraison), M (maturation), E (emergence), S (seed).

The different soil management techniques influenced the vegetative and reproductive performance of the vine, mainly its yield and vigour (Tab. 2).

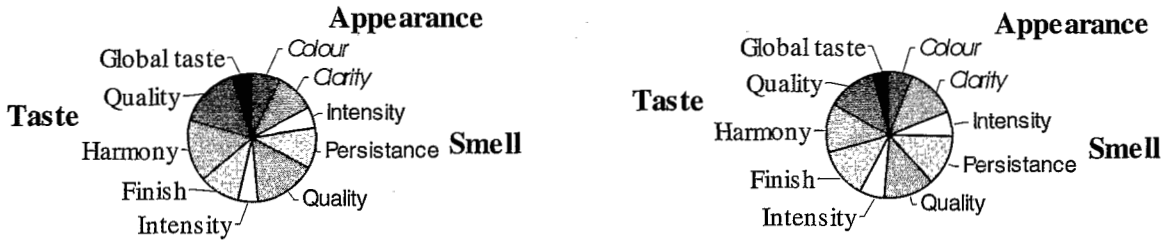
Tab. 2 – Effects of the treatments on vine and must components (average 1997-98).

	Cover crop by M. polymorpha	Natural covering	*Herbicide + tillage*
Bud fertility (no.)	1.34 a	1.27 a	1.44 a
Yield per vine (kg)	2.30 a	1.82 b	2.46 a
Grape yield (t ha^{-1})	7.10 a	5.63 b	7.43 a
Cluster weight (g)	152.23 a	155.73 a	146.53 a
Berry weight (g)	0.12 a	0.12 a	0.13 a
SST (%)	19,6 a	20,1 a	20.0 a
Titrable acidity (g l^{-1})	4.5 a	4.6 a	4.7 a
PH	3.92 a	3.98 a	3.99 a
Dry pruning wood per vine (kg)	0.43 a	0.35 a	0.34 a

Means followed by the same letter are not significantely different at $P \leq 0.05$.

The natural herbage covering influenced vine yield and vigour negatively, while the burr medic increased vigour. Its response was similar to that produced by the traditional soil management technique with regard to bud fertility and yield. Must components were not influenced by the different treatments during the berry ripening process and harvesting.

The wines showed qualitative differences: the natural covering negatively influenced quality because of its more intense colour and poor smell and taste. On the other hand, the wine produced on the plots traditionally managed or covered with *M. polymorpha* obtained similar or higher scores in the panel evaluation (Fig. 2).



Cover crop by *M. polymorpha* Natural covering

Fig. 2 – Differences in qualitative and sensorial characteristics of wines obtained from grapes cultivated with natural or artificial covering in 1997.

Conclusions

These encouraging results validate the interest in the use of self-reseeding annual legumes as cover crops in vineyards located in Mediterranean semi-arid areas with marginal soils. No competition for water during late spring and summer was observed due to the different timing of the phenological phases. Mulch produced by the dead legume plants limited seed germination and growth of weeds.

Cover crop by burr medic determined vine vegetative and productive performance similar to that produces by the traditional management treatment, while natural covering affected grape yield and wine quality negatively. These characteristics were positively influenced by cv Anglona probably due to the improvement of the physical and chemical soil conditions.

The progressive weed invasion on burr medic plots after the third year suggests that further study is necessary, setting up more appropriate management techniques of the sward (re- or over-sowing after 3-4 years, minimum tillage in autumn, more frequent mowing) and identifying a more appropriate mixture of self-reseeding legumes (e.g. medic-subclover mixtures) in order to improve legume persistence. The shading effect of the vine reduces seed softening so it is important to use as components of the mixture also varieties with a restricted number of hard seeds (Piano, 1999).

Finally, the results are a useful indication as the possibilities of a sustainable multi-use system where organic wine production could be also realized.

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