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Climate conditions in Coastal Croatia and their influence on grapevine variety **Plavac mali**

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INTRODUCTION

- Climate is one of the most important factors affecting wine.
- Climate conditions determine whether an area is suitable for planting of a vineyard, and to which extent will a certain variety express its potential.
- Optimum climatic conditions for grapevine production are geographically limited and are very specific. The conditions required to obtain the desired yields and optimum chemical composition of the grapes and the desired quality and type of wine.
- The influence of climate is manifested by the macro-climatic (region, subregion) and mesoclimatic (vineyard, position) activity, and the choice of agrotechnical and ampelographic measures undertaken in the vineyard.
- Based on natural conditions for wine growing in Croatia, viticulture regions are divided into regions of Eastern Continental Croatia, Western Continental Croatia and Coastal Croatia.



INTRODUCTION

- According to the official data of Payment Agency for Agriculture, Fisheries and Rural Development, the most represented and the most important red wine variety in Croatia is Plavac mali (app. 9%)
- Indigenous variety of Croatia with extraordinary potential that can produce excellent red wines.
- The aim was to evaluate which geographical areas in Coastal Croatia are within optimal conditions for the growth and development of the variety Plavac mali.



MATERIALS AND METHODS

- official data of Payment Agency for Agriculture, Fisheries and Rural Development - Vinogradarski registar
- official data from the meteorological station of the Meteorological and Hydrological Service of Agriculture (periods from 1961 to 2017) - trends over 30 year periods (1961-1990, 1988-2017)
- agroclimatic indices calculation: Growing degree-days (GDD or WI) and Heliothermal index (HI)
- samples of technically ripe grapes (20-25kg) in 2016 and 2017 - specifically chosen vineyards throughout the region
- measurement and weighing – grapes, clusters, berries
- analysis of the must (8-10 L) - values of sugar concentration, acidity and pH



HELIO THERMAL INDEKS (HI) - Huglin (1978)

$$HI = \sum_{i=1.4.}^{30.9.} \left[\frac{(T_{sr,i} - 10) + (T_{max,i} - 10)}{2} \right] k$$

- T_{sr} - average daily temperature
 - T_{max} - maximum daily temperature
 - k - latitude /daylength adjustment factor (Croatia 1,03-1,05)
 - period April - September
-
- a coefficient of the thermal component that expresses the mean day length in relation to the latitude



HELIO THERMAL INDEKS (HI) - Huglin (1978)

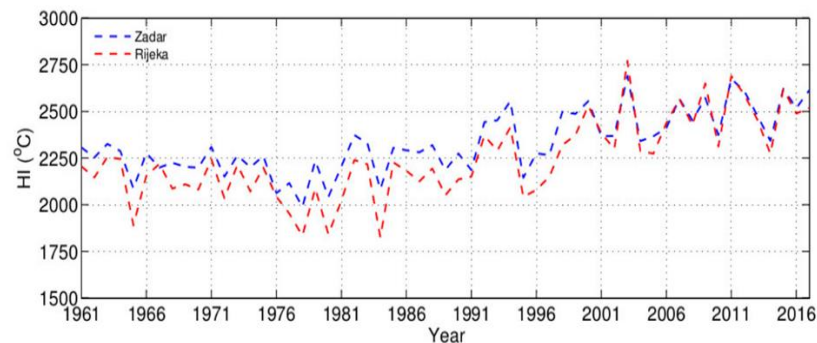
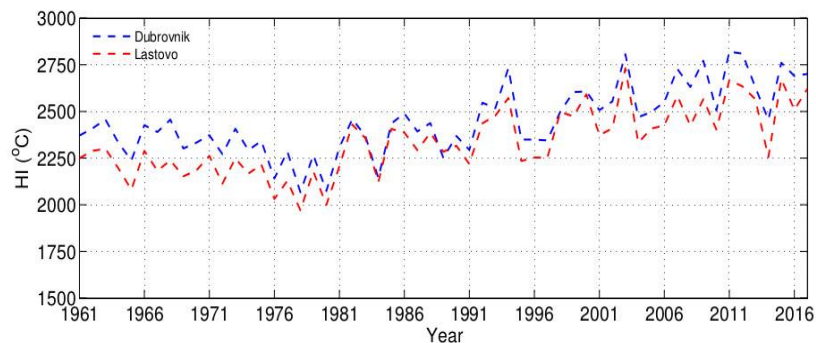
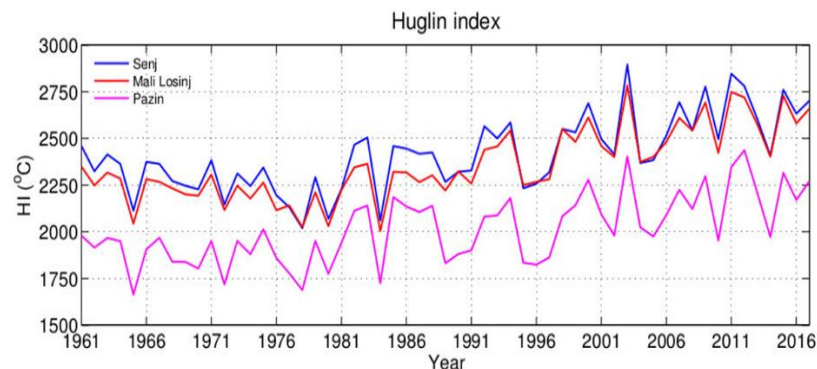
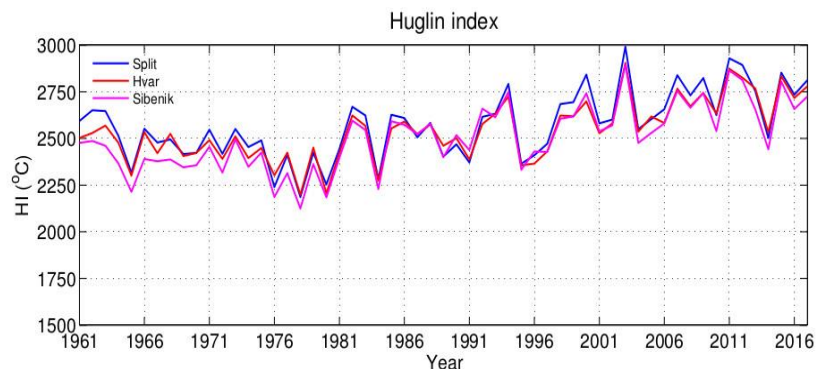
- classification of varieties according to time of maturation - Pulliat (1897)
- classes of viticultural climate for the Heliothermal Huglin index

Index	Class of viticultural climate	Acronym	Class interval	Varietie
HI	Very warm	HI + 3	> 2700 °C	
	Warm	HI + 2	> 2400 °C ≤ 2700 °C	
	Temperate warm	HI + 1	> 2100 °C ≤ 2400 °C	PLAVAC MALI , Grenache, Carignan, Mourvedre
	Temperate	HI - 1	> 1800 °C ≤ 2100 °C	Graševina, Rajnski rizling, Cabernet sauvignon, Syrah
	Cool	HI - 2	> 1500 °C ≤ 1800 °C	Chardonnay, Merlot, Cabernet franc
	Very cool	HI - 3	≤ 1500 °C	Pinot bijeli, Pinot sivi, Pinot bijeli, Rizvanac

*J. Tonietto, A. Carbonneau (2004), M. Ruml et al. (2012)



HELIO THERMAL INDEKS (HI) - Huglin (1978)

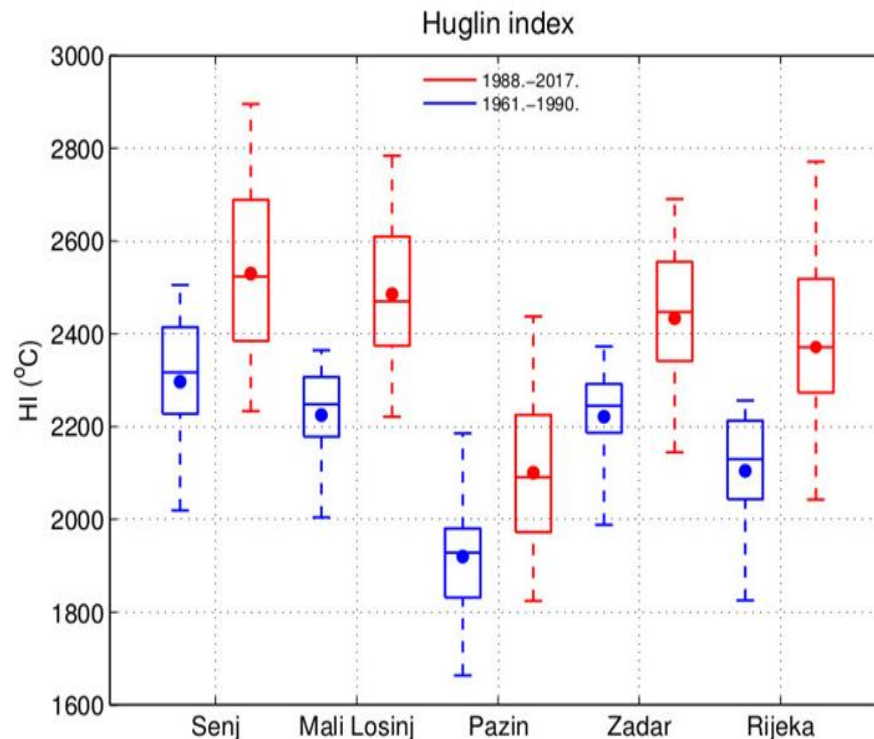
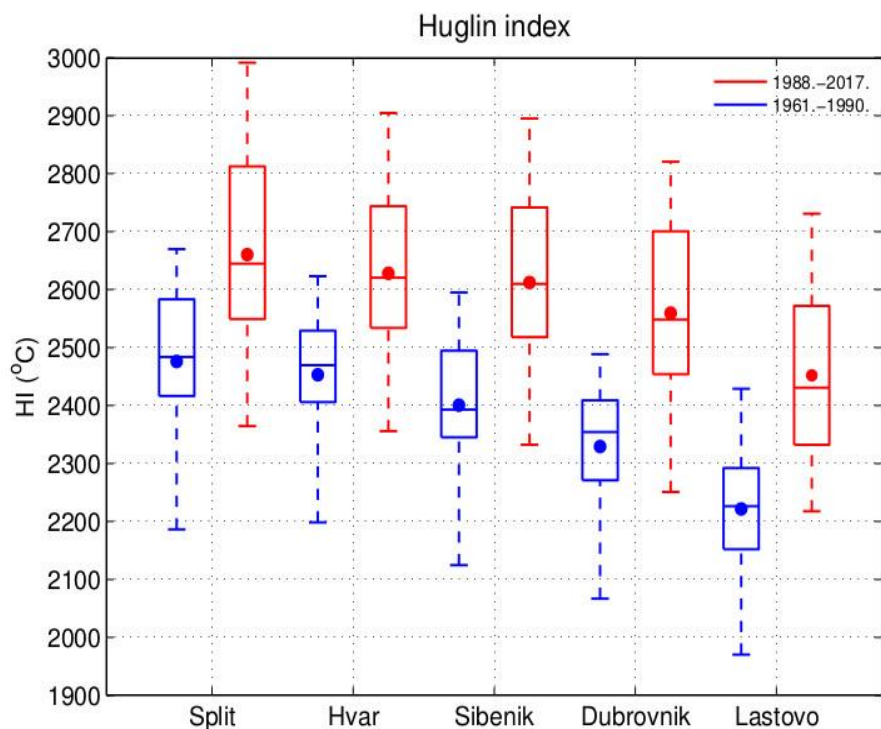


HI (°C)

Meteorological station		Dubrovnik	Lastovo	Hvar	Split	Šibenik	Zadar	Senj	Mali Lošinj	Rijeka	Pazin
MEAN VALUE	1961-1990	2329	2222	2453	2476	2401	2221	2297	2225	2104	1920
	1988-2017	2559	2452	2628	2661	2612	2434	2530	2486	2371	2101



HELIO THERMAL INDEKS (HI) - Huglin (1978)



		HI (°C)								
Meteorological station	Dubrovnik	Lastovo	Hvar	Split	Šibenik	Zadar	Senj	Mali Lošinj	Rijeka	Pazin
DIFFERENCE (1961-1990 AND 1988-2017)	230	230	175	185	211	213	233	261	267	181



GROWING DEGREE-DAYS (GDD or WI) - Winkler (1944)

$$WI = \sum ((T_{max} + T_{min}) / 2) - T_{base}$$

- T_{max} - maximum daily temperature
- T_{min} - minimum daily temperature
- $T_{base} = 10\text{ }^{\circ}\text{C}$
- period April - October

Region I < 1390 °C

Region II 1390 - 1670 °C

Region III 1671 - 1940 °C

Region IV 1941 - 2220 °C

Region V > 2220 °C

- based on the heat unit concept using growing degrees base 10°C
- correlating the WI with quality wine grape production - five regions (Winkler et al, 1974); Croatia - regions B, C I i C II



GROWING DEGREE-DAYS (GDD or WI) - Winkler (1944)



Wine growing regions



0 100 200 300 km



"Reg (EU) 1308/2013 Appendix I"

Source EUROSTAT and DG AGRI C 03

Cartography DG AGRI GIS-Team 09/2015

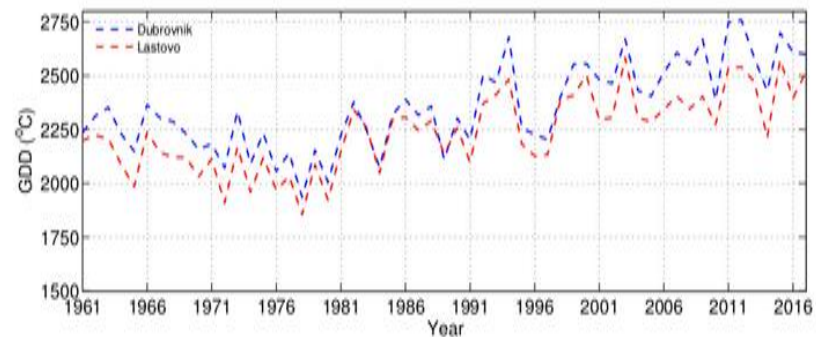
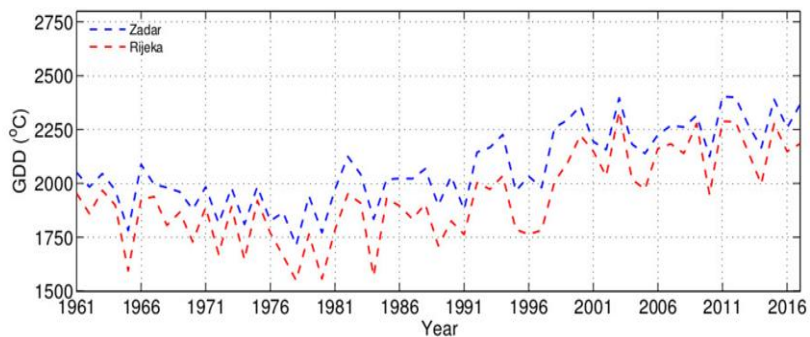
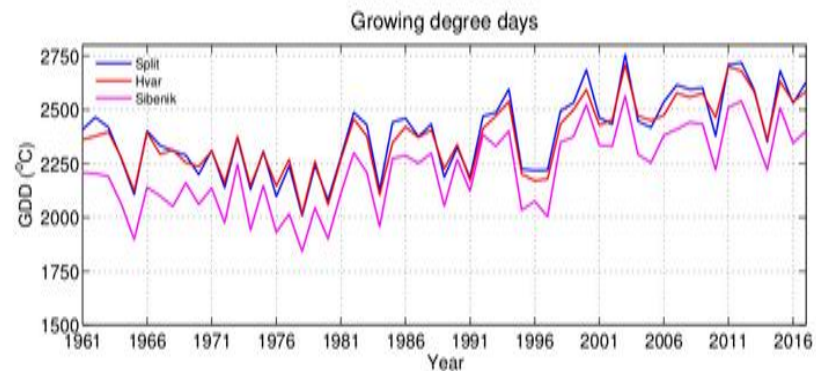
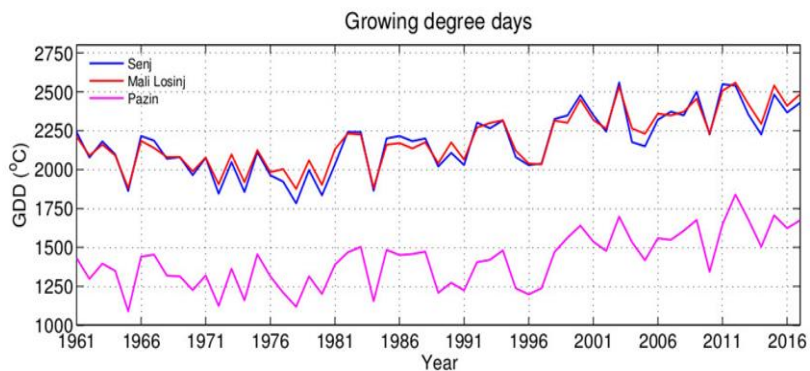
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**source: EUROSTAT and DG AGRI C.03 Cartography DG AGRI GIS-Team 09/2015 c EuroGeographics for administrative boundaries*



GROWING DEGREE-DAYS (GDD or WI) - Winkler (1944)



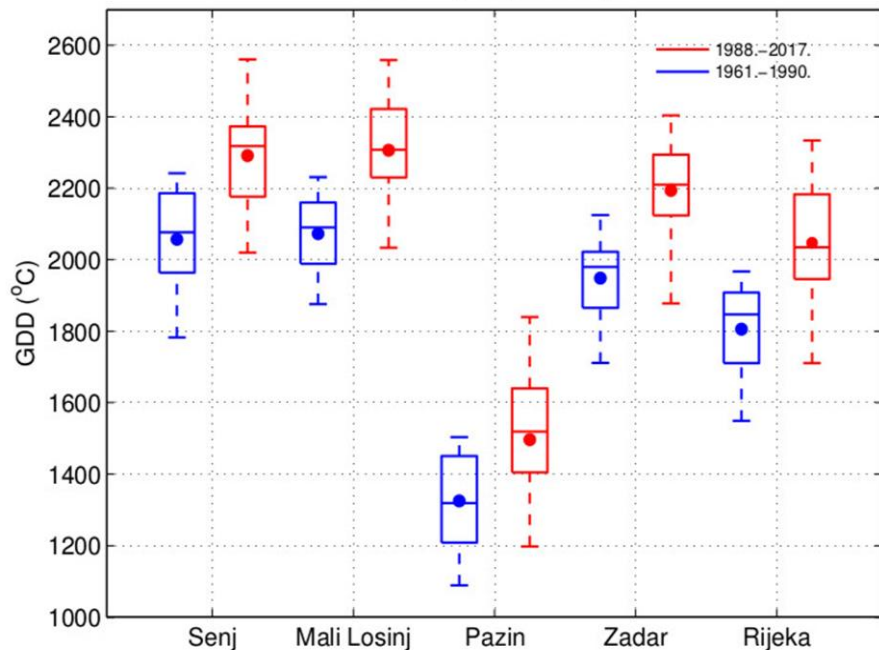
GDD (°C)

Meteorological station		Dubrovnik	Lastovo	Hvar	Split	Šibenik	Zadar	Senj	Mali Lošinj	Rijeka	Pazin
MEAN VALUE	1961-1990	2218	2127	2280	2289	2109	1948	2057	2073	1806	1325
	1988-2017	2481	2353	2463	2484	2326	2194	2291	2306	2047	1495

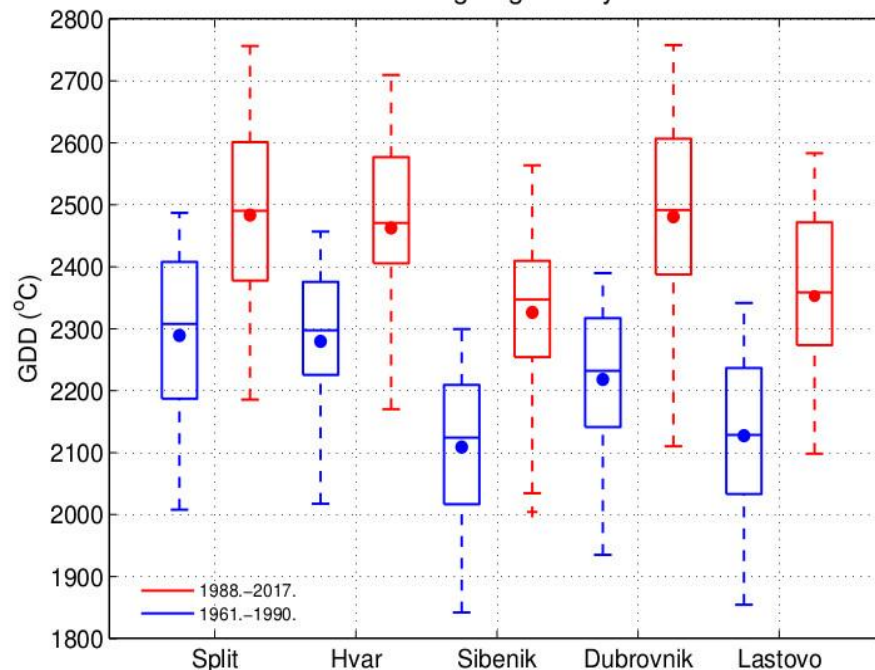


GROWING DEGREE-DAYS (GDD or WI) - Winkler (1944)

Growing degree days



Growing degree days



GDD (°C)

Meteorological station	Dubrovnik	Lastovo	Hvar	Split	Šibenik	Zadar	Senj	Mali Lošinj	Rijeka	Pazin
DIFERENCE (1961-1990 AND 1988-2017)	263	226	183	195	217	246	234	233	241	170



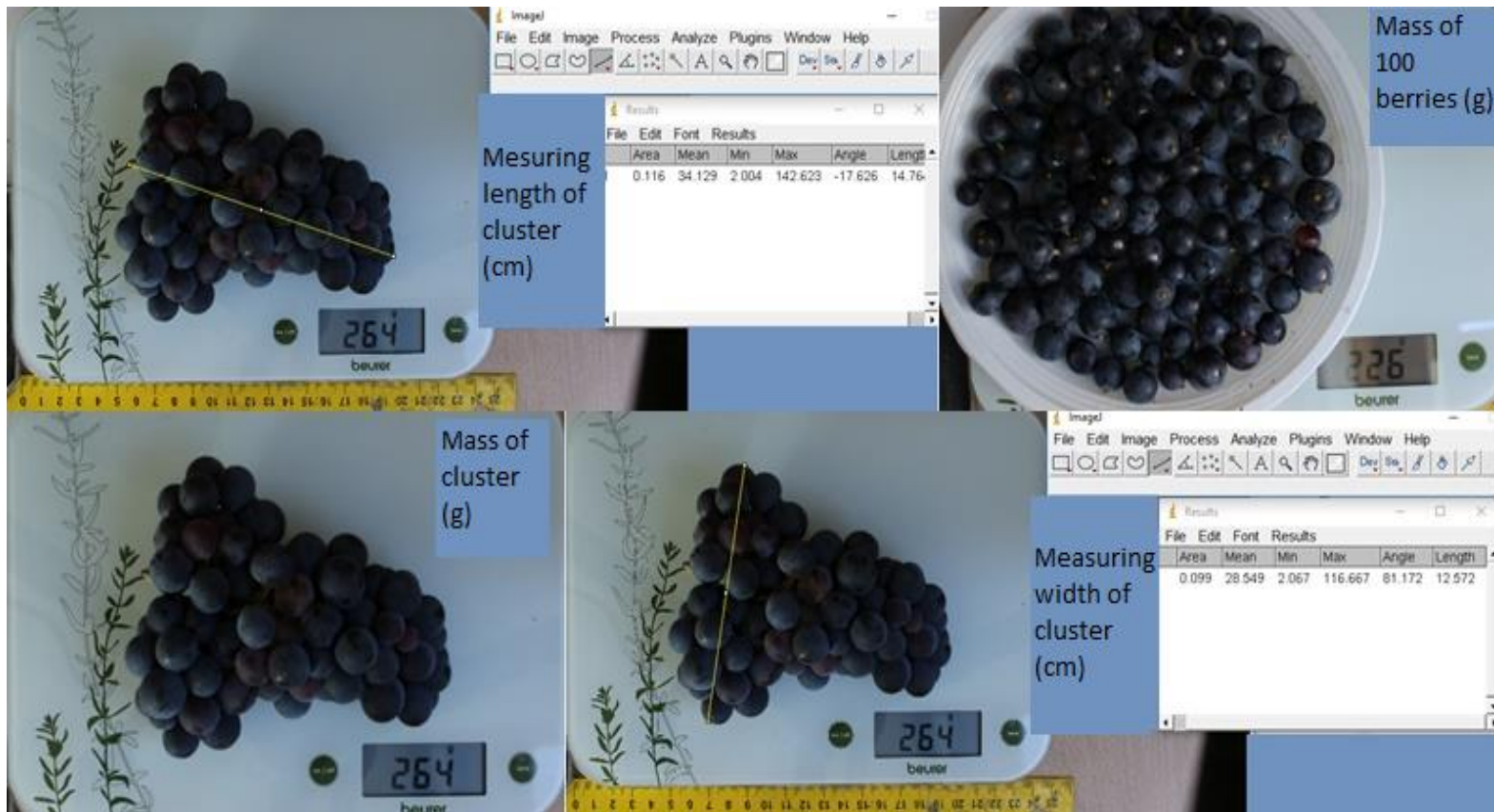
SAMPLES OF GRAPES



- collected samples of technically ripe grapes in specifically chosen vineyards throughout the region



MEASUREMENT AND WEIGHING



- clusters and grapes were measured and weighed



RESULTS - Harvest 2016

Currency code	Sampling date	Winegrowing region	Average lenght of cluster (cm)	Average width of cluster (cm)	Average mass of cluster (g)	Average mass of berry (g)	Average number of berries per cluster
P1	12/10/2016	Konavle	15,2	10,8	183,7	1,59	116
P2	22/9/2016	Pelješac	11,4	8,2	160,1	2,46	65
P3	12/10/2016	Pelješac	13,6	10,5	157,1	2,34	67
P4	12/10/2016	Pelješac	11,6	9,6	143,8	2,12	68
P5	22/9/2016	Korčula	15,0	11,0	301,8	2,75	110
P6	21/9/2016	Hvar	12,7	8,2	154,4	3,88	40
P7	8/10/2016	Kaštela - Trogir	11,6	8,6	106,2	1,22	87
P8	12/10/2016	Šibenik	14,5	10,1	181,4	2,11	86
P9	08/10/2016	Benkovac - Stankovci	16,7	10,3	302,5	2,39	127
P10	08/10/2016	Zadar - Biograd	13,4	9,5	182,5	2,28	80
P11	11/10/2016	Rab	15,9	10,9	195,8	1,36	144
P12	11/10/2016	Krk	12,1	6,7	61,6	1,35	46
AVERAGE			13,6	9,5	177,6	2,2	86



RESULTS - Harvest 2017

Currency code	Sampling date	Winegrowing region	Average length of cluster (cm)	Average width of cluster (cm)	Average mass of cluster (g)	Average mass of berry (g)	Average number of berries per cluster
P1	19/9/2017	Konavle	17,5	13,3	174,3	1,47	119
P2	19/9/2017	Pelješac	14,7	10,8	112,0	2,28	49
P3	24/9/2017	Pelješac	14,6	11,9	126,3	2,03	62
P4	28/9/2017	Pelješac	17,0	9,7	87,1	1,53	57
P5	19/9/2017	Korčula	16,7	11,4	227,1	1,88	121
P6	4/9/2017	Hvar	16,6	12,3	170,3	1,15	148
P7	27/9/2017	Kaštela - Trogir	14,3	12,0	125,9	1,68	75
P8	27/9/2017	Šibenik	14,3	12,2	138,0	1,45	95
P9	25/9/2017	Benkovac - Stankovci	18,6	13,7	252,0	1,70	148
P10	27/9/2017	Zadar - Biograd	14,7	13,1	116,3	1,15	101
P11	9/9/2017	Rab	17,1	12,9	262,7	1,76	149
P12	23/9/2017	Krk	19,1	10,5	76,0	0,86	88
AVERAGE			16,3	12,0	155,7	1,6	101



RESULTS - Harvest 2016

Currency code	Sampling date	Winegrowing region	Must		
			Sugar (°Oe)	Acid (g/L)	pH
P1	12/10/2016	Konavle	92	5,40	3,82
P2	22/9/2016	Pelješac	112	6,00	3,61
P3	12/10/2016	Pelješac	90	4,35	3,68
P4	12/10/2016	Pelješac	107	6,00	3,30
P5	22/9/2016	Korčula	94	6,23	3,31
P6	21/9/2016	Hvar	115	6,15	3,48
P7	8/10/2016	Kaštela - Trogir	91	5,33	3,26
P8	12/10/2016	Šibenik	93	4,90	3,26
P9	8/10/2016	Benkovac - Stankovci	82	10,50	3,02
P10	8/10/2016	Zadar - Biograd	78	3,75	3,65
P11	11/10/2016	Rab	86	4,50	3,85
P12	11/10/2016	Krk	102	7,60	3,26
AVERAGE			86,7	5,3	3,2



RESULTS - Harvest 2017

Currency code	Sampling date	Winegrowing region	Must		
			Sugar (°Oe)	Acid (g/L)	pH
P1	19/9/2017	Konavle	78	3,38	3,68
P2	19/9/2017	Pelješac	115	3,83	3,83
P3	24/9/2017	Pelješac	95	4,24	3,45
P4	28/9/2017	Pelješac	112	6,30	3,20
P5	19/9/2017	Korčula	94	4,95	3,31
P6	4/9/2017	Hvar	85	4,69	3,67
P7	27/9/2017	Kaštela - Trogir	81	4,43	3,34
P8	27/9/2017	Šibenik	108	4,88	3,32
P9	25/9/2017	Benkovac - Stankovci	81	9,83	2,98
P10	27/9/2017	Zadar - Biograd	77	4,88	3,52
P11	9/9/2017	Rab	85	4,31	3,69
P12	23/9/2017	Krk	70	5,29	3,67
AVERAGE			90,1	5,1	3,5



CONCLUSION

Average	Average length of cluster (cm)	Average width of cluster (cm)	Average mass of cluster (g)	Average mass of berry (g)
2016.	13,6	9,5	177,6	2,2
2017.	16,3	12,0	155,7	1,6

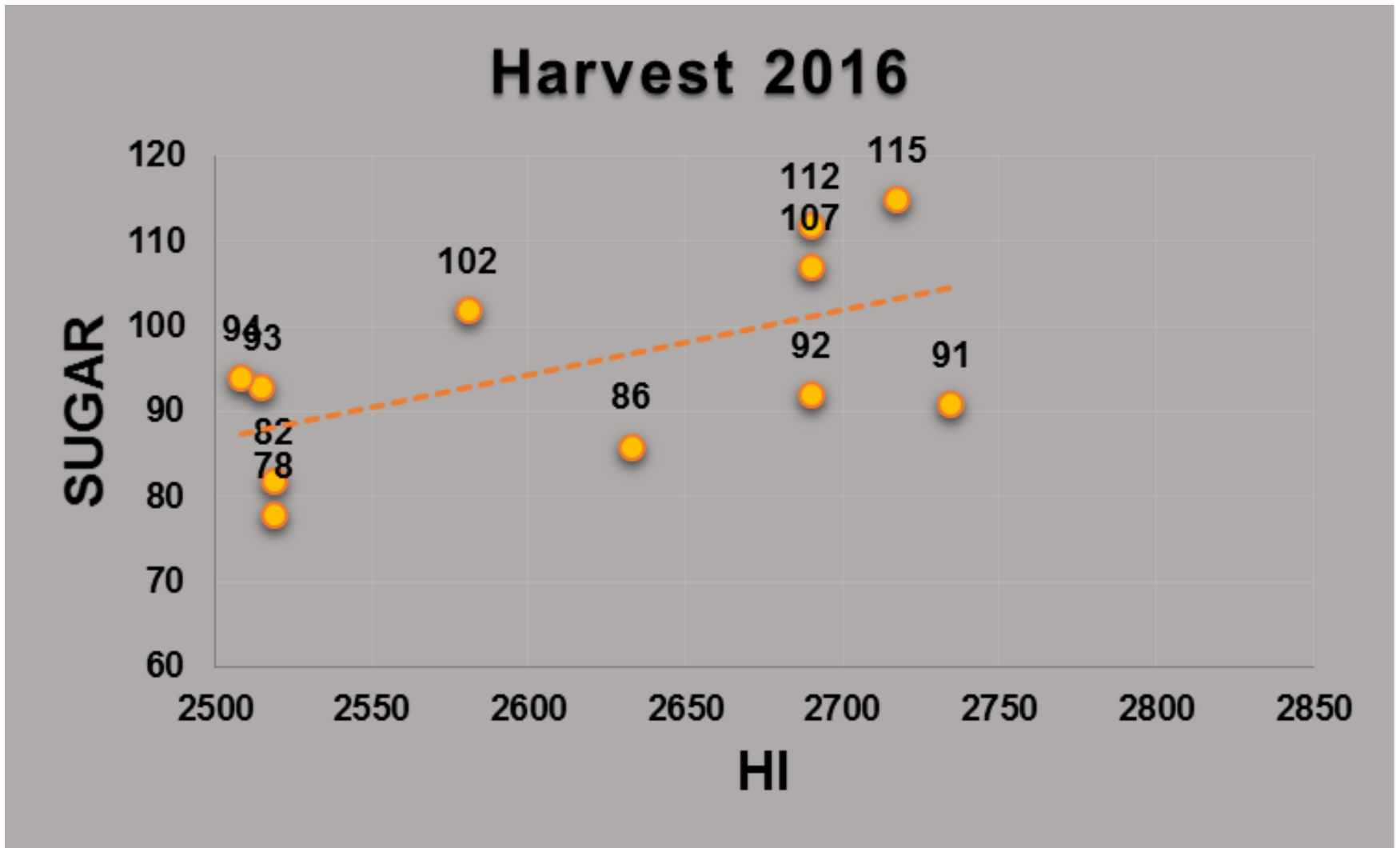
Average	Sugar (°Oe)	Acid (g/L)	pH
2016.	86,7	5,3	3,2
2017.	90,1	5,1	3,5

2016										
Meteorological station	Dubrovnik	Hvar	Lastovo	Mali Lošinj	Pazin	Rijeka	Senj	Split	Šibenik	Zadar
GDD	2609,4	2537,1	2396,9	2409,8	1622,7	2148,1	2367,2	2530,7	2345,1	2257,9
HI	2689,6	2717,2	2508,2	2580,6	2170,7	2488,7	2632,5	2734,3	2657,6	2518,4

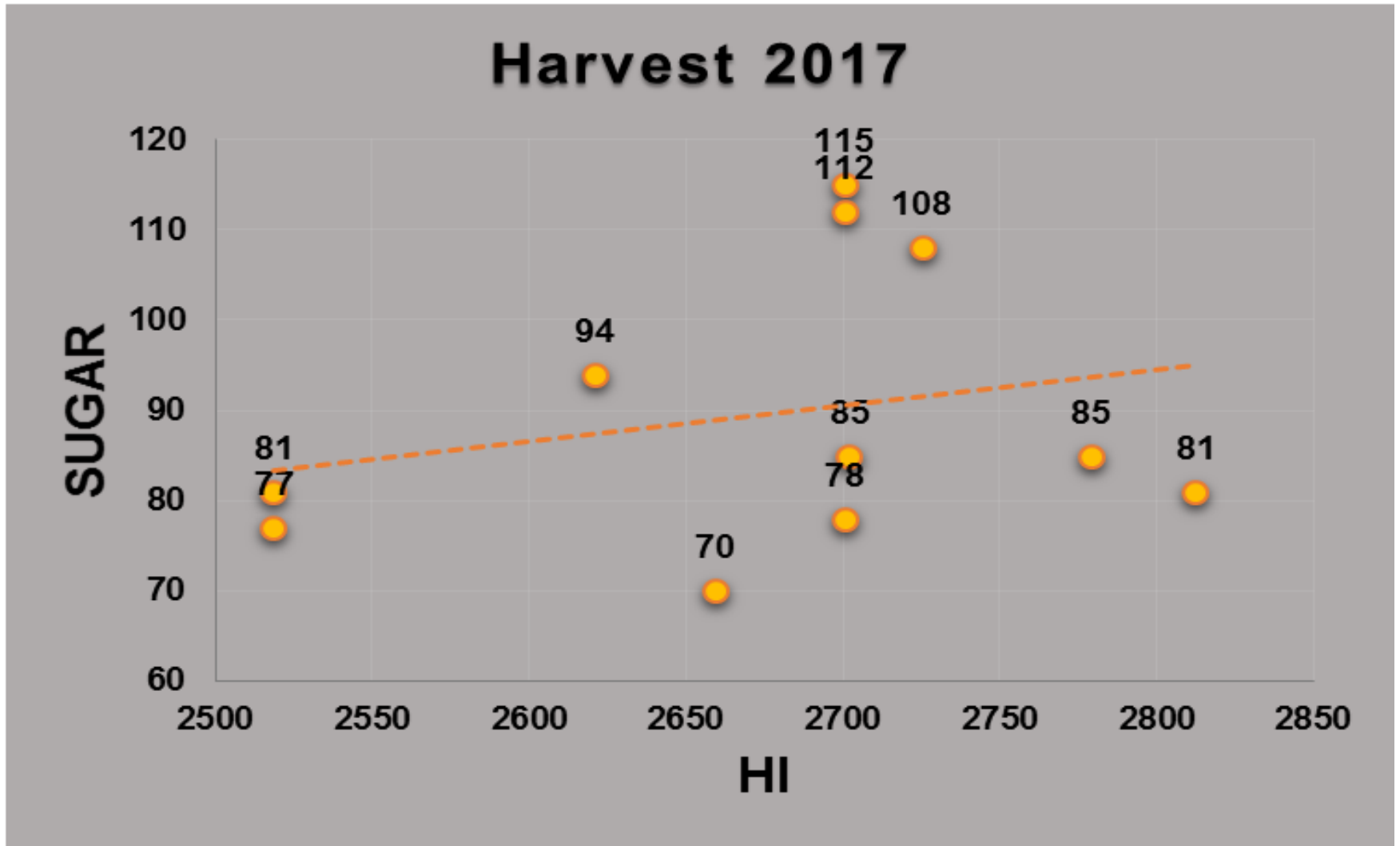
2017										
Meteorological station	Dubrovnik	Hvar	Lastovo	Mali Lošinj	Pazin	Rijeka	Senj	Split	Šibenik	Zadar
GDD	2599,7	2584,7	2519,1	2485,6	1673,9	2183,8	2428,9	2627,4	2401,1	2366,3
HI	2700,6	2779	2620,9	2659,3	2271,7	2518,4	2702	2812,4	2725,1	2613,3



CONCLUSION



CONCLUSION



CONCLUSION

- there is a noticeable trend in the growth of the value of all indices
- new wine-growing areas are expected to be suitable for growing grape wine varieties
- in existing winegrowing areas, it will surely change and expand the existing assortment
- the impact of future climate change will not be uniform for all grape varieties and all winegrowing areas - conditions for potential specific, limited micro-regions (locations) of grapevine growing will be created
- in grape berry rarely reaches their optimal concentrations at the same time - climatic conditions in a particular year, especially in the time immediately before the harvest, significantly affect the dynamics of ripening the grapes and condition the time of harvest



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- 61 producers





THANK YOU FOR YOUR ATTENTION!

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