XIIIth International Terroir Congress
17–18 November 2020
Virtual Congress | Adelaide, Australia

TERROIR VALORIZATION STRATEGIES IN A REFORMED DENOMINATION AREA: THE PROSECCO CASE STUDY

Federica Gaiotti*, Diego Tomasi, Nicola Belfiore, Lorenzo Lovat, Matteo Tonon, Marco Lucchetta, Davide Boscaro

Council for Agricultural Research and Economics-Research Centre for Viticulture and Enology, Viale 28 Aprile, 26, 31015 Conegliano (TV), Italy

*Corresponding author: federica.gaiotti@crea.gov.it

Abstract

Aims: This work summarizes some of the upmost recent studies and valorization strategies concerning the Prosecco wine production area. After the geographical denomination Prosecco (DO) was strongly reformed in 2009, the newborn DOCG (controlled and guaranteed DO) and DOC (controlled DO) areas have required different and specific strategies to promote and protect the value of their production.

Methods and Results:

Landscape and Natural Biodiversity in the DOCG Conegliano-Valdobbiadene

A preliminary survey was carried out among winegrowers of the Prosecco DOCG area to gather information on aspects relating to biodiversity and the landscape. We focused on the biodiversity of Cartizze, one of the most historic and traditional sub-areas, and compared it with the rest of the DOCG. Data from the questionnaire gave a first evaluation on the level of global biodiversity and landscape preservation in this micro-terroir.

Sustainable Agronomic Techniques for the DOC Prosecco Area

Novel systems for precision irrigation of Glera vineyards are under investigation. Concerning the management of newly planted vineyards, we compared the effect of different crop load in young Glera vines, with the aim of defining optimum crop levels to obtain a balanced growth of all structures in developing plants. Furthermore, new irrigation and nutrition strategies to minimize the effects of climate change on the acidity of the variety Glera are under investigation.

Conclusion: Results from the survey on biodiversity indicated that the old age of the vineyards and the traditional agronomic techniques are among the factors contributing to maintain a higher biodiversity in the Cartizze. The loss of landscape identity is an incoming threat and its preservation is one of the most urgent foresight needs. All these elements must be promoted and extended to the other areas in the DOCG Conegliano Valdobbiadene. Results from the studies on vine irrigation, nitrogen supply and crop management indicate that the adoption of appropriate agronomic techniques allow to optimize the inputs to the vineyard, preserving the quality and identity of Prosecco wine in the current climate change context.

Significance and Impact of the Study: The institution of the DOCG and DOC Prosecco denomination areas calls for renewed and effective strategies to promote and protect the value of these two distinct terroirs. Results from these studies will help promoting a higher terroir expression by means of a better exploitation of its natural resources and their economic value, trough the adoptions of agronomic techniques able to promote higher environmental sustainability and greater resilience of Glera to climate change.

Keywords: Glera cv., Prosecco wine, terroir, biodiversity, sustainable agronomic techniques

Introduction

In recent years, Prosecco has become one of the most popular sparkling wines in global markets, with a steadily expanding national and international demand (Rossetto *et al.,* 2011). Given the fast-growing interest for this wine abroad, in 2009 the Prosecco's Denomination of origin was strongly reformed with a double aim: 1) to defend the producers from an unfair competition made by the operators of lands far away from the typical ones of the Prosecco production, both in Europe and in the countries of the "New World", 2) to expand the land allocated to wine-growing so as to match the increasing market demand (Rossetto *et al.*, 2011; Basso, 2019).

According to the 2009 DOs reform, Prosecco is currently made within two production zones: the historical hillside zones of the pre-alps areas in the province of Treviso (DOCG Conegliano Valdobbiadene and Asolo) both replacing former DOC zones, and a larger DOC zone stretching across the entire Veneto and Friuli-Venezia Giulia Regions (Figure 1). In addition, the DOs reform has removed the name "Prosecco" from the national register of varieties substituting it with the synonym "Glera", so now the name Prosecco cannot be used for wines produced outside DOCG or DOC areas.

While this arrangement has opened new opportunities for wine producers, it has also brought new questions on the managing of the new Denominations. Particularly, the co-existence of two distinct *terroirs* under the same collective brand "Prosecco" must be efficiently and clearly communicated, in order to protect and promote the Prosecco value and safeguard the profitability of both denominations.

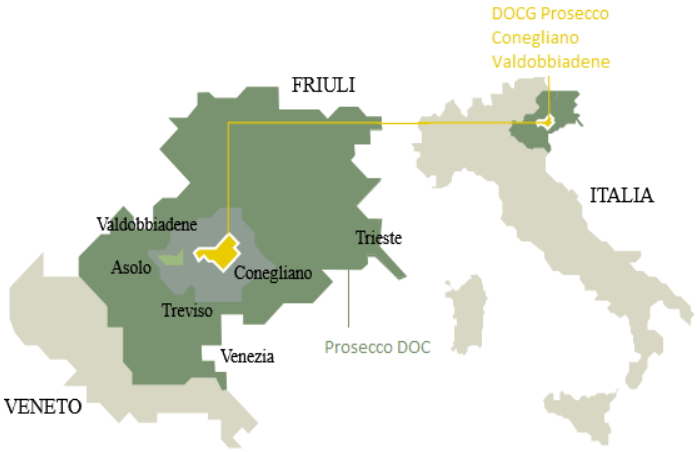

Figure 1: The DOCG Conegliano Valdobbiadene and the Prosecco DOC areas (source DOCG Conegliano-Valdobbiadene Consortium)

The landscape is undoubtedly one of the major elements that makes the **DOCG Conegliano-Valdobbiadene Prosecco area** so unique and unmistakable, as attested by the recent recognition in 2019 of the "The hills of Prosecco di Conegliano and Valdobbiadene" as a UNESCO World Heritage Site. At the moment, the Prosecco region is perhaps the only winemaking UNESCO World Heritage Site that has definitively and finally focused on the landscape. It is therefore an element that must be preserved and enhanced in all its components.

Biodiversity plays a central role as an identifying characteristic of the landscape in question, and lies at the root of another key feature, namely the existence of not one, but many, micro-terroirs within this area. Previous studies regarding the Conegliano Valdobbiadene zone have already highlighted how the synergetic relationship between different soils, climates, wine-growing methods and landscapes corresponds to different organoleptic expressions within this terroir (Tomasi *et al.,* 2013; Alessandrini *et al.,* 2016). Alongside these factors, biodiversity is an element, so far little investigated, that can contribute significantly to the wine's overall quality. It has been reported that a wide inter- and intra-varietal grapevine biodiversity in a given site is a positive resource to rely on, because it improves the adaptation to the environment and represents a source of organoleptic complexity in wines (Schneider, 2006). Additionally, some studies revealed that the microbiome of a wine area can determine many of the sensory properties of the wines produced there (Belda *et al.,* 2020).

The newly designated **Prosecco DOC area** has experienced in the past decade a rapid development of Glera plantations, more than doubling its vineyard surface (source: Consozio DOC Prosecco). The fast expansion of

wine-growing lands, where agronomic management is often oriented toward intensive, highly specialized and mechanized viticulture models, has risen several concerns. On one hand, new producers mainly driven by income expectations might underpay attention to the product quality leading to the erosion of the Prosecco value (Rossetto *et al.,* 2011); on the other hand, the environmental sustainability can take on a marginal weight compared to the economic sustainability, leading to a detrimental exploitation of land and natural resources.

In response to these issues, efforts must be targeted at developing sustainable techniques able to make vineyards less dependent from external inputs and more resilient to changing environmental conditions, in order to preserve the Prosecco wine's quality and identity. Furthermore, the adoption of environmentally sustainable practices can contribute in adding commercial value to Prosecco wine and strengthen its competitiveness in wine markets (Barisan *et al.,* 2019).

Materials and Methods

Survey on Landscape and Biodiversity in the Cartizze and in the Conegliano-Valdobbiadene Prosecco DOCG
In 2019 a survey was carried out among 250 winegrowers of the Prosecco DOCG area to gather information on aspects relating to biodiversity and the landscape. We focused on the biodiversity of Cartizze, one of the most historic and traditional sub-areas, and compared it with the rest of the DOCG. The survey listed 30 questions, including:
a) landscape characteristics in and around vineyards (vine growing systems, natural vegetation, presence of rural constructions, etc)
b) factors potentially affecting the soil and plant microbiome (eg. soil management, fertilization, etc..)
c) grapevine biodiversity (vine age, main varieties-rootstocks cultivated, etc..)

Crop Load Control in Young Glera Vineyards
The trial was carried out in a young vineyard of Glera, grafted onto Kober 5BB and trained on a Guyot system. The vineyard was planted in spring 2017 in Villa Sandi wine farm, Treviso Province (North East of Italy).
Three cluster thinning treatments were compared over 2018-2019 seasons: no thinning (NT), moderate thinning (MT), and severe thinning (ST). Cluster thinning was performed on 16 vines per treatment, between fruit set and pea size stage, by removing 80% and 50% of clusters, for MT and SV respectively. Vegetative growth (pruning weight, trunk diameter), vine physiology, yield and grape quality were analyzed over the 2 year study. To get a comprehensive picture of the plant development, at the end of the 3rd year (beginning 2020) the vine root system of four vines per treatment was analyzed by using the trench method (Bhom, 1979). Roots were classified into three thickness categories according to size: Ø < 2.0 mm = fine roots; Ø 2.0-5.0 mm = medium roots and Ø > 5.0 mm = permanent roots.

Optimizing the Irrigation Management with the use of Computer Vision
A novel system for precision irrigation is under study. The technology is based on a vision apparatus that collects daily 3D pictures of the canopy and has an integrated infrared thermocamera. Trough advanced image analysis the system allows to monitor variation in the volume of the canopy, the average leaf angle and the average canopy temperature. During 2020 we tested the system in commercial Glera vineyards in the Prosecco DOC zone. Vine irrigation was managed in order to impose gradually increasing stress conditions to monitor canopy features, climate, and soil humidity. Stem water potential was measured weakly with a Scholander pressure chamber following Chonè et al. 2011. Further analysis will integrate climate data, canopy measures and vine water potential to validate the system effectiveness in predicting stress conditions.

Fertigation Management for Acidity Maintenance
The trial was carried out in 2019 in a vineyard located in the Prosecco DOC plain area (Tezze di S. Lucia di Piave - TV), trained with double arch system (capuccina) and with a plant density of 2.8m between rows and 1.2m between vines (2.976 vines per ha). The variety was Glera, clone ISV-ESAV 19, grafted onto Kober 5 bb. Soil texture is sandy-loam, with a normal nutrient and organic matter content. The vineyard has been divided in two blocks (treated (N) and no treated (NN)). Nitrogen supply was equal to 13 g/per vine (38.6 kg/ha equal to 112 kg/ha of ammonium nitrate 34,5.0.0) split in three fertigation distributions (1/3 at berry set stage, 1/3 after three weeks and 1/3 10 days before veraison).

Berry samples were collected at harvest for the determination of TSS, pH, titratable acidity, malic and tartaric acids, aminoacidic profile. Two separate micro-vinifications have been made by using 120 Kg of grape for each one. Winter pruning weight was collected since it is a good indicator of the plant vigour; root and cane starch were quantified (mg/g dry weight) at the end of winter period.

Results and Discussion

Landscape and Biodiversity in the Cartizze and in the Conegliano-Valdobbiadene Prosecco DOCG

In 2019, the Unesco's World Heritage Committee recognised the universal value of a unique cultural and agricultural landscape, resulting from an extraordinary interaction between an excellent wine-oriented production and the nature of a fascinating territory. One of the elements that gave rise to the Unesco recognition is the high biodiversity level of the landscape, which has a mosaic structure mainly composed of small variably oriented patches with a high ecosystem value. In our survey, we tried to find out why the landscape in the DOCG Prosecco has conserved its integrity over the decades. The main reasons are: i) vineyard old age (40% planted before 1980), which keeps intact the structure of the landscape; ii) 72% of the vineyards are characterized by numerous historical settlements and manufactures of rural, religious or urban nature, which are jealously preserved by the population; iii) 50% of the vineyards are placed in steep slope soils (slope between 15 and 70%), and as the steepness makes using modern technologies difficult, the vineyard is managed manually. For all these reasons, the landscape has mostly retained its historical integrity.

Focusing on the Cartizze area, the results of the questionnaire showed that the historicity of vine cultivation is one of the main distinctive features of this micro-terroir area. All the Cartizze vineyards are over 40 years old (Figure 2), with several examples of plants of 80-100 years or even older.

The historicity of vine cultivation in this area undoubtedly makes it a site elected to contain a high level of biodiversity. In fact, the data collected showed that in the Cartizze area the level of genetic biodiversity of varieties, biotypes, rootstocks is higher than in other areas of the DOCG.

Minor varieties like Perera, Bianchetta and Versiso are still present in 40% of the Cartizze vineyards, while the percentage decreases to less than 20% in other areas of the DOCG (Table 1).

Moreover, the spread on the nursery market of few selected clones/rootstocks has led to an inevitable reduction of genetic variability in the vineyards planted in the last few decades, but not in the Cartizze, where almost all vineyards were planted before the 80's, favoring the maintenance of a large conservatory of genetic diversity.

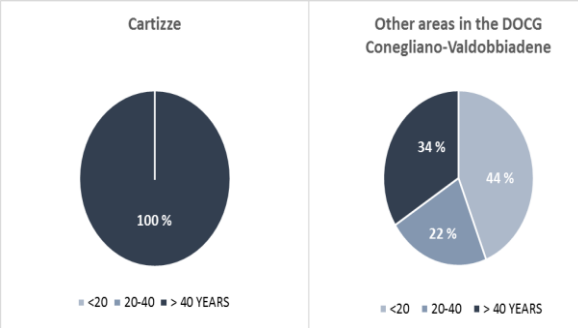

Figure 2: Average age of the vineyards in the Cartizze and in other areas in the Conegliano-Valdobbiadene DOCG. The percentages are calculated on the basis of the responses to the questionnaire compiled by the winegrowers of the areas surveyed.

	Cartizze	Rest of the DOCG
Presence of minor autochtonous varieties	38%	17%
Presence of unknown Glera biotypes	94%	47%
Presence of unknown rootstocks	75%	28%

Table 1: Presence of minor autochtonous varieties, uncknown clones and rootstocks in the Cartizze area and in the rest of the DOCG.

Crop Load Control in Young Glera Vineyards

Results of the two years of trial indicate that crop thinning applied between fruit set and pea-size stage affects the development of permanent structures of the vine (roots and trunk).

No thinned vines (NT) showed lower values for trunk diameter and root numbers compared to the thinned ones (Tab.2, Fig.3). Moderate (MT) and Severe (SV) thinning showed similar values for trunk development and root density, but permanent and medium roots densities were higher when thinning was severe.

Results support the hypothesis that overloading young vines may negatively affect the final development of all vine structures. For vigorous varieties such as Glera, cluster thinning can be an effective practice to promote a better development of permanent structures, namely the root system, increasing the vine's ability to exploit resources in the soil and cope with environmental stresses.

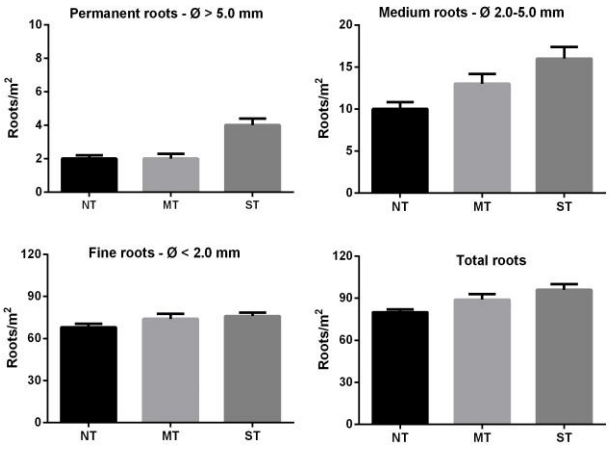

Figure 3: Root density for all root classes and for the total number of roots per profile wall. Data were recorded in January 2020 for all treatments.

Table 2: Vine production and vegetative growth measured as pruning weight and trunk diameter for the three treatments: no thinning (NT), moderate thinning (MT), and severe thinning (ST). Values followed by different letters, are significantly different at $p \leq 0.05$.

Treatment	Yield Kg	Pruning weight Kg	Trunk Ø cm
NT	7,8 a	1,0 a	3,26 b
MT	5,8 b	1,3 a	3,58 a
ST	2,3 c	1,1 a	3,48 ab

Irrigation Management with the Use of Computer Vision

A previous study carried out in 2017-2018 demonstrated a significant correlation between leaf angle and vine water status in Glera variety (Figure 4). In our trial we aimed to integrate this novel measure, with other data commonly detected in the vineyard to assess the vine water requirements (soil moisture, rainfall, temperature). Unfortunately, the North East of Italy had a quite rainy spring-summer 2020 season (rainfall April-August= 650 mm), and even though no irrigation was applied between May and September, vines hardly reached stress conditions. The lowest value for Ψmd was recorded at the end of July, but it indicated only a slight stress (-0.9 MPa). The trial will continue in 2021, and the dataset implementation will allow to validate the effectiveness of the system for Glera variety. This technology is expected to contribute in facing the challenge of water preservation, by defining precisely the timing and amount of water to be applied with irrigation, to match the plants need and to optimize the amount and quality of production.

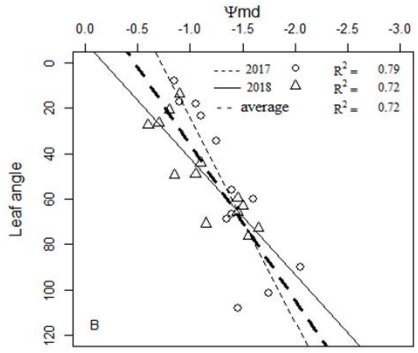

Figure 4: Correlation between leaf angle (degrees from horizontal) and vine water potential (Ψmd) recorded in Glera vines over two seasons (2017-2018).

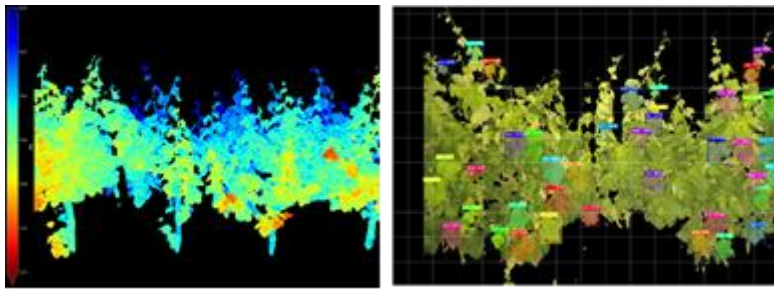

Figure 5: 3D image of the canopy. The system is able to detect automatically the variation in canopy volume and leaf angle.

Fertigation Management for Acidity Maintenance

One of the most negative impact of climate change (rise in temperature and heat weaves) on Glera vineyards is the extreme difficulty in preserving the acidity in ripe berries. Compared to the period before the 2000s, berry acidity is nowadays 2 g/L lower: this is becoming a problem for a variety whose oenological destination is sparkling wine.

In our trial, nitrogen fertilization between fruitset and veraison (50% nitrate and 50% ammoniacal nitrogen) seems to have an impact on fruit acidity without modifying yield and vine vigour. Results from the trial showed no differences in yield, bunch number and berry weight. TSS level was equal between treatments (16.4 and 16.5 °Brix for N and NN, respectively). Berry acidic composition for N and NN was as follow: total acidity 8.6 and 6.5 g/L, tartaric acid 6.2 and 5.6 g/L, malic acid 3.4 and 2.2 g/L, citric acid 0.01 and 0.005 g/L. First samples at veraison did not show any differences and this could be a signal that nitrogen supply can modify malate degradation during ripening stage (Ruffner *et al.,* 1976; Lobit *et al.,* 2006). Amino acid content was significantly different between the two treatments, with a higher amount in N vines (Figure 6). No differences were found in cane starch, but a slight increase was present in N roots (248 mg/g and 215 mg/g in N and NN respectively). Wine organoleptic judgment showed better attributes in terms of freshness, apple and fruity aroma in the wine obtained with N grapes. Further verification is necessary to encourage this agronomical strategy against the negative effect of temperature increase.

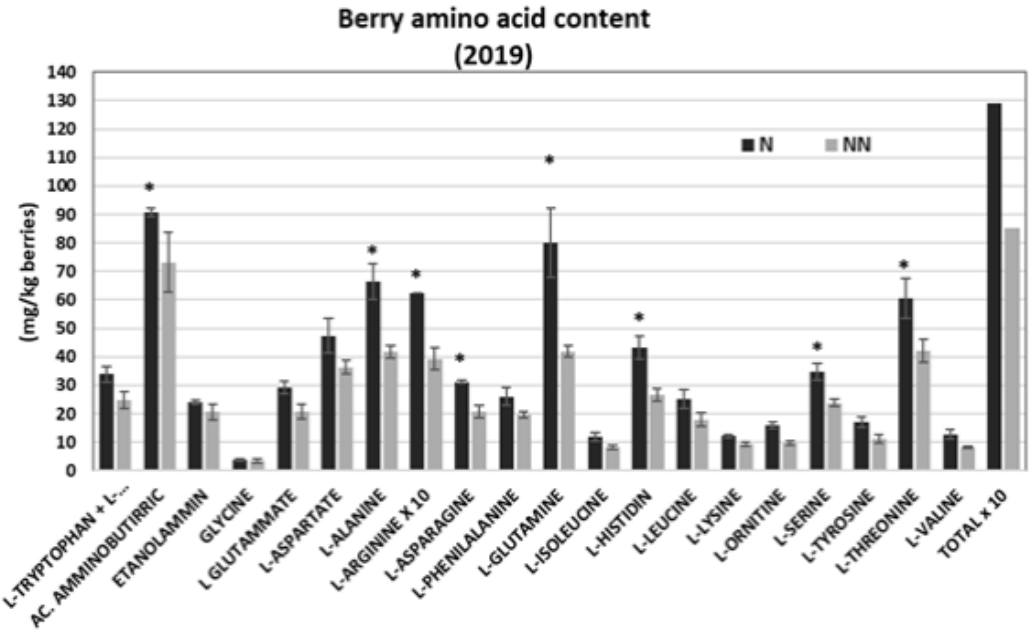

Figure 6: Aminoacid profile in grapes from N and NN treatments.

Conclusions

The institution of the DOCG and DOC Prosecco denomination areas calls for renewed and effective strategies to promote and protect the value of these two distinct terroirs.

Results from the survey carried out in the Conegliano-Valdobbiadene area reveals that biodiversity and landscape are key identifying features of the DOCG area, able to differentiate it from other production sites but also at the root of the existence of many micro-terroirs within the denomination zone.

Results from the studies on vine irrigation, nitrogen supply and crop management will help promote a higher terroir expression by means of a better exploitation of its natural resources, through the adoptions of agronomic techniques able to promote higher environmental sustainability and greater resilience of Glera to climate change.

Acknowledgments

This research was supported by funding from: the PSR 2014/2020 Regione Veneto – Measures 16.1.1 – 16.1.2 – DGR Veneto nr. 736/2018, IRRIVISION PROJECT; PSR 2014/2020 Regione Autonoma Friuli Venezia Giulia – Misure 16.1.1, DGR 1313/2018, DC 398/AGFOR 2020 – GESOVIT PROJECT; Villa Sandi s.p.a., Azienda Agricola Cecchetto**;** DOCG Conegliano Valdobbiadene Prosecco Consortium.

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