BRAZILIAN FRUIT PRODUCTION AND EPIDEMIOLOGY AND MANAGEMENT OF TEMPERATE FRUIT DISEASES

BRAZIL FOR THE WORLD

Brazil - 5º biggest Country

Brazil – South America
Linear distance – 5.200 km

NORTHERN BRAZIL

Clime diversity

Economy diversity

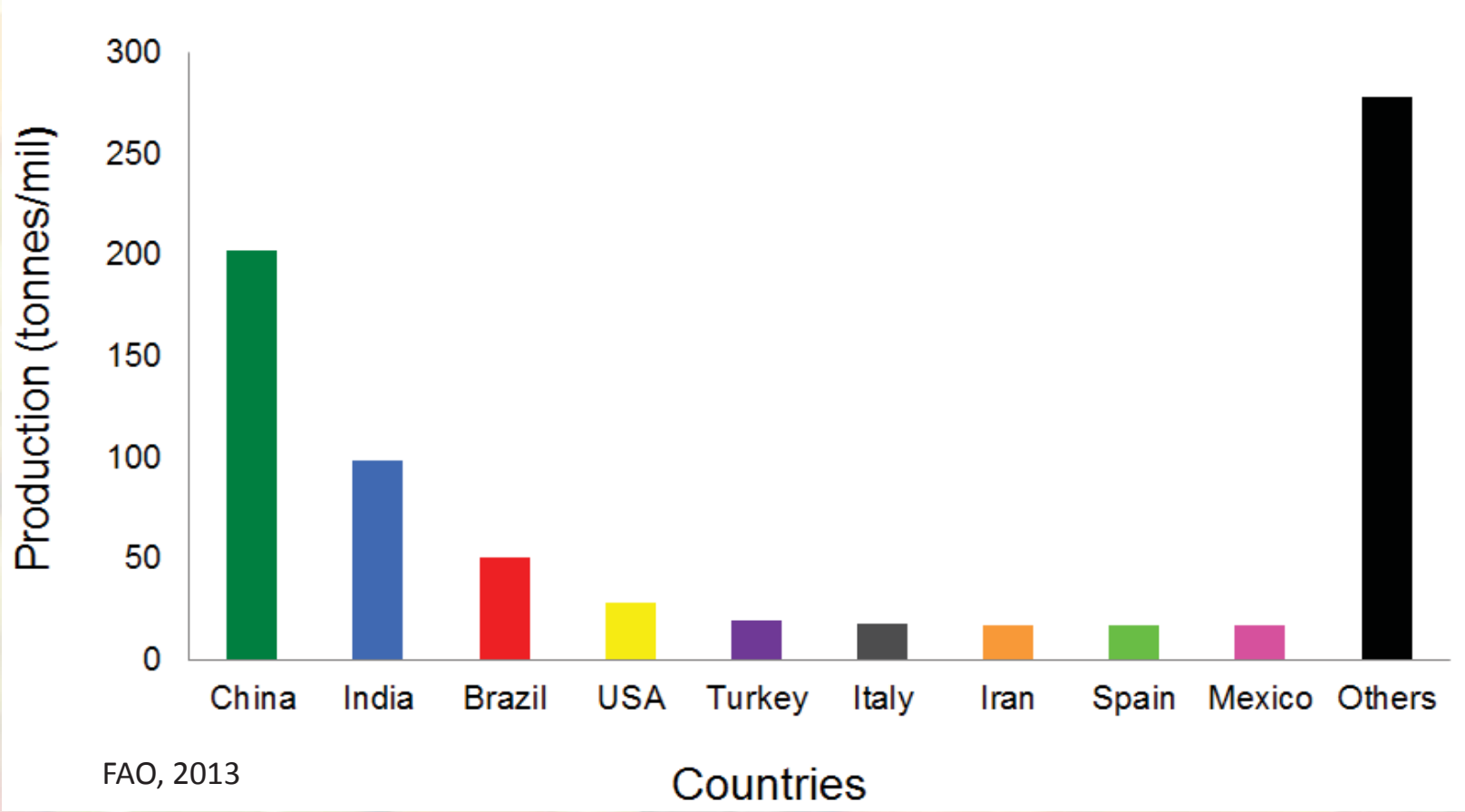
SOUTHERN BRAZIL

Clime diversity

Economy diversity

TEMPERATE FRUIT REGION

WORLD FRUITS PRODUCTION



FAO, 2013

GLOBAL IMPORTANCE

Fruits more produced in the world in 2013

specie	Production (tonnes)
1º Banana	122.114.819
2º Watermelon	109.004.814
3º Apple	89.569.512
4º Orange	89.416.335
5º Grape	88.311.466
6º Plantain	56.561.851
7º Pear	42.644.755
8º Pineapple	29.418.477

Consumption of 12,83 kg/inhab/year

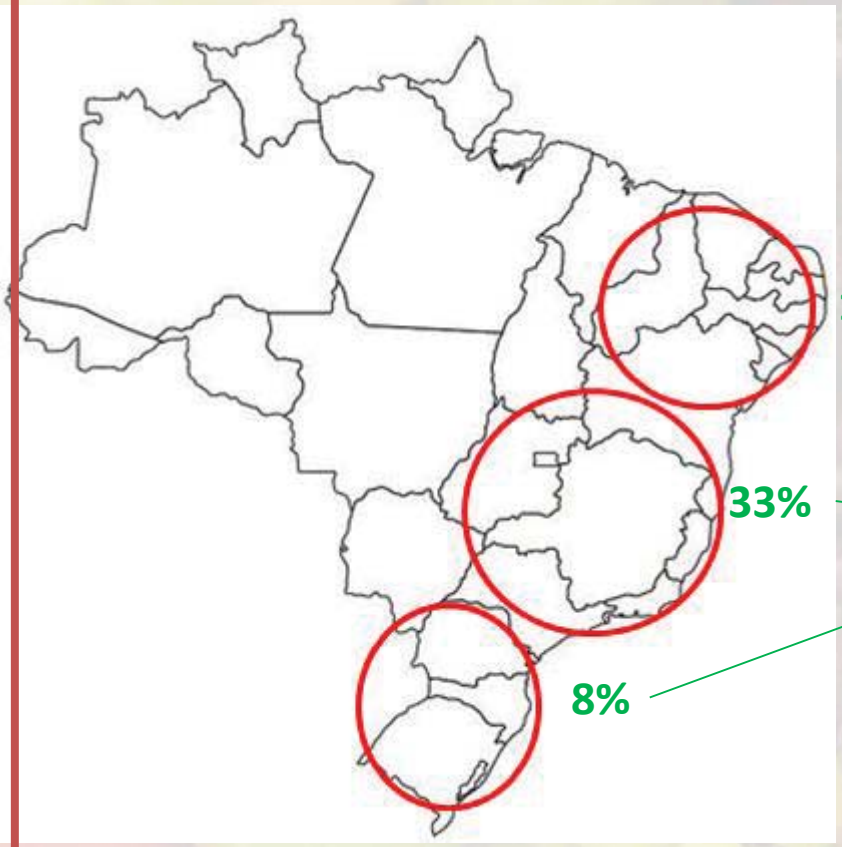
Consumption of 11,13 kg/inhab/year

Consumption of 5,9 kg/inhab/year

IBRAF, 2013

BRAZILIAN FRUIT PRODUCTION

- Production/annual - 50 millions tons.
- Production area - 3 millions ha.
- Fruit variety: Tropical, Subtropical, Temperate.



Biggest Fruits Producers States

BRAZILIAN STATES FRUIT PRODUCERS

Tropical Fruits:

- -Pineapple*;
- -Papaya*;
- - Banana;
- - Melon
- - Mango,
- - Coconut
- - Passionfruit;

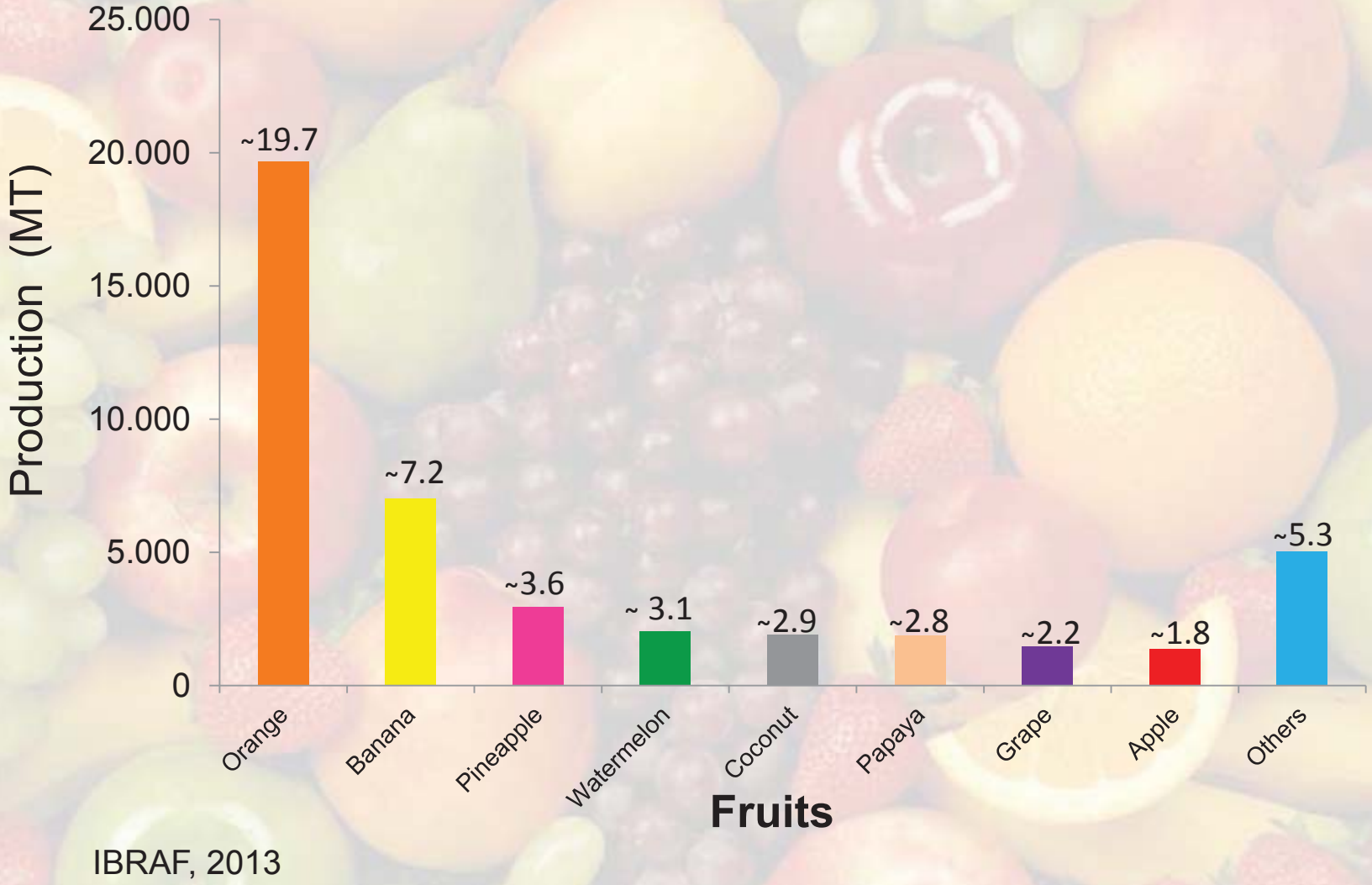
Subtropical fruits:

- - Citrus *
- - Guava

Temperate fruits:

- - Apple;
- - Fig;
- - Grape;
- - Peach;
- - Pear.

BRAZILIAN FRUITS PRODUCTION



IBRAF, 2013

NATIONAL FRUIT IMPORTANCE

Brazil is the biggest producer of:

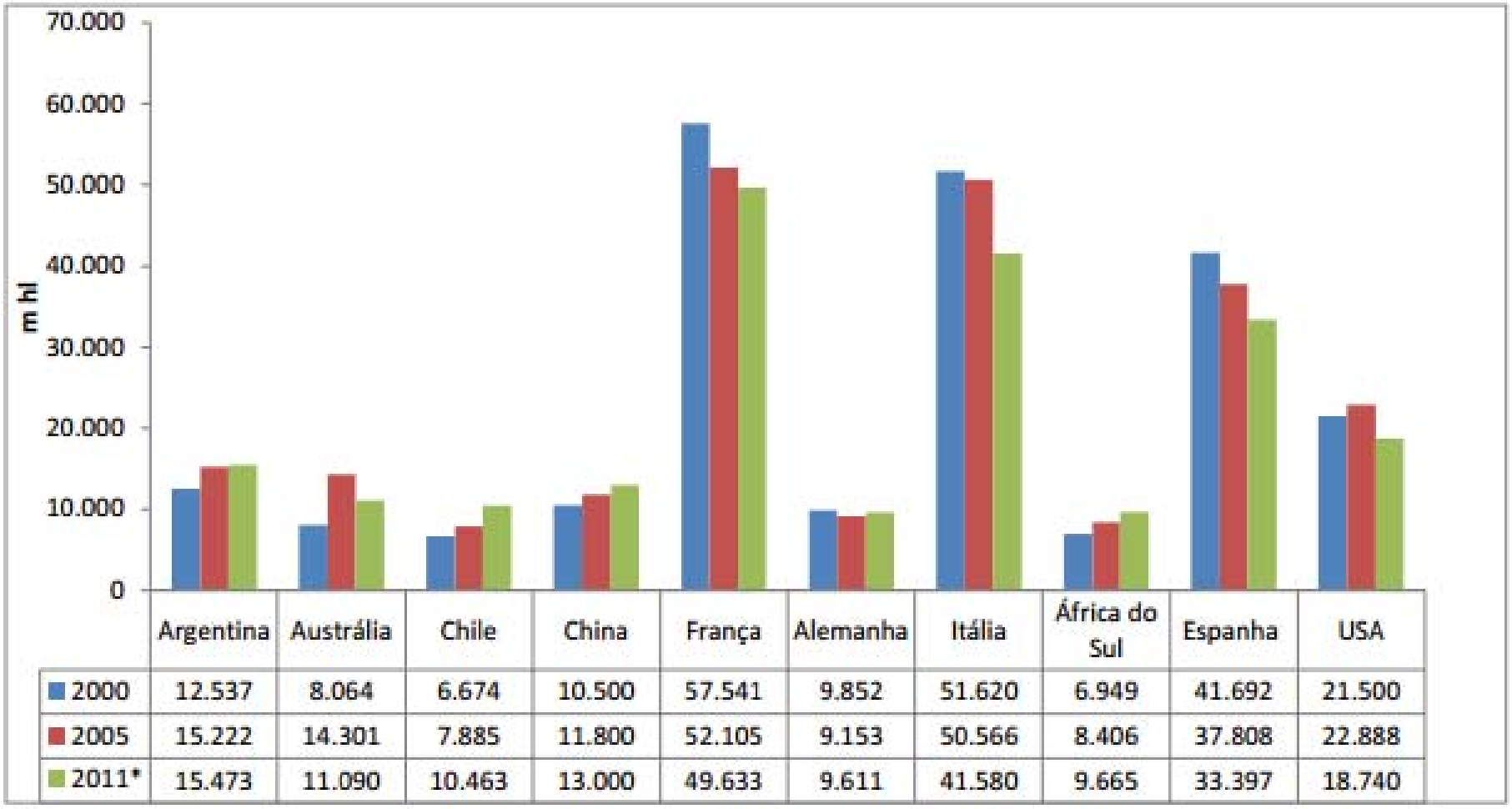
EPIDEMIOLOGY AND MANAGEMENT OF GRAPE DISEASE IN BRAZIL

Grape

INTRODUCTION

- Diseases represent a major threat to the commercial production of grapes in the world;
- Climatic conditions are conducive to the development of several major grape diseases, including anthracnose, downy mildew, powdery mildew, black rot and Botrytis bunch rot.
- Each of these diseases has the potential to destroy the entire crop;
- Most diseases occur simultaneously within the same vineyard during the growing season.

WORLD VITICULTURE PRODUCTION



	Argentina	Austrália	Chile	China	França	Alemanha	Itália	África do Sul	Espanha	USA
2000	12.537	8.064	6.674	10.500	57.541	9.852	51.620	6.949	41.692	21.500
2005	15.222	14.301	7.885	11.800	52.105	9.153	50.566	8.406	37.808	22.888
2011*	15.473	11.090	10.463	13.000	49.633	9.611	41.580	9.665	33.397	18.740

OIV – Statistical Report on World Vitiviniculture
Mhl= millions of hectolitres

BRASILIAN VITICULTURE

- Second most cultivated crop area with 7,5 millions of hectares;
- Special attention for fine wines from European grape varieties of *Vitis vinifera*.

country	area in 2013 (m/ha)
Argentina	218
Austrália	174
Brasil	92
Bulgária	73
Chile	202
China	560
França	807
Grécia	111
Hungria	65
Itália	776
Nova Zelândia	37
Portugal	240
Roménia	204
África do Sul	131
Espanha	1032
Turquia	500
USA	405

country	production 2013 (m/hl)
Argentina	15.473
Austrália	11.010
Brasil	3.450
Bulgária	1.268
Chile	10.572
China	13.200
França	49.633
Grécia	2.587
Hungria	2.447
Itália	41.580
Nova Zelândia	2.350
Portugal	5.925
Roménia	4.708
Federação Russa	6.353
África do Sul	9.336
Espanha	34.300
USA	18.740

BRASILIAN VITICULTURE

- Brasilian wine *per capita* consume - 1,7 liters/year;
- The 2022 wine *per capita* consume expectation will be 9 liters/habitant/year (IBRAVIN, 2013)

Consumi pro capite annui - stima 2012

	Abitanti	Consumi (hl/m)	litri pro capite
TOTALE MONDO	6,900	245.3	3.6
FRANCIA	63	30.3	48.2
STATI UNITI	303	29.0	9.6
ITALIA	60	22.6	37.7
GERMANIA	83	20.0	24.0
CINA	1,348	17.8	1.3
REGNO UNITO	62	12.5	20.2
SPAGNA	46	9.3	20.2
RUSSIA	145	*10.1*	7.0
ARGENTINA	40	10.1	24.9
ROMANIA	22	*4.9*	22.9
AUSTRALIA	22	5.4	24.2
PORTOGALLO	11	4.6	42.5
CANADA	34	*3.7*	11.0
BRASILE	199	3.4	1.7
SUD AFRICA	50	3.6	7.2
OLANDA	17	3.8	23.0


BRASILIAN MAP OF VINICULTURE
FINE WINES
WINES + JUICE
IN NATURE
Vale do São Francisco
Sul de Minas
Planalto Catarinense
Serra Gaúcha
Campanha

Phytosanitary problems – diseases

- **CAN REACH -** 100 % of losses;
- Inadequate training systems and pruning methods increase the most important grape diseases;
- Excessive fungicides utilization for diseases control – wine quality.




Anthracnose

- It is especially serious on new sprouts during rainy season;
- Among various foliar diseases of grapevine in Brazil, anthracnose has longest spell spread over the period from August to November.

ETIOLOGY:

- *Elsinoe ampelina – Sphaceloma ampelinum;*
- The fungus overwinters as sclerotia (around world – no Brazil) or conidia and mycelium (Brazil) on infected shoots, canker and dormant buds;
- In the spring, conidia on infected shoots/canker/buds germinate abundant when they are wet for 12 hours or more and the temperature 24-26°C .

Anthracnose - symptoms

• Beginning with small round spots with brown or black margins with greyish-white center which cause malformed leaves that shrivel up and drop.

• Greyish in the center with a raised dark reddish brown to violet-black edge

• Deep elongated cankers. Infected shoots crack and become brittle

• Reddish circular spots becoming violet with a greyish center and a raised black edge "bird's eye rot"

Anthracnose - control

1. Sanitation is very important;
2. Eliminate wild grapes near the vineyard;
3. . Varieties differ in their susceptibility;
4. Canopy management can aid in disease control.
5. Fungicide use:

- Phenological stage - 5 (green tip) – dormant application of Liquid Lime Sulfur in early spring, followed by applications of foliar fungicides during the growing season with copper, mancozeb, captan, chlorothalonil, folpet, ziran, dithianon.

Downy Mildew

- ✓ Downy mildew is a highly destructive disease of grapevines in all grape-growing areas of Brazil where there is spring and summer rainfall at temperatures above 10ºC;

- ✓ Susceptibility within the Brazilian species *Vitis vinifera*, varies from highly susceptible to tolerant.

ETIOLOGY:

- ✓ *Plasmopara viticola*, produces asexual, biflagellate zoospores and sexual oospores. Its mycelium is aseptate. It is an Oomycete in the order Peronosporales;

- ✓ Most taxonomists no longer include oomycetes, and have placed them instead in the kingdom Chromista.

Downy Mildew - symptoms

•Roughly circular yellowish discolourations called “oil spots”.

•White fluffy growth primarily on the lower leaf surface.

As lesions age, they turn brown and getting dry

•White fluffy sporulation on small berries.

Severely infected berries may shrivel and drop off.

Epidemiology

- The causal fungus, *Plasmopara viticola* overwinters as thick-walled oospores in infected tissues and in the soil.
- A minimum of 10 mm of rain is required for oospores to produce sporangia that are dispersed by rain splash to young green tissue.
- The sporangia release motile zoospores that swim to the stomata, germinate and infect tissues.
- Disease development is most rapid between 20^{o}C and 25^{o}C with frequent rain or dew.

Downy Mildew - control

1. **Cultural practices**

- ✓ vineyards location (fog, cold wind), drainage, type of irrigation and training systems and pruning methods should all be selected to reduce the risk of disease.

2. **Genetic resistance**

- ✓ All cultivars of *Vitis vinifera* (the Eurasian species) are considered susceptible (Chardonnay, Pinot Noir, Cabernet Sauvignon and Semillon);

- ✓ Several North American species show resistance to downy mildew (e.g. *V. labrusca* and V. *rotundifolia*);

Downy Mildew - control

3. Chemical control

- ✓ Both pre-infection (protective - **cymoxanil**) and post-infection (systemic or penetrant - **metalaxyl**) fungicides are widely used for the control of downy mildew.

4. **Forecast system**

- ✓ scout walk slowly along the vines looking for oilspots on at least 200 vines;

- ✓ More than 2 oilspots per 50 vines would be considered a risk to the vineyard.

Powdery mildew

- It is very common and widespread disease of grapevines in the Northeast Brazil area with low rainfall period.

- Losses may be up to 40-60%. Infected berries tend to be higher in acid content and are unsuitable for wine making.

ETIOLOGY:

- *Erysiphe necator (*previously *Uncinula necator);*

- The powdery mildew fungus overwinters as chasmothecia (tiny, round, black fruiting bodies) at São Francisco river (South Bahia).

Powdery mildew - symptoms

On all tissues of leaves, berries, powdery mildew looks like a greyish-white powder. Canes lesions develop into brown irregular blotches

Powdery mildew - control

Forecast system:

1. After you find powdery mildew, an epidemic will begin when there are 3 consecutive days with 6 or more continuous hours of temperatures between 70° and 85°F as measured in the vine canopy;

2. Starting with the index at 0 on the first day, add 20 points for each day with 6 or more continuous hours of temperatures between (21°C) 70°and (29°C) 85°F;

3. Until the index reaches 60, if a day has fewer than 6 continuous hours of temperatures between 70° and 85°F, reset the index to 0 and continue.
4. 4. If the index reaches 60, an epidemic is under way. Begin using the spray-timing phase of the index.

SPRAY INTERVALS BASED ON DISEASE PRESSURE USING THE POWDERY MILDEW INDEX

				Suggested spray schedule		
Index	**Disease pressure**	**Pathogen status**	**Biologicals[1] and SARs[2]**	**Sulphur**	**Sterol-inhibitors[3]**	**Strobilurins[4]**
0-30	low	present	7- to 14-day interval	14- to 21-day interval	21-day interval or label interval	21-day interval or label interval
30-50	intermediate	reproduces every 15 days	7-day interval	10- to 17-day interval	21-day interval	21-day interval
60 or above	high	reproduces every 5 days	use not recommended	7-day interval	10- to 14-day interval	14-day interval

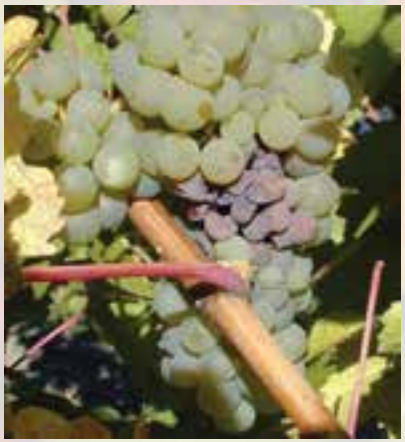
1 Bacillus pumilis (Sonata) and Bacillus subtilis (Serenade)
2 SAR = Systemic acquired resistance products (AuxiGro, Messenger)
3 tebuconazole (Elite), triflumizole (Procure), myclobutanil (Rally), and fenarimol (Rubigan)
4 methyl (Sovran), and pyraclostrobin/boscalid (Pristine)

Botrytis bunch rot

- There are several late-season bunch rots that can affect wine grapes in Southern Brazil. The most common of these is Botrytis bunch rot, the same fungus that causes gray mold in a number of other crops.

ETIOLOGY:

- Asexual phase - *Botrytis cinerea;*
- Sexual phase - *Botryotinia fuckeliana*




Botrytis bunch rot - epidemiology

- ✓ *Botrytis* overwinters as mycelium or sclerotia on bark and as mycelium in dormant buds and in mummified fruit;
- ✓ In the spring, conidia are produced which can infect leaves and young clusters before bloom;
- ✓ The fungus may infect blossoms leading to fruit infection, but the fungus becomes inactive (latent) in the fruit possibly due to low sugar and high acid contents;
- ✓ It becomes active again when the berries begin to soften. Fruit infection usually begins in berries with 5 to 8 percent sugar (at veraison), with berries remaining susceptible up to harvest and also post-harvest.

Botrytis bunch rot - control

During the growing season:

- ✓ Avoid overhead irrigation and keep irrigation periods as short as possible;
- ✓ Prevent excessive vine growth by judicious use of fertilizer;
- ✓ Canopy management by shoot thinning and leaf removal before fruit set;
- ✓ Remove leaves and lateral shoots located opposite, one node above, and one node below each fruit cluster;

- ✓ Prevent berry damage by control of powdery mildew;

- ✓ Minimize berry damage by birds and insects.

Botrytis bunch rot - control

Fungicide	Chemical Group	Active ingredients	Rate/ha	Comments
Rovral	2	iprodione	1.5 kg/ha	Maximum 2 sprays/season
Elevate	17	fenhexamid	1.12 kg/ha	Maximum 3 sprays/season
Pristine	7+11	pyraclostrobin + boscalid	420 – 735 g/ha	Maximum 2 sprays/season. Wine grapes only.
Luna Tranquility	7+9	fluopyram +pyrimethanil	1.2 L/ha	Maximum 2 sprays per season. Wine grapes only.
Scala	9	pyrimethanil	2.0 L/ha	Maximum 3 sprays/season
Vangard	9	cyprodinil	750 g/ha	Maximum 2 sprays/season
Switch	9+12	cyprodinil +fludioxonil	775-975 g/ha	Maximum 2 spays/season
Serenade MAX	NC	*Bacillus subtilis*	3-6 kg/ha	Biofungicide. Disease suppression only.

EFFECT OF DIFFERENT TRAINING SYSTEM (DRIVING SYSTEM) ON THE DOWNY MILDEW AND BOTRYTIS BUNCH ROT INTENSITY ON DIFFERENT GRAPE CULTIVARS AT SOUTHERN BRAZIL

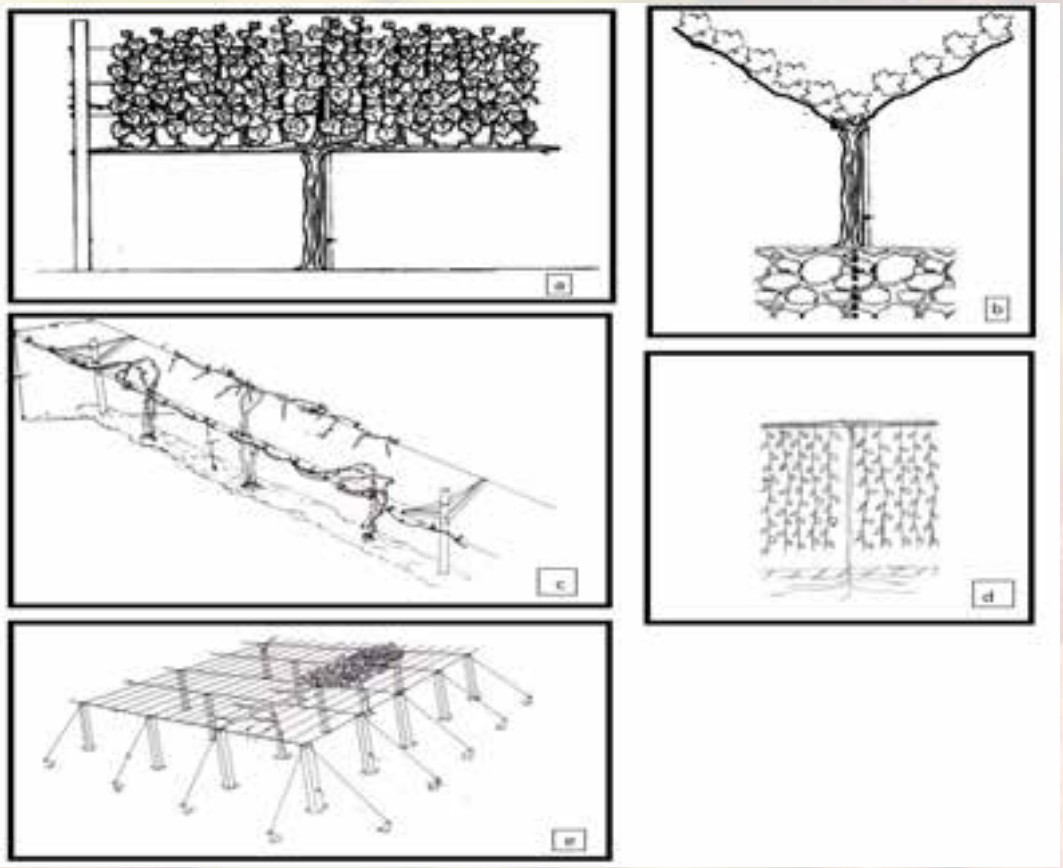
HYPOTESIS

- ✓ Diversity of vegetative canopy and perene part of the plant can affect the diseases intensity;

- ✓ Training systems influence the canopy envirounment conditions, and can affect many diseases incidence and severity

❖ TREATMENTS:

1. Cabernet Sauvignon and Merlot cultivars;
2. Differents diseases (Downy mildew, Botrytis buch rot and Anthracnose
3. Different altitudes (highlands);
4. Differents training systems.



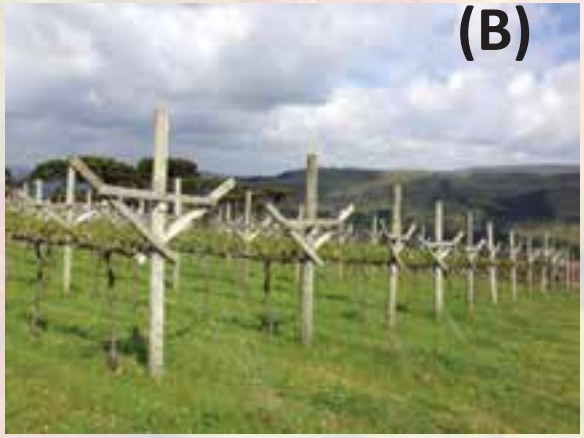
Vineyard training systems:

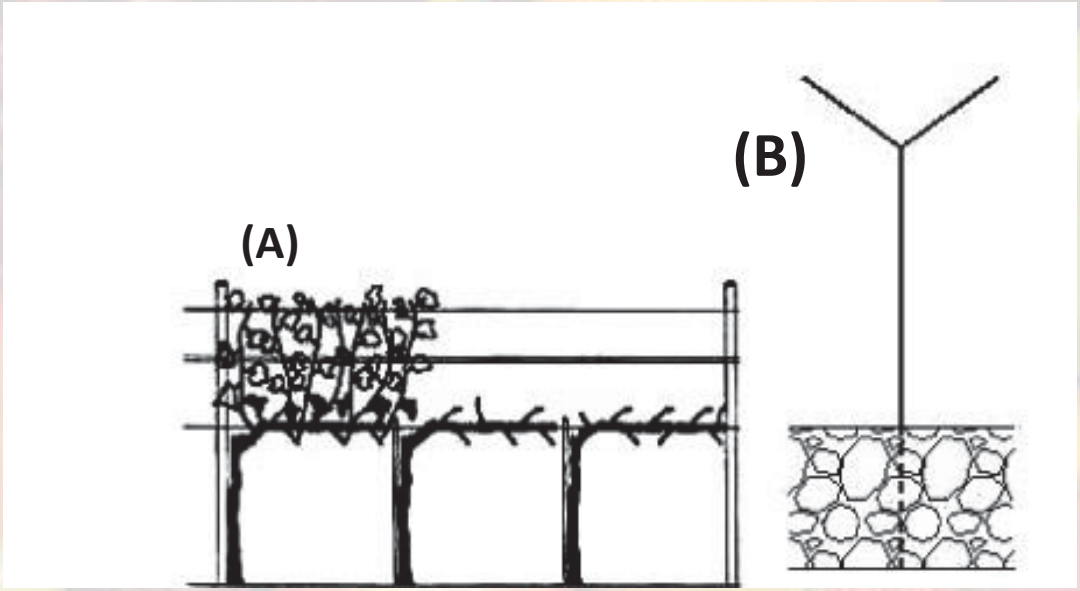
a) Vertical shoot positioning (VSP)/espallier (Espaldeira);
b) "Y"-shaped or Lyre trellis or (Manjedoura);
a) Geneva Double Curtain (GDC);
b) Single curtain and;
e) `Tendone`/trellised vine (latada)

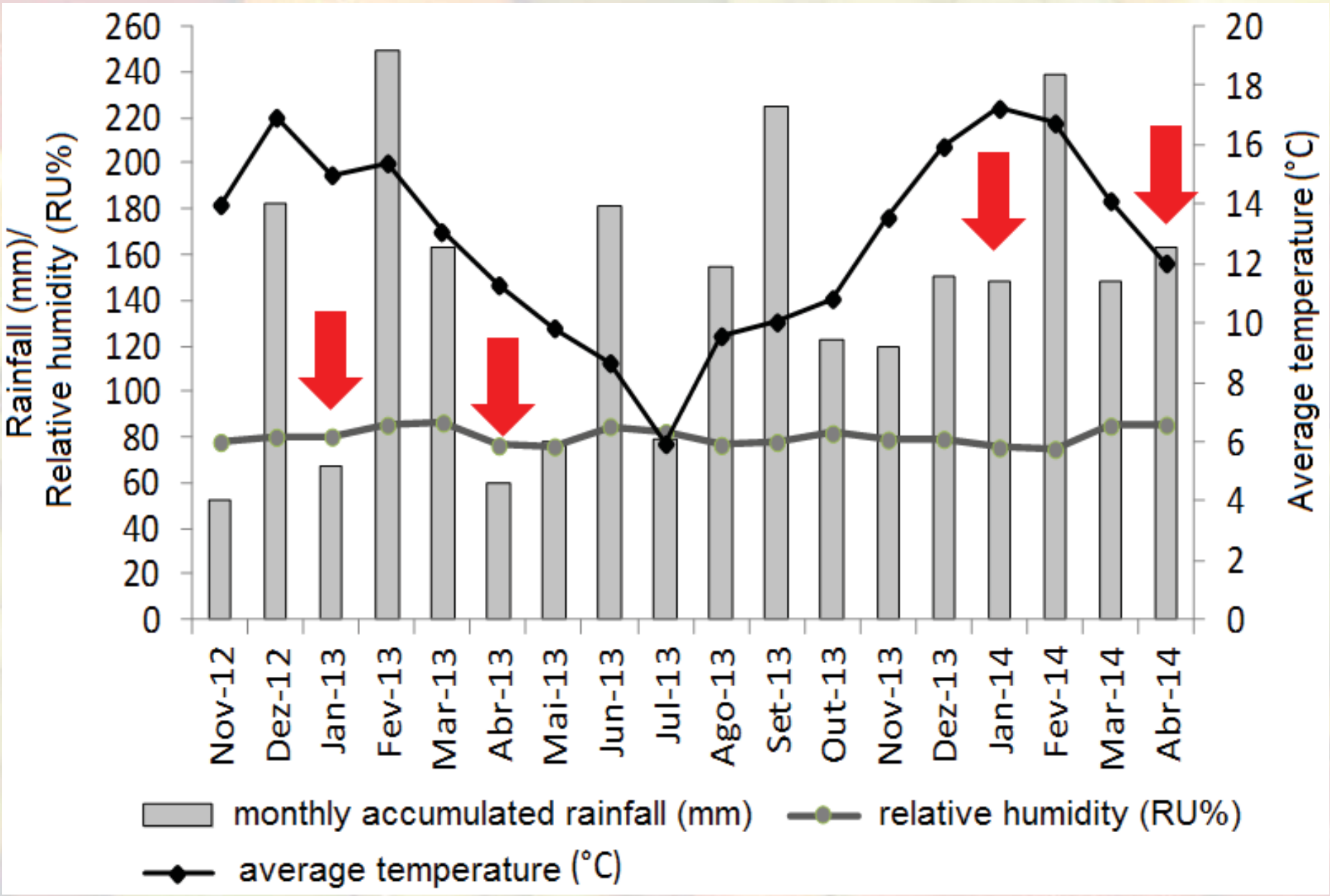
EXPERIMENT 1:

- Cabernet Sauvignon cultivar at some areas at 1230 m above sea level):

a) Vertical shoot positioning (VSP)/espallier (Espaldeira);
b) 'Y'shaped or Lyre trellis (Manjedoura);

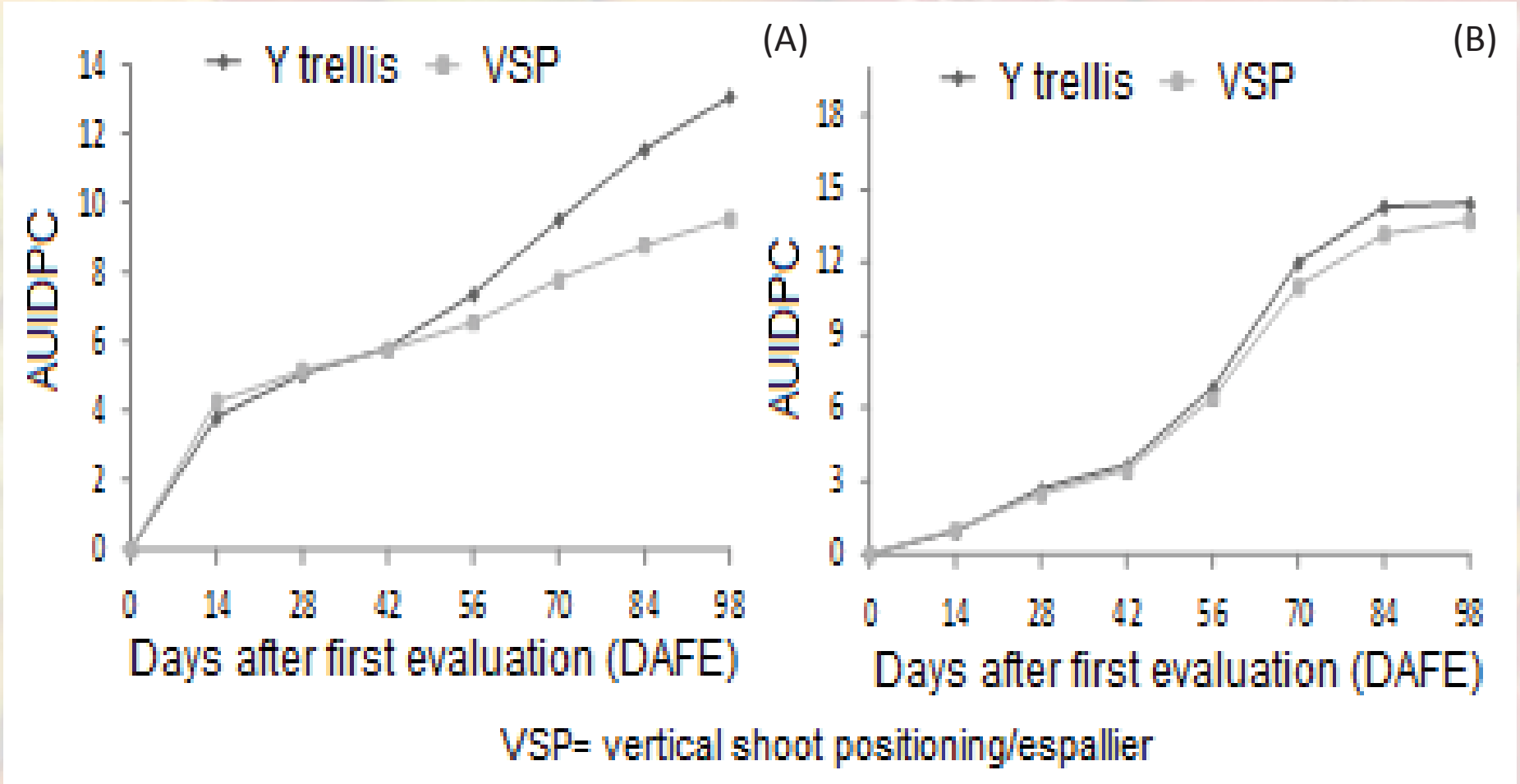





Rainfall (mm)/
Relative humidity (RU%)
Average temperature (°C)
260
240
220
200
180
160
140
120
100
80
60
40
20
0
20
18
16
14
12
10
8
6
4
2
0
Nov-12
Dez-12
Jan-13
Fev-13
Mar-13
Abr-13
Mai-13
Jun-13
Jul-13
Ago-13
Set-13
Out-13
Nov-13
Dez-13
Jan-14
Fev-14
Mar-14
Abr-14
monthly accumulated rainfall (mm)
relative humidity (RU%)
average temperature (°C)

TRAINING SYSTEM(driving system)

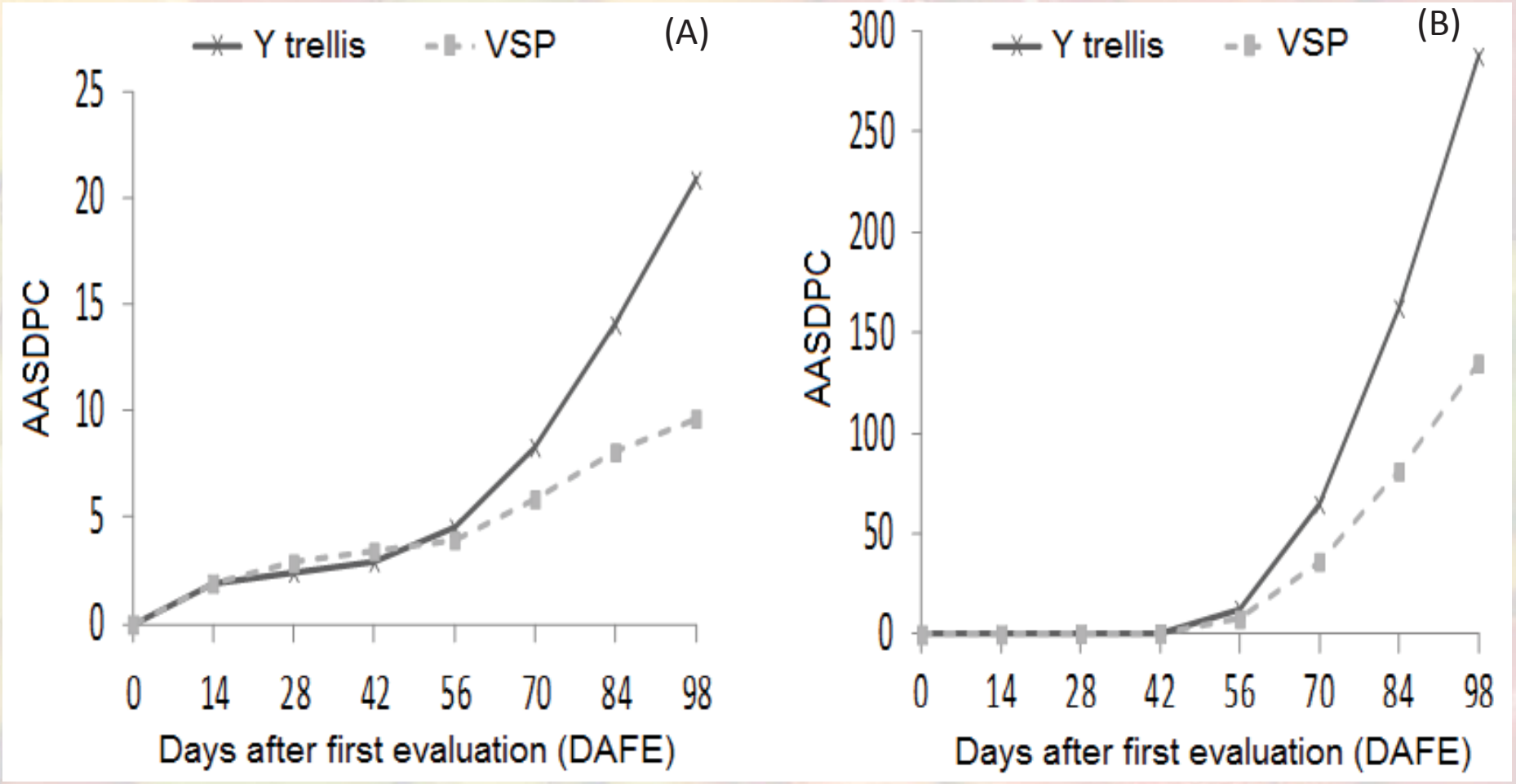
AREA UNDER DOWNY MILDEW **INCIDENCE** PROGRESS CURVE DURING A) 2012/2013 growing season and B) 2013/2014 growing season.



VSP= vertical shoot positioning/espallier

TRAINING SYSTEM(driving system)

AREA UNDER DOWNY MILDEW **SEVERITY** PROGRESS CURVE DURING A) 2012/2013 growing season and B) 2013/2014 growing season.



VSP = Vertical shoot positioning/espallier

EFFECT TRAINING SYSTEM ON DOWNY MILDEW

Beginning of symptoms appearance (BSA), time to reach de maximum disease intensity (TRMDI), maximum severity (Y_{max}) and area under the disease progress curve (AUDPC)

Cycle 2012/2013			
	Downy mildew		
	Y trellis/ Manjedoura	VSP/Espaldeira	C.V.(%)
BSA	17,5 A[3]	17,5 A	42,4
Imax.	71,6 A	40,8 B	16,5
TRDMDI	91,0 A	86,3 A	17,4
Smax.[1]	1,66 A	0,66 B	16,2
TRMDS	98,0 A	92,2 A	8,2
AUIDPC	59,9 A	48,0 B	4,4
AUSDPC	55,0 A	35,8 B	10,2
Cycle 2012/2013			
	Downy mildew		
	Y trellis/ Manjedoura	VSP/Espaldeira	C.V.(%)
IAS	38,5 A	36,7 A	24,3
Imax.	80,56 A	76,71 A	9,0
TAMID	82,5 A	84,9 A	16,8
Smax.[1]	31,1 A	7,6 B	40,5
TAMSD	98,0 A	97,1 A	2,5
AACPID[2]	54,7 A	51,3 A	8,7
AACPSD[2]	619,3 A	226,3 B	27,5

VSP = Vertical shoot positioning/espallier

EFFECT TRAINING SYSTEM ON BOTRYTIS BUCH ROT

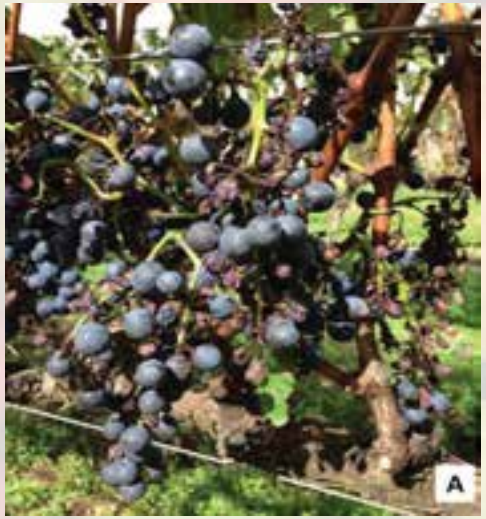
Incidence and severity of Botrytis bunch rot in Cabernet sauvignon.

Botrytis bunch rot			
	Cycle 2012/2013		
	Y trellis/ Manjedoura	VSP/ Espaldeira	C.V. (%)
Incidence (%)	100 A[3]	66,67 B	24,5
Severity (%)	20,38 A	3,47 B	26,4
Cycle 2013/2014			
	Y trellis Manjedoura	VSP Espaldeira	C.V.(%)
Incidence (%)	65,82 A	48,32 B	8,8
Severity (%)	2,1 A	1,18 B	15,3

VSP = Vertical shoot positioning/espallier

BOTRYTIS BUNCH ROT (driving system)

- The microclime developed by Vertical shoot positioning (VSP)/espallier (Espaldeira) with bigger canopy ventilation and higher sun exposure can affect the lower Botrytis bunch rot intensity.



Conclusions

- Vertical shoot positioning (VSP)/espallier (Espaldeira) system showed lower podery mildew and Botrytis bunch rot intensity when compared with Y shaped or lyra trellis (Manjedoura);
- The microclime conditions founded at the VSP can affected the both diseases intensity;
- The Y shaped (manjedoura) system used to need extra phytosanitary management to control both diseases when comparared with VSP system;
- The VSP system is more indicated for integrated management of both diseases in Cabernet Sauvignon at southern Brazil.

Control strategy – hail protection nets

Santa Catarina State, Southern Brazil •
Latitude: 28°39'South
Cool to mild winters Av Min for July: 10C
Between 800 and 1200 chilling hours
Warm to hot summers
Av Jan Max: 28 0C
Av Jan Min: 16 0C

Control strategy – Apple hail protection nets

Beginning of symptoms appearance (BSA), time to reach de maximum disease intensity (TRMDI), maximum severity (Y_{max}) and area under the disease progress curve (AUDPC) of apple scab on leaves of 'Royal Gala' and 'Fuji' apple (2003/04 e 2004/2005), Southern Brazil.

		BSA(days)		TRMDI(days)		Ymax(%) [a]		AUDPC [b]	
Net	cultivar	2003/04	2004/05	2003/04	2004/05	2003/04	2004/05	2003/04	2004/05
Black	Royal Gala	8Aa	9Ba	89Aa	85Ba	1.55Aa	1.72Ba	70,84Aa	73,13Aa
	Fuji	7Aa	10Aa	86Aa	91Aa	1.37Aa	1.45Aa	69,67Aa	75,50Aa
White	Royal Gala	13Aa	16Ab	99Ab	97Ab	1.03Ab	1.56Aa	58.57Ab	49.62Bb
	Fuji	14Ab	17Ab	95Ab	101Ab	0.83Ab	0.99Bb	43,12Ab	50.77Ab
Uncovered	Royal Gala	20Ab	24Ab	109Ab	102Bb	0.97Ab	1.28Bb	52,01Ab	60,04Ab
	Fuji	11Aa	22Bb	121Ac	113Ac	0.94Ab	0.90Ab	42.93Ab	40,93Ab
C.V (%)		19.01	16.76	15.10	17.23	13.97	14.88	20.31	21.47

Average follow by the same capital letter in the row and small letter in the column are not significant different by *t* test ($P < 0.05$).

CROP PROTECTION 38 (2012) 49-52

Control strategy – hail protection nets

Beginning of symptoms appearance (BSA), time to reach de maximum disease intensity (TRMDI), maximum severity (Y_{max}) and area under the disease progress curve (AUDPC) of Glomerela leaf spot on leaves of 'Fuji' apple (2003/04 e 2004/2005), Southern Brazil.

	BSA (days)		TRMDI (days)		Y_{max} (%)[1]		AUDPC[2]	
net	2003/04	2004/05	2003/04	2004/05	2003/04	2004/05	2003/04	2004/05
uncovered	36Aa*	45Aa	87Aa	91Aa	0,82Aa	0,47Ba	15,66Aa	11,02Aa
white	31Aa	42Ba	82Aa	86Aa	0,90Aa	0,33Ba	24,87Aa	13,25Ba
black	10Ab	27Bb	69Ab	73Ab	2,10Ab	1,62Ab	41,18Ab	32,31Ab
C.V (%)**	23,14	21,02	19,87	25,64	17,73	20,09	22,33	23,71

CROP PROTECTION 31 (2012) 40-44

Control strategy – Grape hail protection nets

NEW RESEARCH ON FIELD

EXPERIMENT 3 (still on field):

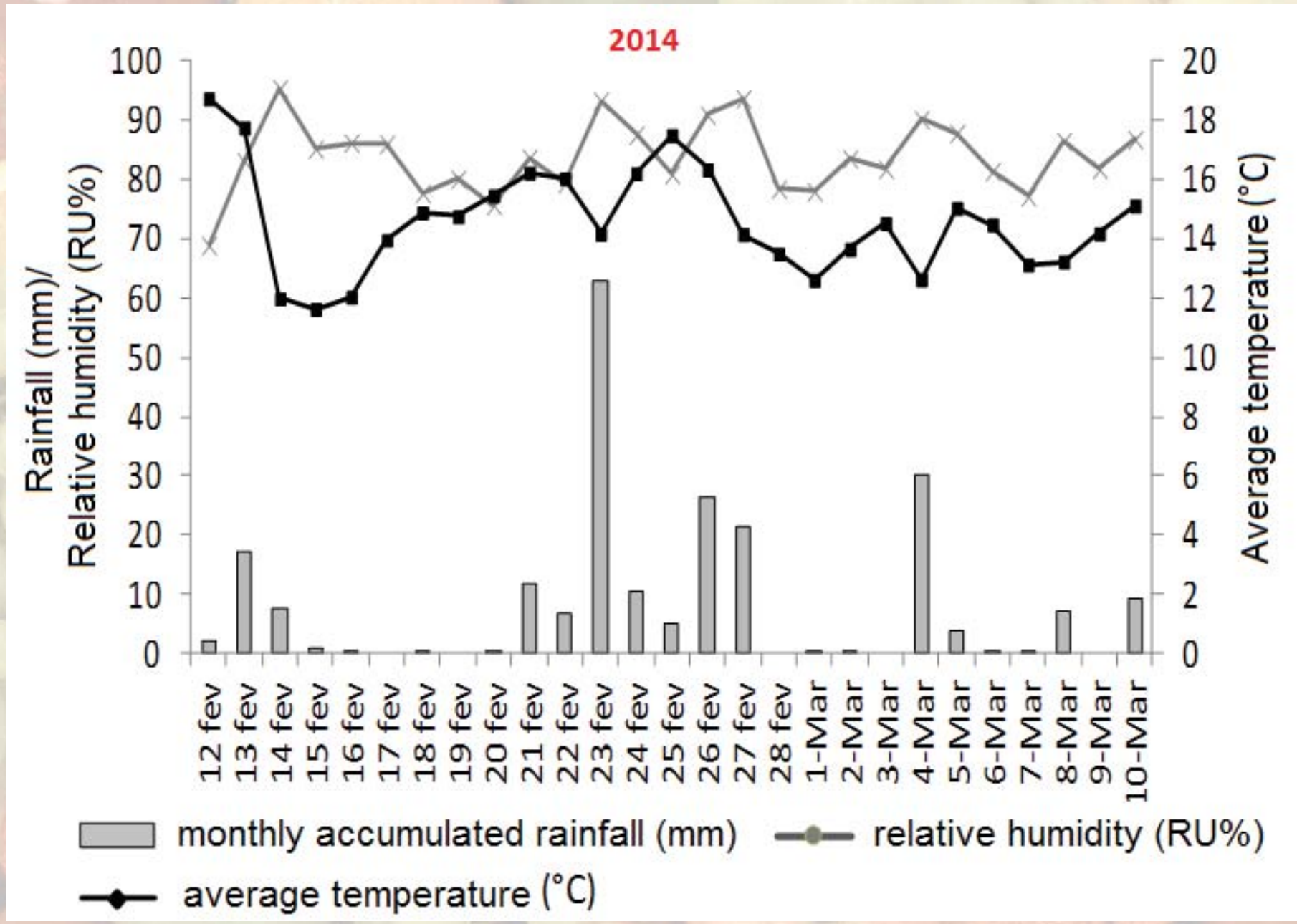
SANJO
Produtos de origem

- Sauvignon Blanc and Chardonnay cultivars at 1350 m above sea level;
- Botrytis bunch rot incidence and severity;
- Total phenolic rate (Folin-Ciocalteau reagent method (AMERINE; OUGH, 1976)
- Training systems:

1. Vertical shoot positioning – VSP (Espaldeira)
2. `Y`Trellis/ Manjedoura

Y`Trellis/ Manjedoura

Vertical shoot positioning – VSP (Espaldeira)


2014
Rainfall (mm)/
Relative humidity (RU%)
Average temperature (°C)
100
90
80
70
60
50
40
30
20
10
0
20
18
16
14
12
10
8
6
4
2
0
12 fev
13 fev
14 fev
15 fev
16 fev
17 fev
18 fev
19 fev
20 fev
21 fev
22 fev
23 fev
24 fev
25 fev
26 fev
27 fev
28 fev
1-Mar
2-Mar
3-Mar
4-Mar
5-Mar
6-Mar
7-Mar
8-Mar
9-Mar
10-Mar
monthly accumulated rainfall (mm)
relative humidity (RU%)
average temperature (°C)

Botrytis bunch rot			
Cycle 2013/2014			
CHARDONNAY	`Y`Trellis/ Manjedoura	VSP/ Espaldeira	C.V. (%)
Incidence[1] (%)	90,66 A[3]	92,99 A	15,2
Severity[2] (%)	10,58 A	4,92 B	12,2
Total Poliphenol (mg galic ac.L^{-1})	789,4 A	662,1 B	4,4
SAUVIGNON BLANC			
Incidence[1] (%)	90,67 A	74,0 B	12,1
Severity[2] (%)	13,16 A	5,65 B	12,5
Total Poliphenol (mg galic ac.L^{-1})	304,3 A	302,02 A	10,3

[1]Obtida através da porcentagem de cachos com podridão cinzenta em relação ao total avaliado.[2]Obtida através da porcentagem de bagas com podridão cinzenta em relação ao total de bagas por cacho.[3]Médias seguidas da mesma letra maiúscula na linha dentro de cada sistema de condução, não diferem significativamente entre si pelo teste F ($P<0.05$).

THANKS YOU!

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