Vitis **47** (2), 131–132 (2008)

Research Note

A multidisciplinary approach to grapevine zoning using GIS technology: An example of thermal data elaboration

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Summary: In this study we suggest a multidisciplinary approach to zoning based on G.I.S. technology. An example of thermal data elaboration (air temperature) combined with the information derived from the heat requirements of 22 varieties is presented, based on an experiment conducted in an area of the province of Benevento (Campania region, southern Italy). The method combines thermal informations with the Amerine-Winkler bioclimatic index, to obtain a subdivision of the considered territory into five areas, according their thermal suitability. Through the model it was possible to create a map of the optimum thermal suitability of the considered varieties in the various zones of the studied territory.

K e y w o r d s : viticultural zoning, climate, thermal needs.

Introduction: The grapevine zoning can be used to evaluate the effects of different factors on the quality expression of different grapevine varieties.

The most frequent factors studied through multidisciplinary approaches that can influence the qualitative expression of the grapevine are climate (Hunter and Bonnardot 2002, Scaglione *et al.* 2003 a); soil aspects (Nadal *et al.* 2002, Scaglione *et al.* 2002, 2003 b), topography (Sotés and Gomez-Miguel 2002); sensory analyses (Ubigli *et al.* 2002). In this research we show an example of thermal data elaboration (air temperature) combining the information derived from the heat requirements of 22 varieties with the thermal availability of an area (Telesina Valley) situated in the province of Benevento (Campania region, southern Italy).

Material and Methods: To determine the thermal need of 22 varieties, all-native to the Campania region (Tab. 1), their phenological stages were monitored (Baillod and Baggiolini 1993, Intrieri *et al.* 1987). The heat requirement of the cultivars was calculated according to Amerine-Winkler model (1944) more answering respect to others like the Huglin's index (that consider a shorter period, until the 30 September) for the esteem of the thermal requirements of the Campania's varieties, because of their period of maturation, generally after the month of September. The thermal data were taken from 12 stations (regional

T a b l e 1

Thermal needs of the tested varieties (period '92-2003). Areas marked by an asterisk represent varieties not compatible with the thermal availability of the Telesina valley

Varieties	Place of observ. (province)	Years of observ.	Thermal need (DD)	Range applied to zoning
Aglianico (b)	Avellino, Benevento	'93,'94','95,'96	1804	1754-1854
Agostinella di C. (w)	Salerno	'97, ,98, ,99	1798	1748-1848
Bianco antico (w)	Salerno	'98,'99,2000	1794	1744-1844
Biancazita (w)*	Salerno	'98,'99,2000	2011	1961-2061
Camputese (w)*	Napoli	2000,'01,'02,'03	1958	1908-2008
Cannamelu (b)*	Napoli	2000,'01,'02,'03	1958	1908-2008
Catalanesca (w)	Salerno	'98,'99,2000	1865	1815-1915
Cerreto (w)	Salerno	'98,'99,2000	1790	1740-1840
Coda di cavallo (w)*	Salerno	'98,'99,2000	1903	1850-1950
Coda di pecora (w)*	Salerno	'98,'99,2000	1946	1896-1996
Falanghina (w)	Salerno	'98,'99,2000	1736	1686-1786
Fiano (w)	Avellino	'93,'94','95,'96	1625	1575-1675
Forastera (w)*	Napoli	2000,'01,'02,'03	1950	1900-2000
Guarnaccia (w)*	Napoli	2000,'01,'02,'03	1980	1930-2030
Malvasia di C. (w)	Benevento	'92,'93	1880	1830-1930
Pepella (w)*	Salerno	'98,'99,2000	1916	1866-1966
Piedirosso (b)	Avellino	'93,'94','95,'96	1700	1650-1750
Ripolo (w)	Salerno	'98,'99,2000	1829	1779-1879
S. Nicola (w)*	Salerno	'98,'99,2000	1952	1902-2002
S. Pietro (w)	Salerno	'98,'99,2000	1896	1846-1946
Sciascinoso (b)	Salerno	'93,'94,'95,'96	1650	1600-1700
Trebbiano tosc. (w)	Benevento	'92,'93	1650	1600-1700

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office CEPICA, Telese T., Benevento province), during the 13-year-period 1984-1996.

Amerine-Winkler's index: 365 matrices of the thermal data (a matrix per day of the year) were built in order to calculate the index for the T. valley. To apply the index to each point of the territory, two conditions needed to be satisfied: (1) Time distribution of the data: a database of averaged thermal data, needed to be consistent for the time period 1984-1996; (2) Spatial distribution of the thermal values: A thermal matrix for the T. valley was elaborated. The spatial distribution of the data was obtained using regression functions among elevation and daily data of mid temperature.

Results and Discussion: The thermal requirement of the grapevines (Tab. 1), ranged from 1600-1700 to 1950-2050 degree-days (DD). According to the model proposed, applied to the Californian territory (1944), no cultivar of Campania was compatible with region 1 (thermal availability less than 1390 DD); Fiano, Sciascinoso and Trebbiano t. resulted compatible with region 2 (1391-1670 DD); San Nicola, Biancazita and (eventually) Forastera (1950 DD) were compatible with region 4 (1951-2200 DD); no cultivar was compatible with region 5, (up to 2220 DD), while 17 cultivars resulted compatible with region 3 (1671-1950 DD), (Tab. 1).

In conclusion, on the base of their thermal requirements the larger part of the tested cultivars was characterized by an heat requirement compatible with moderate-warm areas (region 3 of Amerine-Winkler), while, even though limitedly to the tested grapevines, Campania resulted almost lacking in varieties with highest or lowest thermal requirements. These results may be of appreciable interest in order to plan grapevine cultivation in new territories characterised by moderate-warm climate.

The application of the model to the T. valley, permitted to have a subdivision of the territory into five areas, according to their thermal availability, ranging from less than 1200 to about 1900 DD. Because of high thermal requirements, 8 cultivars were judged unsuitable for cultivation in the area (Tabs 1, 2).

'Cerreto', 'Aglianico', 'Agostinella di C.', 'Bianco A.' and 'Ripolo' were suitable for more than 35 % of the valley (Tab. 2); 4 cultivars ('Coda di C.', 'Fiano', 'Forastera', 'Sciascinoso' and 'Trebbiano t.') showed limited suitability (less than 15 %), 'Catalanesca', 'Falanghina', 'Malvasia di C.' and 'Piedirosso', showed an intermediate level of suitability (from 17 to 28 %), (Tab. 2).

In particular, for example 'Malvasia di C.' (Tab. 1), was compatible with the territory situated in the central area of the valley characterised by an higher thermal availability compared to the mountain's territories around the valley with lower thermal availability. That area was compatible with other varieties characterised by a lower heat requirement as 'Fiano' or 'Sciascinoso'. In conclusion, the use of the GIS technology for zoning studies represent an interesting method to study the effects of different factors on the response of grapevines in different environments. In this study analysing the only thermal availability between grapevines and territory, it was possible to suggest the optimal territory for each tested cultivar.

Table 2

Suitable territory for the tested cultivars, estimated with the GIS method

Varieties	Potential surface (ha)	Potential surface (%)
Aglianico (b)*	8109.7	40.32
Agostinella di C. (w)*	7962.3	39.59
Bianco antico (w)	7694.1	38.26
Biancazita (w)	0.0	0.00
Camputese (w)	0.0	0.00
Cannamelu (b)	0.0	0.00
Catalanesca (w)	4859.2	24.16
Cerreto (w)	9460.7	47.04
Coda di cavallo (w)	1305.7	6.49
Coda di pecora (w)	0.0	0.00
Falanghina (w)	5586.6	27.78
Fiano (w)	0.0	0.00
Forastera (w)	1872.4	9.31
Guarnaccia (w)	0.0	0.00
Malvasia di C. (w)	3523.9	17.52
Pepella (w)	0.0	0.00
Piedirosso (b)	4043.5	20.10
Ripolo (w)	7049.2	35.05
S. Nicola (w)	0.0	0.00
S. Pietro (w)	1599.2	7.95
Sciascinoso (b)	2469.6	12.28
Trebbiano tosc. (w)	2469.6	12.28

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Received January 19, 2007