Sustainable management of intercropped vineyards on sandy acid soils

Cabras M., Dettori D., Mercenaro L., Nieddu G., Porqueddu C.

in

Kyriazopoulos A.P. (ed.), López-Francos A. (ed.), Porqueddu C. (ed.), Sklavou P. (ed.).
Ecosystem services and socio-economic benefits of Mediterranean grasslands

Zaragoza : CIHEAM
Options Méditerranéennes : Série A. Séminaires Méditerranéens; n. 114

2016
pages 279-282

Sustainable management of intercropped vineyards on sandy acid soils

M. Cabras[1], D. Dettori[1], L. Mercenaro[2], G. Nieddu[2] and C. Porqueddu[1]*
[1]CNR-ISPAAM Traversa La Crucca 3, Località Baldinca, 07100 Sassari (Italy)
[2]DESA, Università degli studi di Sassari, Via E. de Nicola, 07100 Sassari(Italy)
*e-mail: c.porqueddu@cspm.ss.cnr.it

Abstract. A two-year experiment was carried out to study alternative systems of soil management and the possible effects on the grapevine. Conventional tillage was compared with legume cover crops based on subterranean clovers. Two different mixtures were utilized: *Trifolium subterraneum* cv Campeda (60%), *T. brachycalycinum* cv Antas (20%) and *T. subterraneum* cv Seaton Park (20%) in the first site and *T. subterraneum* cv Campeda (60%), *T. brachycalycinum* cv Antas (20%) and *T. subterraneum* cv Denmark (20%) in the second one. Data on seedling establishment and re-establishment, soil covering rate, canopy height, phenology of subterranean clover varieties, dry matter production were collected. Regarding grape vine, data on grape production and quality were recorded. The cover crops controlled the growth of weeds and ensured an excellent covering of the soil. No negative effects of cover crops on grape production and quality were observed in comparison with the tillage treatment.

Keywords. Vineyard cover crops – Annual self-reseeding legumes – Subterranean clovers – Grape production.

Gestion durable de vignobles avec cultures intercalaires sur sols sableux acides.

Résumé. *Une expérience de deux ans a été réalisée pour étudier des systèmes alternatifs de gestion des sols et les effets possibles sur la vigne. Dans un essai en champ on a comparé le travail du sol classique avec des cultures de couverture de légumineuses sur la base de trèfles souterrains. Deux mélanges différents ont été utilisés:* Trifolium subterraneum *cv Campeda (60%),* T. brachycalycinum *cv Antas (20%) et* T. subterraneum *cv Seaton Park (20%) dans le premier site et* T. subterraneum *cv Campeda (60%),* T. brachycalycinum *cv Antas (20%) et* T. subterraneum *cv Denmark (20%) dans le second. On a recueilli les données sur l'établissement et le ré-établissement des trèfles, le taux de couverture du sol, la hauteur de la canopée, la phénologie des variétés de trèfle souterrain, la production de matière sèche. En ce qui concerne la vigne, les données sur le nombre de bourgeons, pousses, nombre de grappes par plante et production de raisin ont été enregistrées. Les cultures de couverture ont contrôlé la croissance des mauvaises herbes et ont assuré une excellente couverture du sol. Aucun effet négatif sur la production de raisin n'a été observé mais plutôt une meilleure qualité en utilisant les mélanges de trèfles souterrains par rapport au traitement classique du sol.*

Mots-clés. *Cultures de couverture des vignobles – Légumineuses annuelles en auto-réensemencement – Trèfles souterrains – Production de raisin.*

I – Introduction

Cover cropping in vineyard is an alternative technique to traditional tillage and to chemical weed control and represents also an effective tool to mitigate soil erosion. The use of cover crops remains hampered in Mediterranean areas under rainfed conditions. They compete with grapevine for water in summer, when low rainfall and high evaporative demand usually results in severe summer drought, leading to higher water stress and consequently to lower growth and yield. Nonetheless, in order to gain the potential benefits of cover crops under Mediterranean conditions, annual self-reseeding forage legumes as subterranean clovers may be used. These species have an autumn-spring cycle which allows them to reduce the water requirements to approximately 350 mm per year. Early-senescent and self-reseeding legumes can meet the objectives of improving soil characteristics and reduce the competition for water resources. Moreover, the use of self-reseeding annual cover crops reduces the production costs, avoiding the purchase and the sowing of seeds each year (Porqueddu *et al*., 2000). With this research, the authors aimed to provide useful information for an alternative soil management of a vineyard grown in a hilly area characterized by acid sandy soils and low fertility.

II – Materials and methods

The experiment was carried out in the years 2008-2010 in two private vineyards located in Enas-Loiri (site A, N 40.5, E 9.2 and 50 m a.s.l.) and Luogosanto (site B, N 41.0, E 9.1 and 200 m a.s.l.), in north-eastern Sardinia. The climate of the sites was typical of central Mediterranean area with a mild winter and rainfall concentrated between autumn and spring. The average total annual rainfall was 526 mm and 591 mm in site A and site B, respectively. In both sites, the soil was granitic-sandy type with pH (water) = 5.8 (A) and 5.6 (B) with low fertility (0.07 and 0.12 N%; 6.0 and 6.5 ppm P). The vineyards were planted in 1998 using the local white variety Vermentino grafted on 1103 Paulsen. Vine stocks were spaced 1.00 X 2.50 m in site A and 1.30 X 2.30 m in site B and trained by a cordon spur pruned. Both vineyards were under drip irrigation. Two different soil managements were tested at both sites: conventional tillage (CT), performed with mechanical tools, and legume cover crop (LCC), where legumes were subterranean clover varieties used in the inter-rows. In site A, a mixture of *Trifolium subterraneum* cv Campeda (60%), *T. brachycalycinum* cv Antas (20%) and *T. subterraneum* cv Seaton Park (20%) was used. In site B, *T. subterraneum* Campeda (60%), *T. brachycalycinum* Antas (20%) and *T. subterraneum* Denmark (20%) were used. The seeding rate was 34 kg ha^{-1} and 42 kg ha^{-1} in site A and in site B, respectively. Plot size was 1 ha for each treatment.

The sowing of the inter-rows was done in November 2008, using a rotary tiller with seed drill and packed roller. The following data on the cover crop were collected: establishment and re-establishment (on 80 quadrats of 0.12 m^2), soil covering (seasonal visual score), sward height before chopping, main phenological phases of sown species (seedlings emergence, flowering, fruit set and senescence), dry matter yield (on 12 quadrats of 0.5 m^2) and its botanical composition. Seeds were hand harvested in July on 12 quadrats of 0.12 m^2. On the vine, the following observations were carried out: grape production and characteristics of the cluster, berries and must quality.

III – Result and discussion

During the two years of the experiment, the dynamics of soil covering was similar in both sites. Nonetheless, soil covering due to subterranean clovers was slightly higher in site B than site A (Fig.1). In both sites the seedlings emergence and the sward establishment was slow, especially in A where winter soil covering was only 20%. Similar observations were reported by Pou *et al.* (2011). In the spring of the establishment year, soil covering increased up to 64% and 88% in site A and site B, respectively. In the second year, soil covering was quite high in both sites, ranging from 50% in winter (site A) to 93% in spring (site B). The contribution of spontaneous species to soil covering ranged from 24% (winter) to 16% (spring) in site B in the first year, but it did not exceed 3% in the second year. In site A, the contribution of spontaneous species was always less than 5%. The most frequent spontaneous species identified were: *Echium vulgare* L., *Vulpia ligustica* All., *Bromus hordeaceus* L., *Avena sterilis* L., *Lolium rigidum* Gaudin, *Anagallis arvensis* L., *Sonchus arvensis* L., *Fumaria officinalis* L., *Galactites tomentosa* M., *Parentucellia viscosa* L., *Inula viscosa* L. Subterranean clovers flowered in late February. Full plant senescence took place in mid-June. The high self-reseeding ability of subclovers guaranteed a high natural re-establishment in autumn 2009 with an average of 1,200 seedlings m^2 in both sites (Table 1). In the second year, despite a higher seed production than in the previous year, there was a sharp decrease in the number of seedlings per m^2 at site B. As a consequence of the abundant rainfall in autumn in both years, subterranean clovers showed a fast vegetative growth, controlling weed development. Among subclovers varieties, cv Antas increased its contribution to soil covering in both mixtures along time. In spring 2010, cv Antas reached 51%, cv Campeda 33% and cv Seaton Park 16% in site A while cv Antas dominated (93%) on cvs Campeda (5%) and Denmark (2%) in site B. In the first year, only one chopping after seed ripening was done, with the aim to allow a good self-reseeding. In the second year, due to a favourable meteorological pattern, two chopping were necessary. Two-year total dry matter yield was higher in site B than in site A: 6.3 t ha^{-1} and 2.6 t ha^{-1}, respectively (Table 2).

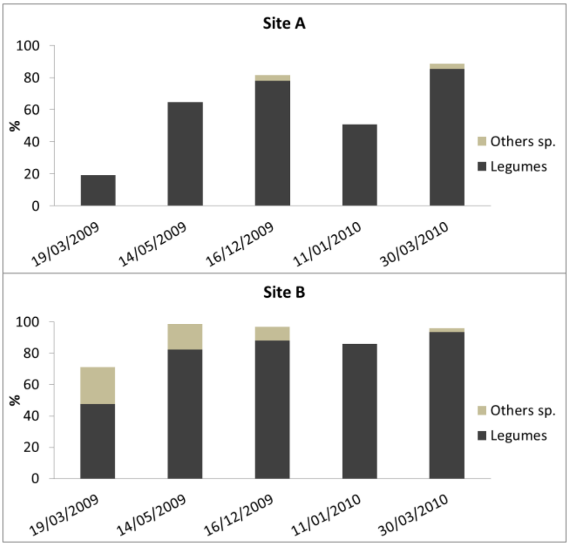

Fig. 1. Seasonal pattern of soil cover in site A (above) and B (below) during 2009 and 2010.

Table 1. Number of seeds in July and seedlings at autumn re-establishment in the two sites

Variable	Site A		Site B	
	2009	2010	2009	2010
Seeds m^{-2}	8755 (±5119)	12581 (±4872)	12040 (±3955)	15282 (±3365)
Seedlings m^{-2}	1215 (±260)	2520 (±816)	1221 (±402)	516 (±131)

The standard deviation is reported in brackets.

Table 2. Dry matter yield for each cut (t ha-1) in the two sites

Site	26/05/2009	11/01/2010	30/03/2010
A	0.21 (± 0.16)	0.58 (± 0.35)	1.87 (± 1.19)
B	1.45 (± 0.54)	1.31 (± 0.22)	3.57 (± 0.69)

The standard deviation is reported in brackets.

The yield of vine plants and its components widely varied between sites and years. In 2010, grape production was significantly higher than the previous year. In both years and sites, CT showed higher production than LCC, but with no significant differences, as found by Porqueddu *et al.* (2000). The number of clusters was influenced by the year and site but not by the treatment. Moreover, the use of legumes as a cover crop did not modify the fertility of the vines but it caused a production drops due to competition for water that induced a lower weight of berries, as previously reported by Mercenaro *et al.* (2014). Regarding fruit quality, in the first year sugar content of the berries in LCC was statistically higher than CT in all three sampling dates in site A. In site B, despite the higher amount of total soluble solids in LCC than CT in all sampling dates, no significant differences for sugar content was found between treatments

(Fig. 2). In the second year, no statistical differences between treatments for sugar content were found in both sites except for one sampling date, although in site B berry sugar content in LCC tended to be higher than in CT. In general, LCC seemed to favour the accumulation of sugars, probably because legume cover crops have the potential to supply nitrogen to grapevines, especially during the times of N-peak demand in early spring and fruit set (Patrick *et al*., 2004). Regarding the acidity, in both sites and years, the malic acid content measured in the berries of CT was higher than in LCC. No differences were observed on tartaric acid and the pH of must.

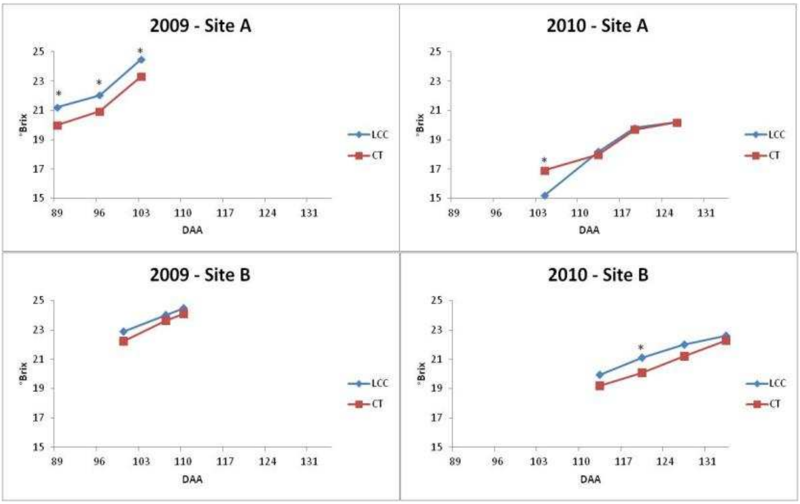

Fig. 2. Pattern of total soluble solids (Brix) in the berries during ripening stage (DAA= day after anthesis).

IV – Conclusions

The outcome of this study confirmed that appropriate varieties of subterranean clovers can be used for intercropping in vineyards located on acid sandy soils. Despite a slow winter sward establishment, subterranean clovers assured a high soil covering from the first spring along the two years, allowing to achieve the two main objectives of the vine grower: weed control and limitation of soil erosion. Moreover, summer mulch produced by senescent legume plants limited seed germination and growth of weeds. Yet, subterranean clover did not have negative effects on grape production and must quality. Cover cropping, as alternative technique of soil management, can be a useful tool to improve the sustainability and multi-functionality of wine farms. In fact, it can be used to improve the ecosystem services with positive effects on carbon sequestration, biodiversity, landscape and, last but not least, as a source of fodder for livestock during winter.

References

Mercenaro L., Nieddu G., Pulina P. and Porqueddu C., 2014. Sustainable management of an intercropped Mediterranean vineyard. In: *Agriculture Ecosystems and Environment*, 192, p. 95-104.

Patrick A.M., Smith R., Keck K., and Berry M.A., 2004. Grapevine Uptake of 15N-Labeled Nitrogen Derived from a Winter-Annual Leguminous Cover-Crop Mix. In: *American Journal of Enology and Viticulture*, 55, p. 187-190.

Porqueddu C., Fiori P.P. and Nieddu S., 2000. Use of subterranean clover and burr medic as cover crops in vineyards. In: *Cahiers Options Méditerranenéennes, vol.* 45, p. 445-448.

Pou A.M., León J.G., Moreno M., Mir M.T., Gil H.M. and Llompart J.C., 2011. Cover cropping in *Vitis vinifera* L. Cv manto negro vineyards under mediterranenan conditions: effects on plant vigour, yield and grape quality. In: *Journal International des Science et du Vin*, 45 (4), p. 223-234.