

Agroclimatic characterization of Monreale DOC appellation for vine growing

Caractérisation agroclimatique de l'appellation viticole Monreale DOC

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Abstract

This paper presents the results of an agroclimatic study of the viticulture area called DOC Monreale (Pa), Italy, which was carried out with the aim to supply a working instrument supporting viticulture planning. The global extension of the municipalities belonging to DOC Monreale is about 98,000 ha, where vine-growing is estimated at about 11,500 ha, 177 of which have DOC appellation. These municipalities are Camporeale, Corleone, Monreale, Piana degli Albanesi, Roccamena, Santa Cristina Gela, San Cipirello and San Giuseppe Jato. The vines provided for DOC Monreale are mostly autochthonous varieties such as Catarratto bianco, Grillo, Ansonica, Nero d'Avola, Perricone etc.; some allochthonous varieties are provided as well, such as Pinot blanc, Chardonnay, Merlot, Pinot noir, Cabernet Sauvignon, Sangiovese, Syrah etc. The training systems adopted are espalier and gobelet.

The agroclimatic analysis concerned rainfalls, temperatures, vine specific bioclimatic indexes (Winkler, Huglin, Branas and Fregoni), ET₀, and hydro-cultural consumptions. The agrometeorological data were provided by the Sicilian Agrometeorological Informative Service (SIAS) having one weather station at Camporeale (37°54'08"N, 13°06'03"W), and by Regional Hydrographical Service (SI) having one weather station at San Giuseppe Jato (37°58'27"N, 13°12'35"W) at 450 m a.s.l..

The study allowed achieving a macro - characterization of DOC Monreale territory, which is functional to any kind of further study for territorial programming, to an adequate selection of cultivars, as well as to the increase of vine growing discipline and the choice of effective agronomic management techniques.

Keywords: bioclimatic indexes, temperature, territory, GIS.

Introduction

The adaptability of viticulture to a wide range of conditions and the criteria used to describe local aptitude can vary in different areas. There is a need to use an integrated approach considering several levels of knowledge with the final goal to define the best models characterizing natural potentials of viticulture environment. In fact, grape and wine quality is determined by multiple interactions among rootstock, vine and other factors due to human intervention, such as vineyard managing, cultural techniques, as well as the environmental elements, especially climatic and pedological traits (Champagnol, 1984; Jackson and Lombard, 1993).

Agroclimatic characterization for vine growing is needed in order to understand the diversity of climatic conditions. An agroclimatic analysis studies the viticultural aptitude by the following three fundamental steps: general characterisation of climate (static and dynamic climatology); analysis of climatic resources (radiation, thermal, water); and analysis of climatic limitations (temperature thresholds, water limitations, hail, etc). Further, the multi-year biological observations (phenology/physiology) carried out on representative vineyards proves fundamental for the study of

the relations with climatic features by using bio-climatic indexes based also on thermal data (Vaudour, 2005).

The aim of the present work is to represent a general climatic characterization, the consistency of viticulture of DOC Monreale area, and a more detailed analysis on toposcale spatial distribution for bioclimatic indexes as well. This second theme is presented here by means of the elaboration in GIS environment of geo-topographical information partly obtained by a topoclimatic study of Sicily (Drago et al., 2005).

The present survey focused on a macro climatic characterization of viticulture area located in DOC Monreale. The researches carried out in agro meteorological field brought the improvement of climatic parameters and the vine interactions by the application of adequate cultural techniques.

Material and methods

The global extension of the municipalities belonging to DOC Monreale is about 98,000 ha, where vine-growing can be at present estimated at about 11,500 ha, 177 of which belonging to DOC and 3534 to IGT appellation (Table 1). These municipalities are: Camporeale, Corleone, Monreale, Piana degli Albanesi, Roccamena, Santa Cristina Gela, San Cipirello and San Giuseppe Jato. The consistency of viticulture data in the DOC area were supplied by the Operative Unit 29 of the Agriculture and Forest Council Department of Sicilian Region.

In order to accomplish a detailed characterization of the main climatic aspects of DOC Monreale area, as for temperature and precipitations this work considered 1965-1994 dataset provided by Regional Hydrographical Service (SI) for San Giuseppe Jato weather station (37°58'27"N, 13°11'20"W) and presents some elaborations: Peguy climatogram (1970), monthly Thornthwaite-Mather (1955) soil water balance.

Further, an interesting comparison between monthly average potential evapotranspiration assessed by applying the Penman-Monteith (Allen et al., 1998) method and another applying the Thornthwaite (1955) method is presented. The former used the Sicilian Agrometeorological Information Service (SIAS) dataset (average 2002-2007) concerning the weather station localized at Camporeale (37°54'08"N, 13°06'03"W); the latter exploited the database concerning San Giuseppe Jato SI weather station (1965-1994).

Topographic parameters such as aspect, topographical position, etc. considered by the present work were obtained by using the methodological description reported in Drago et al. (2005) and Policarpo et al. (2008).

The data registered by the weather stations were elaborated in order to calculate bioclimatic indexes based on air temperature, which is estimated the most influent climatic feature interesting the seasonal evolution of the species and the characteristics of the final oenological product (Acunzo, 2003). Thus, the following toposcale (1:10000) maps were realized: "Winkler Index" (Winkler et al., 1962), "Huglin Index" (Huglin, 1983), "Hydro-thermal Branas Index" (Branas et al., 1946) and "Quality Fregoni Index" (Fregoni et al., 2000).

As phenoclimatic indexes reflect the biological and cultural needs of vine, they allow the characterization of a cultural area and the estimation of new ones. Hence, vine success depends on the modality of its interaction with the rootstock, throughout its answering at the pedoclimatic conditions. This survey presents the data concerning Winkler index for beginning and end flowering, beginning and end veraison, and ripening for some vines (Malvasia di Lipari, Nero d'Avola and Ansonica or Insolia) of DOC Monreale area. These data were obtained by GeReCa project (Policarpo et al. 2007) and they include triennial averages (2005-2007) and standard deviation of the above-mentioned phenological phases.

Results and Discussion

The training systems mostly adopted are espalier (spur cordon and Guyot) and gobelet (Table 2). In particular, Table 2 presents a training systems partitioning for white and black varieties in dry and wet vineyard used in DOC Monreale appellation. Cataratto bianco is the most representative among the white cultivars with about 5000 ha (Table 3); as for the black cultivars, Nero d'Avola is the most representative one, with about 879 ha (Table 4). DOC Monreale area (Fig. 1 and 2) presents the

character described by a *Csa* Köppen macro-climatic condition, distinctive of the Mediterranean climate, with mild and rainy winters, and hot-dry summers (Drago, 2002).

Annual total rainfall average is about 700 mm, while annual average temperature is about 18°C. Monthly distribution is shown in Fig. 3, by the typical Peguy climatogram: spring-summer months are characterized by hot-dry climate (from May to September); from October to April the area enjoys a temperate climate.

Monthly variation of some Thornthwaite-Mather soil /water balance parameters (Fig. 4) reveals a long period of water deficit (difference between potential and effective evapotranspiration) lasting from April to October.

The comparison between Penman-Monteith and Thornthwaite methods showed a similar pattern with a little differences in the ET0 value (Fig. 5).

A consideration of the maps presented in Fig. 6 should highlight that in the vine areas of whole DOC Monreale Winkler index values are between 2000 and 2500, more than satisfying the ripening needs of the vines cultivated in the DOC area (Table 5); other areas presenting an index value lower than 1800 are not cultivated at vine, mainly for their high slope and consequent low accessibility. Huglin index varies from a minimum of 2200 to a maximum of 2600. Hydro-thermal Branas index, varying from 1400 to 1700, determines a very low susceptibility to downy mildew attacks (the minimum index value is 2500) . Finally, Fregoni quality index varies between 150 and 300.

The most important bio-climatic indexes still adopted in viticulture, Winkler and Huglin, prove adequate enough for the definition of vine macroclimatic adaptability especially when relating to thermal conditions, as air temperature may represent the main limiting factor. On the contrary, the indexes revealed their low flexibility for a complete exploration of the whole information characterizing the territorial elaborations obtained by the application of a high spatial resolution analysis methodology, like the one presented in this work. In particular, a careful look at standard classes division for Winkler index gives evidence of a plain trend to level the gaps existing among territories which are characterized by important pheno-climatic differences. Similarly, this is also assertable for Huglin index, even if in a lower measure.

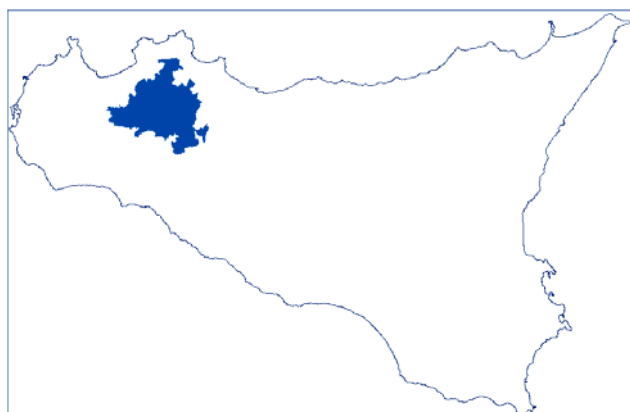


Figure 1 DOC Monreale area in blue

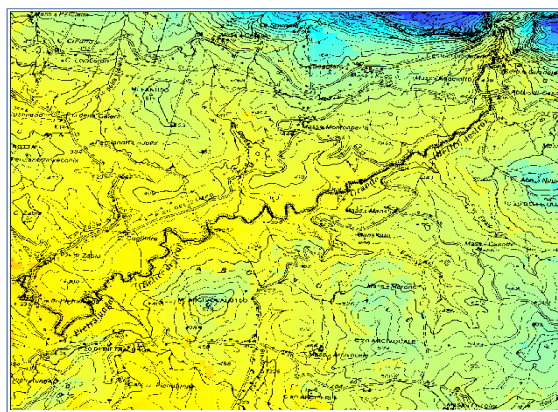


Figure 2 Particular of DOC Monreale area.

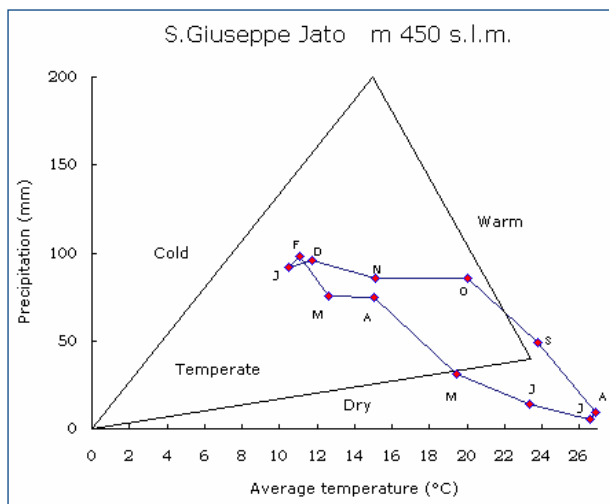


Figure 3 Peguy climatogram for S. Giuseppe Jato (average 1965-1994).

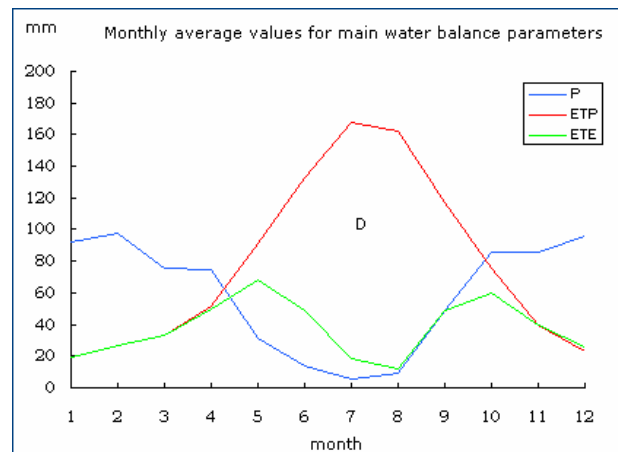


Figure 4 Thornthwaite-Mather main water balance parameters for DOC Monreale area (average 1965-1994). P=precipitation; ETP=potential evapotranspiration; ETE= effective evapotranspiration; D= deficit.

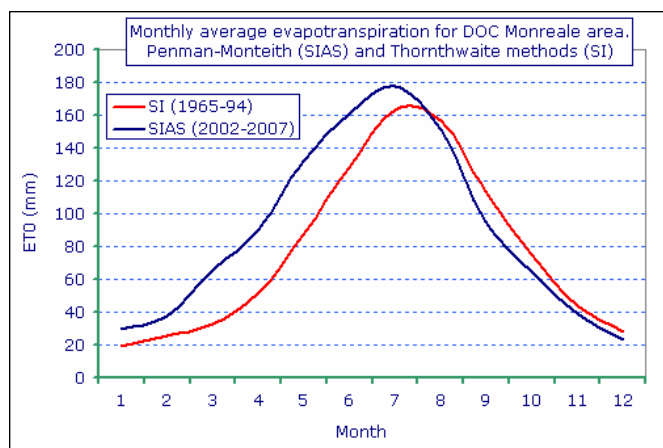


Figure 5 Potential (reference) evapotranspiration for DOC Monreale area estimated using two methods.

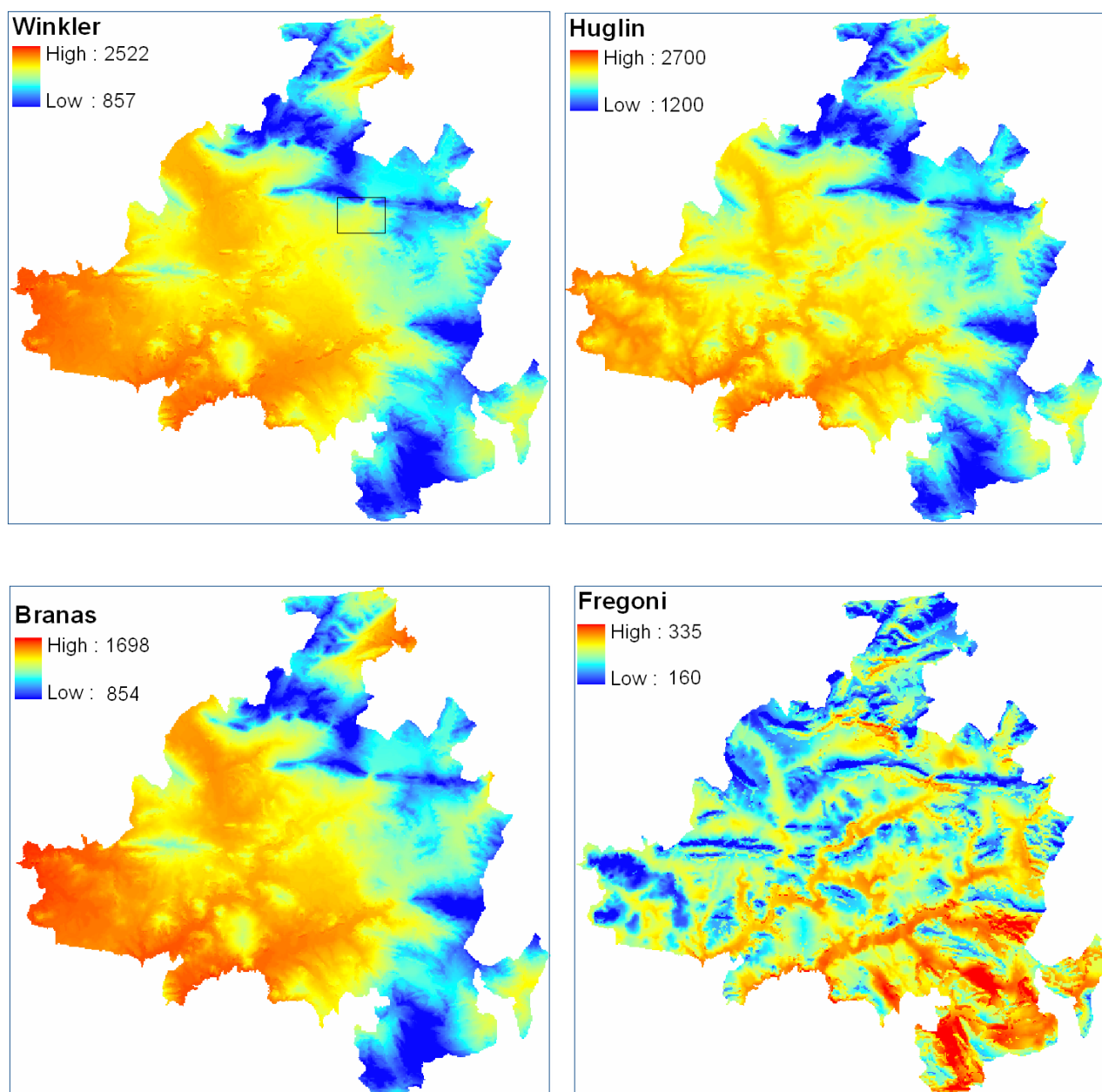


Figure 6 Winkler, Huglin, Branas and Fregoni indexes for DOC Monreale area. In the second figure (top right), Winkler index topscale representation for a portion of DOC area.

Municipality	Vineyard surface (Ha)	DOC appellation (Ha)	IGT appellation (Ha)	No appellation (Ha)
Camporeale	1041.7	57.6	381.8	602.3
Corleone	858.8	14.6	122.4	721.8
Monreale	7202.7	104.5	2506.1	4592.1
Piana degli albanesi	210.3	0.0	137.1	73.2
Roccamena	424.4	0.0	0.0	424.4
San Cipirello	705.8	0.0	159.6	546.2
San Giuseppe Jato	862.0	0.0	159.6	702.4
Santa Cristina	132.2	0.0	67.8	64.4
Total	11437.9	176.7	3534.4	7726.8

Table 1 Viticulture surface and its distribution in DOC and IGT appellation in the municipality of DOC Monreale appellation (2008).

Training	White (Ha)	Black (Ha)	Total (Ha)	Dry (Ha)	Wet (Ha)
Gobelet	220.7	12.9	233.6	218.2	15.4
Spur Cordon	55.6	193.1	248.7	144.5	104.2
G.D.C.	5.4	8.1	13.5	7	6.5
Guyot	7032.1	2647.4	9679.5	7337.8	2341.7
Pergola	1018.3	198.6	1216.9	345.4	871.5
Other training	21.8	23.9	45.7	38.8	6.9
Total	8353.9	3084.0	11437.9	8091.7	3346.2

Table 2 Training systems used for white and black variety in dry and wet vineyard in DOC Monreale appellation (2008).

Cultivar	Surface (Ha)	Cultivar	Surface (Ha)
Catarratto bianco	5036.8	Nero d'Avola	878.9
Trebbiano toscano	1239.7	Merlot	561.4
Other grapes	870.2	Other grapes	491.6
Chardonnay	383.8	Syrah	469.9
Ansonica	215.1	Cabernet sauvignon	357.5
Grecanico	186.9	Sangiovese	153.8
Viogner	101.1	Nerello mascalese	66.8
Pinot gris	64.0	Perricone	39.4
Damaschino	52.3	Petit Verdot	32.2
Grillo	51.2	Cabernet franc	19.2
Muller - Thurgau	49.5	Pinot noir	13.3
Sauvignon	48.1	Total	3084.0
Malvasia bianca	43.3		
Pinot blanche	12.0		
Total	8353.9		

Table 4 Black variety consistency in DOC Monreale appellation (2008).

Table 3 White variety consistency in DOC Monreale appellation (2008).

Cultivar	Start Flowering	End Flowering	Start Veraison	End Veraison	Maturation
Ansonica	345.6 ± 13.6	441.0 ± 11.0	1335.8 ± 57.1	1462.6 ± 147.9	1510.5 ± 165.5
Cabernet franc	292.8 ± 22.6	424.8 ± 21.0	1032.0 ± 115.4	1335.0 ± 116.2	1461.7 ± 83.6
Cabernet sauvignon	314.1 ± 21.7	452.7 ± 23.0	1109.7 ± 73.1	1324.6 ± 138.2	1453.5 ± 94.4
Chardonnay	270.9 ± 30.2	386.9 ± 32.2	1010.3 ± 82.7	1256.0 ± 96.3	1319.6 ± 130.5
Muller Thurgau	297.2 ± 26.2	372.3 ± 21.9	843.4 ± 116.3	1085.9 ± 52.7	1205.7 ± 46.2
Nero d'Avola	340.7 ± 22.3	437.1 ± 37.4	1128.5 ± 61.0	1437.8 ± 31.1	1544.4 ± 19.9
Pinot noir	268.1 ± 30.7	366.3 ± 28.1	1019.5 ± 84.2	1250.1 ± 78.8	1283.8 ± 99.0
Viognier	363.7 ± 25.0	457.8 ± 31.6	1186.3 ± 76.7	1397.1 ± 38.0	1474.7 ± 95.9

Table 5 Triennial average (2005-2007) of Winkler index during the phenological phase in some present cultivars in DOC Monreale appellation (average ± standard deviation).

Conclusion

This data system would make easier the selection of the best cultivars for the DOC area, vine growing discipline, and the choice of adequate agronomic management techniques. Further, the availability of high spatial resolution maps does allow to represent territorial distribution of climatic elements and indexes until 1:10.000 scale or more, namely farm scale. A finer procedural reclassification of the most used classical indexes is needed, as far as the ones now available were conceived and realized for macro and mesoscale applications.

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