CLIMATE ANALYSIS TO INTRODUCE RESISTANT VINES IN THE PROTECTED AREAS OF THE CASTELLI ROMANI REGIONAL PARK

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INTRODUCTION

From a historical point of view, innovation in wine-growing plant material has focused more on sanitary and clonal selection since 1962 than on plant breeding (Teissedre, 2018). Interspecific hybridization of grapevines began in the 19th century and was initially aimed at introducing pest and disease resistance in offspring. (Galet 1999). Later, several breeding programmes implemented worldwide led to the development of varieties showing different characteristics such as cold-hardiness, short/long growing season, and pest resistance (Reynolds, 2015). Nowadays, ssustainability of agriculture production is becoming a fundamental requirement for citizens and institutions; only recently the winemaking sector has become aware of the need to reduce the use of pesticides. During the last ten years European Commuity have promoted sustainable agriculture and in 2009 (DIR.n.128/2009,art.1) was specify sustanable use of pesticedes, in order to reduce risks to human health and impacts on the environment encouraging member states to favour (Art.14) phytosanitary defence methods of lower risk such as integrated defence and organic agriculture, in accordance with Reg. (CE) n. 834/2007.
The reduced number of treatments required makes resistant vines an opportunity for the sustainability of viticulture and a resource for protected areas, oases and natural parks.
In 2016, CREA Viticulture and Enology and Regional Agency for the Development and Innovation of Agriculture of Lazio (ARSIAL) created a pilot vineyard to test the adaptability of resistant vines to environmental conditions of Lazio region. The climate plays a fundamental role in the wine production and quality. Thermal resources define the vegetative development, the ripening processes and period. The climate and the soil are the fundamental factor to express the potential of a cultivar, the type, quality and style of a wine. Aim of this study was to analyze the agro-climatic resources of some sites into the Castelli Romani Park to assess their suitability for growing resistant vines.

MATERIALS AND METHODS

PLANT MATERIAL

The experimental vineyard located in Velletri (Rome), at 41°40.5′ latitude; 12° 50.7′ longitude E; 355 m above sea level, on south-western side of Lazio Volcano. The plant material was supplied by VCR, in 2016 and mentioned in Tab.1.

Plant distance: (0.9 m x 2.3 m), 4,800 vines per hectare; vertical shoot positioning training system, pruning single Guyot.The vineyard is made up in 12 rows of 80 vines (1 cultivar per row). In the first row Trebbiano Toscano cv was planted, used as test for white grapes, while for red grapes the reference vine was Sangiovese cv, planted in the twelfth row. Phenological observation had place every week and defined by an international standard code BBCH (Stauss R.,1994). The dates of phenological phases (flowering, veraison and ripening of berries) are shown in Tab.6.
The bunches have been examined weekly until the beginning of ripening, to detect any incidence of powdery mildew and its severity. Visual evaluations were performed according to the protocol of the European and Mediterranean Plant Protection Organization (EPPO) guideline regarding the evaluation of fungicide efficacy on powdery mildew [PP 1/4(4)]

Tab. 1 - Resistant Cultivar

White berries cv	Red berries cv
Fleurtai ®	Cabernet Eidos®
Soreli®	Cabernet Volos®
Sauvignon Kretos®	Merlot Kanthus®
Sauvignon Nepis®	Merlot Khorus®
Sauvignon Rytos®	Julius®

Tab. 2 - SIARL Registry of agrometeorological stations

CODE	Municipality	Location	Altitude	UTM 33N	
				X	Y
RM12SIE	FRASCATI	Prata Porci	164	308.408	4.634.127
RM16SIE	GROTTAFERRATA	Valle Marciana	201	304.625	4.629.343
RM15SIE	MONTEPORZIO	Camaldoli	583	310.182	4.630.486
RM10SPE	VELLETRI	Cantina Sperimentale	322	315.725	4.618.132

CLIMATIC DATA

In order to evaluate the Castelli Romani Regional Park weather, data were collected by four agrometeorological stations belonging to the regional agro-meteorological network managed by ARSIAL, (Integrated Agrometeorological Service of the Lazio Region), and located in the park area Tab.2; Velletri station (cod.RM10SPE) is located inside the CREA vineyard.
For each station, daily values of some meteorological variables relative to the past 5 years have been considered: max, media, min temperature (°C), precipitation (mm), air humidity (%).
Then, the following bioclimatic indices were developed: Growing Degree Days (DGG)(°C), Heliothermic Index (HI) (°C), Night Freshness Index (IFN) (°C), Rainfall Rate(RR (mm). The bioclimatic indices were calculated according to OIV VITI 423-2012.

RESULTS and DISCUSSION

Monthly rainfall rate, for each station, has been reported in Tab.3; the rain values are between 800 and 1200 mm per year. The rainfall rate values showed a constant increase in the water reserve in all months of the year, including the period of grapevine vegetation.
Monthly values of relative humidity during vegetation period Fig.1, remain consistently above 60% even when rainfall drops to a minimum and to 70% in April, May and September.
Monthly values of precipitation from April to September are reported in Fig. 2. The rains amount to values of about 80 mm in the months of April and May, while the relative humidity reaches 70%, critical conditions because they favor the downy mildew inoculum. In June and July the amount of precipitation decreases to around 20 mm, with the exception of Velletri (55 mm) which is the most rainy site. In August, the rains rise to 40 mm and in September intensify up to 100 mm.
The heliothermic index of Velletri, Grottaferrata and Frascati sites ranges between 2500 and 2700; Monteporzio is the site with the lowest value, 2200. Speaking of bioclimatic indexes, according to the climatic classification proposed by Tonietto and Carbonneau (2004), for heliothermic index, Monteporzio site belongs to HI+1: temperate warm class of viticultural climate (Class interval > 2100<=2400); therefore the thermal resources allow the cultivation and maturation of all the cultivated varieties.

Tab. 3 *Monthly Rainfall Rate average*

2015-2019	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Velletri	90.4	205.0	326.6	398.0	491.6	547.8	574.2	624.2	744.2	869.2	1100.0	1212.4
Monteporzio	53.4	140.0	260.0	332.6	420.2	442.8	456.4	498.8	610.4	761.4	904.6	983.4
Grottaferrata	34.0	117.4	230.0	289.8	335.6	369.8	377.8	412.8	498.4	607.6	697.2	744.2
Frascati	41.0	115.2	197.0	249.4	344.2	372.8	393.8	428.6	516.2	616.8	752.8	810.6

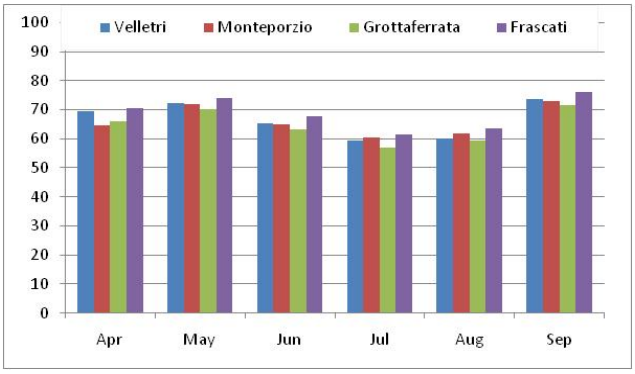

Fig. 1- *Monthly Relative Humidity average 2015-*

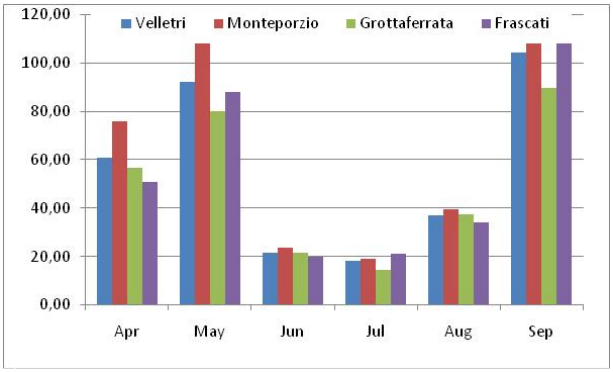

Fig. 2 - *Monthly Rainfall average 2015-2019*

Velletri, Frascati and Grottaferrata fall into HI+2: warm class of viticultural climate (Class interval > 2400 <=3000); the warm class is characterized by thermal resources that exceed the ripening needs of the varieties.
The night freshness index has a certain variability between one year and another; in 2017 the lowest values were recorded, 11°C in Monteporzio and Grottaferrata (data not shown). With reference to the index of night freshness or index of the cold night CI, Velletri, Frascati and Grottaferrata are in CI-1: temperate nights viticultural climate class (CI>14< 18); there is an intermediate condition between cool nights and warm nights; in this climate the late varieties mature at a lower temperature than the early ones.

Tab. 4 - *Index 2015 - 2019*

2015 - 2019	HI (°C)
VELLETRI	2533 ± 278
MONTEPORZIO	2242 ±122
GROTTAFERRATA	2618± 79
FRASCATI	2732±106

Tab. 5 - *Night Freshness Index IFN*

2015 - 2019	IFN (°C)
VELLETRI	15.1±1.85
MONTEPORZIO	13.1±1.4
GROTTAFERRATA	15.1± 2.4
FRASCATI	15.1± 1.4

Monteporzio, on the other hand, falls intoCI+1: cool nights viticultural climate class (Class interval > 12<= 14); in this class, ripening occurs under condition that can be more or less cool, depending on how early the varieties are. Conditions are cooler than in class "Temperate nights" so that a maximum threshold of nights temperature favorable to ripening will not be exceeded for any variety (Tonietto and Carbonneau, 2004).

With reference to water resources, the drought index has not been calculated; however, the precipitation data during the year, in all stations, recorded values of a good level of water availability, sometimes in excess during ripening.
For what concern the experimental Velletri vineyard, 2017 was the first year of vegetation. In 2018 and 2019 the vegetative development and the first productions were characterized by a very different climatic trend, Fig. 3. Spring 2019 was characterized by temperatures below the climatic average until June. In Tab 6 phenological BBCH code of resistant cultivars have been reported. The cold delayed flowering delayed 21 days, compared to 2018, until the GDDs reached the threshold of around 500 GDDs. The veraison occurs after reaching 1000-1400 GDD, with 35-10 days of delay according to the cultivar and finally, the maturation (1600-1900 GDD) was delayed by about 10 days compared to 2018.

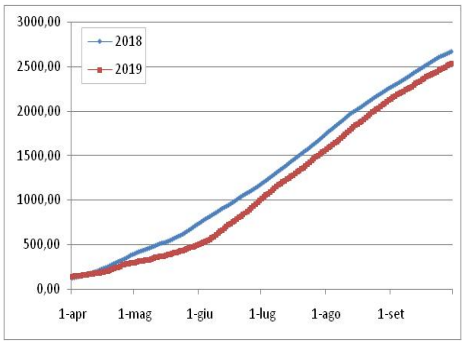

Fig. 3 - *GDD 2018 e 2019*

BBCH	2018	GDD 2018	2019	GDD 2019
65	22 May	470	10 Jun	498
Flowering	24 May	499	13 Jun	550
81	25 Jun	968	2 Aug	1454
Veraison	25 Jul	1486	5 Aug	1507
89 Ripening	28 Jul	1540	13 Aug	1671
of berries	20 Aug	1993	30 Aug	1971

Tab. 6 – *GDD at phenological stages 65, 81, 89, years*

Resistant cultivars were slightly earlier than the reference cultivars, Trebbiano Toscano and Sangiovese cvs. Earliness is particularly evident in the ripening phase: in fact, the resistant cultivars matured between the end of July and the middle of August. The Tuscan Trebbiano cv matured reaching around 2400 GDD; this happened on 15th September 2018 and 20th September 2019.
Sangiovese cv matured on reaching around 2300 GDD; 5th September 2018 and 15th September 2019.
The bunches were generally medium to small, weighing between 160 and 180 g; Soreli® cv had a heavier bunch, about 250 g; the reference varieties had bunches with an average weight of 500 g, and 350 g for Trebbiano Toscano cv and Sangiovese cv respectively.
These cultivars showed a good resistance to downy mildew. Tolerance to powdery mildew is less uniform, varying in intensity between the various groups (sensitive Sauvignon Kretos® and Cabernet Volos®); .
The results presented show that Frascati and Grottaferrata sites belong to the same climatic belt as Velletri, especially as regards to thermal resources. The heliothermic index and the nocturnal freshness index place Monteporzio in a cooler climate. Precipitation can be somewhat critical in all sites; in spring for fungal infections and especially in late summer during the ripening phase.
Considerations on the first results obtained from Velletri resistant vines. The white berry cultivars ripen before Trebbiano Toscano, the reference cultivar; Sauvignon Nepis® has produced very little; Sauvignon Kretos® is sensitive to powdery mildew; in 2018 it compromised its production. The most promising varieties seem to be Sauvignon Rytos®, Soreli® and Fleurtai®; but an additional observation period is required.
All the red grape varieties have completed the ripening of the grapes. Merlot Khorus®, Merlot Kanthus®and Cabernet Volos® anticipated Sangiovese, the reference cultivar; only Cabernet Eidos® developed at the same time as Sangiovese (results of a previous work, Cecchini et al., 2020).

CONCLUSION

Red grape varieties are more promising than the white ones, in quality and quantity. These vines can be considered for viticulture into the Castelli Romani Regional Park.
To express a judgment on white grape varieties it is necessary to wait for the production potential to fully express itself; susceptibility to powdery mildew and botrytis must be assessed and possibly addressed with new sustainable defense techniques.
The white vines could probably provide better performance in the climatic conditions of Monteporzio, characterized by a colder temperature than in Velletri.
The resistant vines were produced to obtain resistance to plant diseases but also to the cold. The Lazio area examined was rather warm, according to the new classifications.
Therefore, resistant vines showed great earliness compared to European reference cultivars and do not always meet the criteria for achieving quality.
The sites in the Castelli Romani Regional Park territory were found to be "hot wine growing areas"; perhaps this is partly due to the fact that the agro-meteorological stations in the area are located at low altitude. However, there is a hilly belt of higher altitude that certainly determines climatic conditions more responsive to quality viticulture, with colder temperatures, higher temperature ranges and cool nights. It is necessary to complete this climatic survey also in the vast area not affected by the SIARL weather network, rather by using data from other networks, to have a better understanding of the current situation and a view to a constant evolution of the climate.

REFERENCES:

Cecchini F., Serra M.C., Bevilacqua N., Costa C., Valori R., Pallottino F., Casadei G., Menesatti P., and Antonucci F. (2020) Advanced Modeling for the Identification of Different Pathogen Tolerant Vines to Reduce Fungicides and Energy Consumpion. Sustainabilit 2020,12,1900; doi:10.3390/su12051900 - www.mdpi.com/journal/sustainability

European and Mediterranean Plant Protection Organization (EPPO) Available online: http://www.eppo.int/RESOURCE/eppo_standards/pp1_list

® Italian National Register Available online: http://catalogoviti.politicheagricole.it/catalogo.php/assessed on 28 February 2020/

Council Regulation (EC) No 834/2007 of 28 June 2007 on organic production and labelling of organic products and repealing Regulation (EEC) No 2092/91

DIRECTIVE 2009/128/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 21 October 2009 establishing a framework for Community action to achieve the sustainable use of pesticides(Text with EEA relevance)

Galet P., 1999. Précis de Pathologie Viticole, 3e édition. JFImpression

REGOLAMENTO (CE) n. 479/2008 DEL CONSIGLIO del 29 aprile 2008 relativo all'organizzazione comune del mercato vitivinicolo, che modifica i regolamenti (CE) n. 1493/ 1999, (CE) n. 1782/2003, (CE) n. 1290/2005 e (CE) n. 3/2008 e abroga i regolamenti (CEE) n. 2392/86 e (CE) n. 1493/1999

Reynolds A.G., (2015). Reynolds A.G., 2015. Grapevine Breeding Programs for the Wine Industry. Elsevier, Cambridge. http://dx. doi.org/10.1016/B978-1-78242-075-0.01002-4

Risoluzione OIV VITI 423-2012l - All.2

Stauss R. Compendium of Growth Stage Identification Keys for Mono- and Dicotyledonous Plants – Extended BBCH scale 1994 Basel ISBN 3-9520749-0-X

Teissedre P.L., (2018). Composition of grape and wine from resistant vine varieties *OENO One*, 2018**,** 52, 3, 211-217 V I N E A N D W I N E OPEN ACCESS JOURNAL doi:10.20870/oeno-one.2018.52.3.2223

Tonietto J., Carbonneau A. (2004) - A multicriteria climatic classification system for grape-growing regions worldwide – Agricultural and Forest Meteorology, ELSEVIER www.sciencedirect.com

Vivai Cooperativi Rauscedo Quaderni tecnici VCR Le varietà resistenti alle malattie L'innovazione in Viticoltura 4^ Edizione 2019

ABSTRACT

Ten resistant cultivars were planted in the experimental vineyard of CREA, in Velletri. The cultivars used were crossbreeds established by the University of Udine, the Institute of Applied Genomic(IGA)and Vivai Cooperativi Rauscedo(VCR). They are downy mildew resistant and powdery mildew tolerant cultivars; so, they require a reduced number of fungicide treatments. Agronomical adaptability to Latium environmental conditions were analyzed for three vegetative seasons (2017-2019).
The resistance to fungal diseases suggests promoting resistant vines in protected areas, where viticulture must be characterized by a very low environmental impact and at the same time must be able to produce wines of a certain value. Resistant cultivars can be used to produce wines of a certain typicality as IGP (Reg. 479/2008, art. 34).
The aim of this study was to evaluate whether the climatic conditions of some sites of Castelli Romani Regional Park were suitable for the cultivation of resistant vines. With this objective, the weather conditions detected in Velletri have been considered and compared with those recorded in some other sites.
Some meteorological variables have been considered and some bioclimatic indices were calculated: Growing Degree Days (DGG), Heliothermic Index (HI), Rainfall Rate (RR), Night Freshness Index(IFN), (OIV, 2012), according to the climatic characterization of grape-growing regions (Tonietto and Carbonneau, 2004).
Keywords: **r**esistant vines, bioclimatix index, grape vine sustainability.