EFFECTS OF SOIL DEGRADATION AND ORGANIC TREATMENTS ON VEGETATIVE GROWTH, YIELD AND GRAPE QUALITY

Javier Tardaguila[(1)]*, Paolo Storchi[(2)], Sergio Puccioni[(2)], Alessandra Zombardo[(2)], Semih Tangolar[(3)], Serpil Tangolar[(3)], Melike Ada[(3)], Mehmet Erdem Kiraz[(4)], Brice Giffard[(5)], Emma Fulchin[(6)], Hans-Josef Schroers[(7)], Radojko Pelengić[(7)], Eugenio Moreda[(1)], Juan Fernandez-Novales[(1)], Edoardo A.C. Costantini[(2)]

[(1)] Instituto de Ciencias de la Vid y del Vino, University of La Rioja, CSIC, Logroño, Spain
[(2)] CREA-VE, Research Centre for Viticulture and Enology, Arezzo, Italy
[(3)] Department of Horticulture, University of Çukurova, Adana, Turkey
[(4)] Alata Horticultural Research Institute, Mersin, Turkey
[(5)] INRA, UMR 1065 Santé et Agroécologie du Vignoble, ISVV, Université de Bordeaux, Villenave d'Ornon Cedex, France
[(6)] Vitinnov-ADERA, Bordeaux, France
[(7)] KIS - Agricultural Institute of Slovenia, Ljubljana, Slovenia

***** Corresponding author Email: javier.tardaguila@unirioja.es

Abstract

Delimited degraded soil areas caused by an improper land preparation before vine plantation and or management can be observed in conventional and organic European vineyards. Soil malfunctioning including: poor organic matter content, imbalanced nutritional status, altered pH, water deficiency, soil compaction and/or scarce oxygenation. The goal of the present study was to compare the effects of some agronomic strategies to restore optimal soil functionality in degraded areas in organic commercial vineyards located in five countries, and to evaluate the impact of these soil management practices on vegetative growth, yield and grape quality parameters. Grapevines located in non-degraded soils showed higher vegetative growth and yield, and lower total soluble solids in grapes. Generally, there were no significant differences in vegetative growth, yield and grape quality among the soil management strategies in degraded areas.

Keywords: *restoring degraded soils, grapevine, cover crops, land preparation, organic viticulture*

Introduction

Viticulture is one of the most erosion-prone land uses (Garcia-Ruiz, 2010). Some vineyards are located on steep slopes and shallow soils where heavy rain events generate runoff, and soil tillage exacerbates soil losses (Le Bissonnais and Andrieux, 2007). In both conventional and organic European vineyards, it is no rare to have delimited areas characterizedby problems in vine health,grape production and

DOI: 10.6092/issn.2281-4485/7898

quality, that show a bad soil functioning. Causes for soil malfunctioning can be manifold and they sometimes interact such as: poor organic matter content, imbalanced nutritional status, altered pH, water deficiency, soil compaction and/or scarce oxygenation. In the bibliography, cover cropping has been extensively assessed in a variety of soil and climate conditions across the world, largely under Mediterranean climate (Quader et al., 2001; Pardini et al., 2002; Dinatale et al., 2005; Ingels et al., 2005; Gaudin et al., 2010; Marques et al., 2010). These studies identify a large variety of ecosystem services provided by cover crops in vineyards, such as weed control, pest and disease regulation, water supply, water purification, field trafficability, soil biodiversity and carbon sequestration. The EU Organic Farming Regulations (834/2007 and 889/2008) provide general considerations on the maintenance of soil fertility and biodiversity, but do not include guidelines on the preparation of soil for planting of perennial crops and the maintenance of its functionality. The recovery of optimal production and ecosystem functionality of degraded vineyards is the object of the research project of ReSolVe - Restoring optimal soil functionality in degraded areas in organic Vineyards, funded for by the European Fund FP7 ERA-net Project, CORE Organic Plus. The ReSolVe project involves eight research groups in six different countries: Italy, Spain, France, Sweden, Slovenia and Turkey. The aim of the present study was to compare the effects of selected organic agronomic strategies to restore optimal soil functionality in degraded areas in different country partners, and to evaluate the impact of these soil management practices on the grapevine growth, yield and grape quality parameters.

Materials and methods

The experimental study was carried out in season 2017 in nine organic commercial vineyards located in Italy (Chianti Classico wine district and Maremma), France (Montagne St. Émilion and La Clape), Spain (La Rioja) and Slovenia (Koper) for wine grapes, and in Turkey (Dokuztekne and Sarıveli) for table grapes. Four different soil treatments: Control degraded, Composted Organic Amendment (COMP), Green Manure (GM) and Dry Mulching (DM) were implemented in the degraded areas to appraise the restoration and improvement of these soils as described by Priori et al., this issue. Additionally, a control treatment corresponding to a non-degraded soil was also included and named T0. Effects of these soil treatments on each experimental plot have been evaluated through different measurements of vegetative growth (chlorophyll, SPAD units), yield components (yield per vine) and grape composition (total soluble solids) to characterize and compare the three different soil remediation strategies. Data analysis were performed by one-way ANOVA comparing the means to test the influence of the all treatments involved in the nine experimental vineyards plots. The ANOVA statistical analysis obtained for each parameter of vegetative growth, yield components and grape composition is displayed below. These parameters were also evaluated farm-by-farm in each country. Means separation was performed using Student-Newman-Keuls test at significance level $p = 0.05$.

Results and discussion

Figure 1 provides vegetative growth, determined as leaf chlorophyll contents in different organic vineyards corresponding to the five soil treatments. The highest SPAD index was reached in the non-degraded soil. Statistically significant differences between degraded and non-degraded soils were obtained in Fontodi (Italy) and Celebi (Ceyhan/Turkey) farms. No statistically significant differences were found between the four soil treatments in degraded soils in the four organic vineyards in Turkey and Italy.

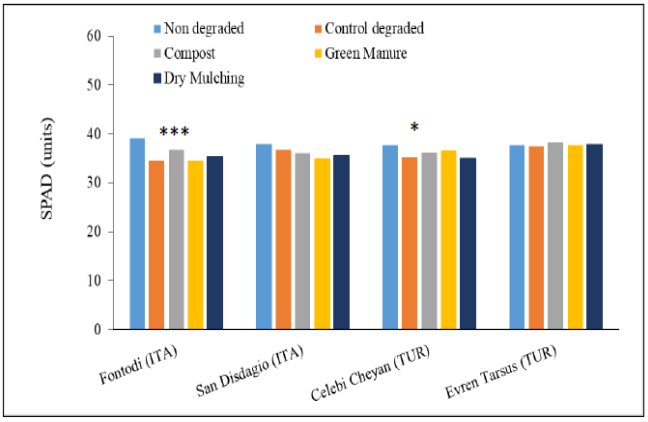

Figure 1.
Vegetative growth (as SPAD units) in four organic vineyards in Italy and Turkey corresponding to the five soil treatments.

Statistical analyses were performed using Student Newman Keuls test at a significance level p = 0.05.
**=0.05>p>0.01;*
*** =0.01>p<0.001;*
**** = p < 0.001.*

The mean values of yield per vine in the nine vineyards and in the four soil treatments are displayed in Figure 2. As vegetative growth, the highest values of yield per vine were observed in non-degraded soils except in Puelles farm (Spain). No statistically significant differences were found between the four soil treatments in degraded areas whatever the sites.

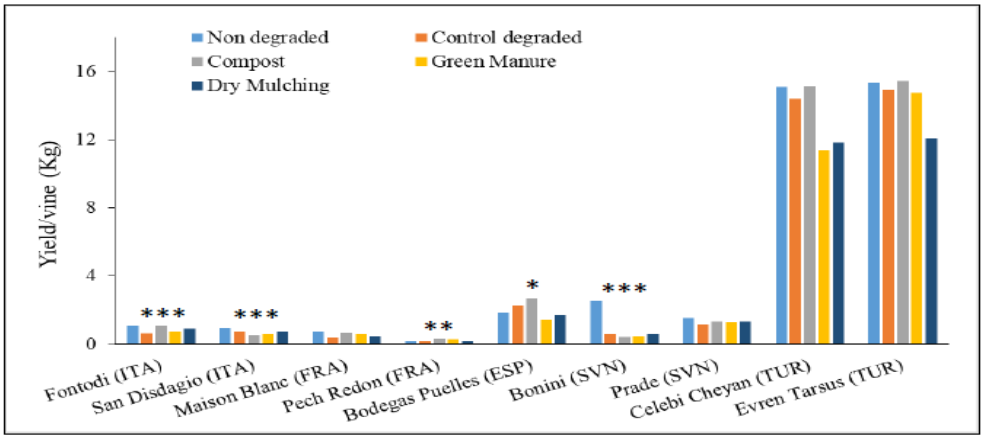

Figure 2. *Impact of soil treatment on grape yield in nine organic vineyards in five countries. No significant statistical differences were found between the four treatments applied in all sites.*

DOI: 10.6092/issn.2281-4485/7898

Regarding grape composition, the values of total soluble solids (sugars) in the organic vineyards corresponding to five soil treatments are presented in Figure 3. Significant differences were found between degraded and non-degraded soils in Turkey (Çelebi farm) and Slovenia (Bonini and Prade farms). However, no significant differences in total soluble solids were found among the soil management strategies in degraded areas.

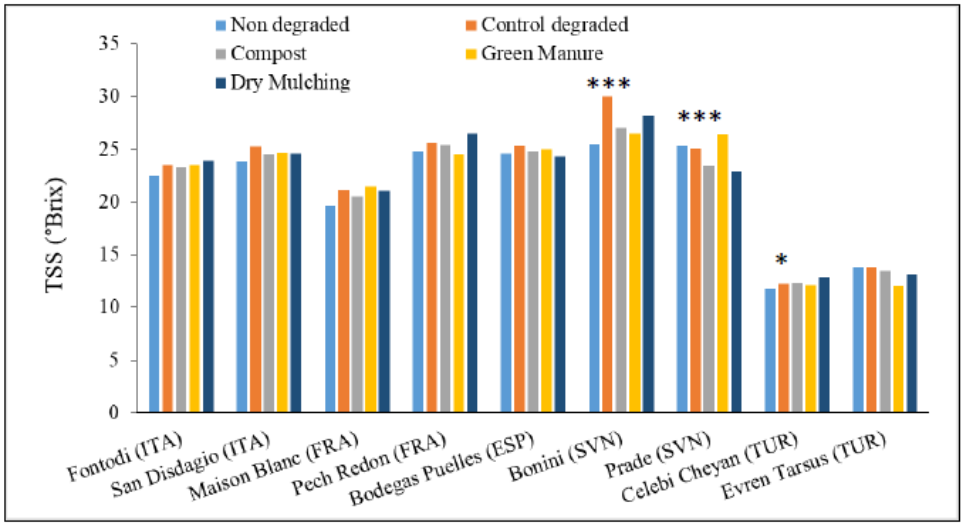

Figure 3. *Impact of soil treatment* on *total soluble solids (TSS) in grapes in nine organic vineyards of five countries. Statistical analyses were performed using Student Newman Keuls test at a significance level p = 0:05. * = 0.05 > p > 0.01; ** =0.01>p<0.001; *** = p < 0.001*

Conclusions

Grapevines located in non-degraded soils showed higher vegetative growth and yield, and lower sugar concentration in grapes. The impact different soil treatments were consistent among the five countries. Generally speaking, there were no significant differences on vegetative growth, yield and grape quality among the soil management strategies in degraded areas. Which may most probably due to insufficient project period (3 years) to obtain effect of organic additives responses as organic material enrichment response to plant and soil need more than couple of years.

Acknowledgments: This work is part of the RESOLVE project, for which the authors acknowledge the financial support provided by transnational funding bodies, being partners of the FP7 ERA-net project, CORE Organic Plus, and the cofund from the European Commission.

References

DINATALE, A., PARDINI, A., ARGENTI, G. (2005) Cover crops effects on plant and insect biodiversity in Western Australian vineyards. In: Silvopastoralism and Sustainable Land Management. CABI, Lugo, Spain, pp. 255–256.

GARCÍA-RUIZ, J.M. (2010) The effects of land use on soil erosion in Spain: a review. Catena, 81:1–11.

GAUDIN, R., GARY, C. (2012) Model-based evaluation of irrigation needs in Mediterranean vineyards. Irrigation Science, 30:449–459.

INGELS C.A., SCOW K.M., WHISSON D.A., DRENOVSKY R.E. (2005) Effects of cover crops on grapevines, yield, juice composition, soil microbial ecology, and gopher activity. American Journal of Enology and Viticulture, 56:19–29.

LE BISSONNAIS Y., LECOMTE V., CERDAN O. (2004) Grass strip effects on runoff and soil loss. Agronomie, 24:129–136.

MARQUES M.J., GARCÍA-MUÑOZ S., MUÑOZ-ORGANERO G., BIENES R. (2010) Soil conservation beneath grass cover in hillside vineyards under Mediterranean climatic conditions, Land Degrad. Dev., Madrid, Spain, 2010.

PARDINI A., FAIELLO C., LONGHI F., MANCUSO S., SNOWBALL R. (2002. Cover crop species and their management in vineyards and olive groves. Advances in Horticultural Science, 16:225–234.

QUADER M., RILEY I.T., WALKER G.E. (2001) Distribution pattern of root-knot nematodes (Meloidogyne spp.) in South Australian vineyards. Plant Pathology. 30:357.

DOI: 10.6092/issn.2281-4485/7898