Pre-harvest factors in Pear Brown Heart Disorder

Biochemical and statistical approaches

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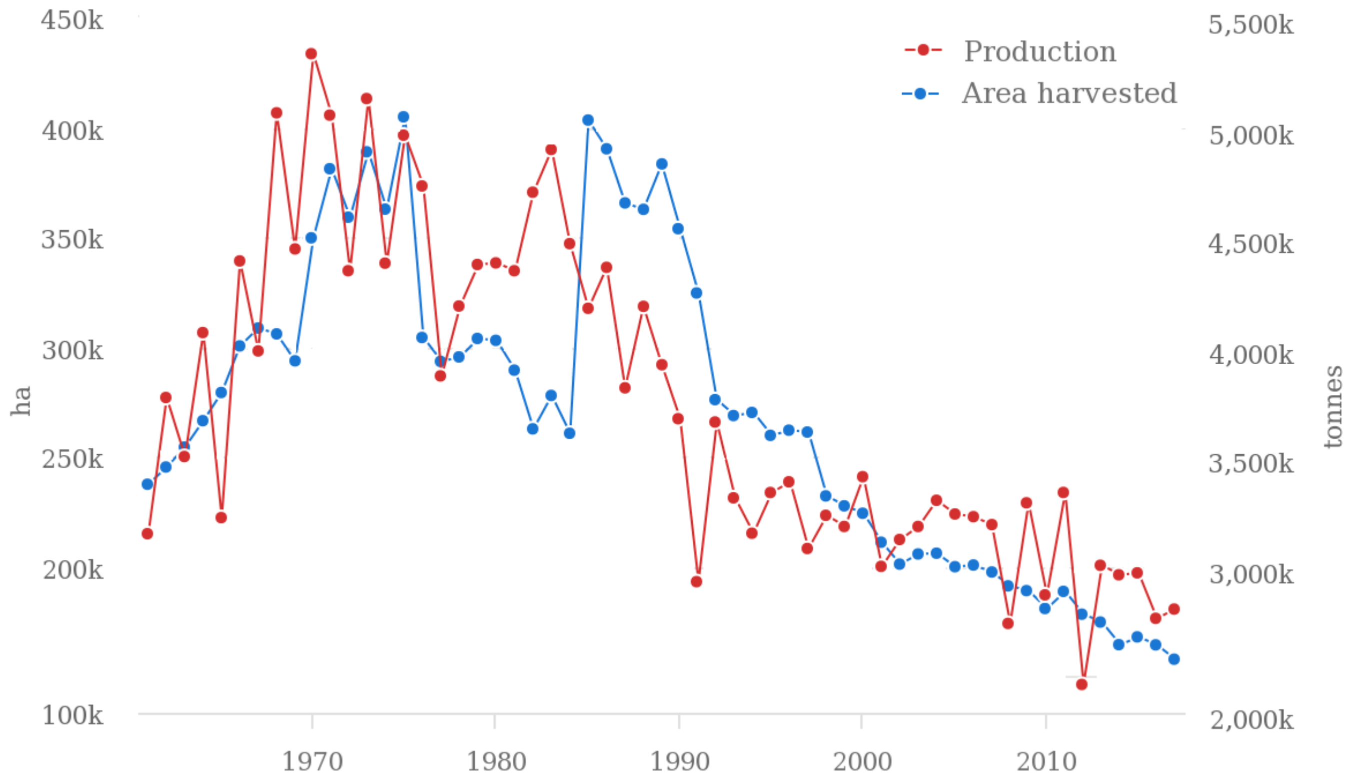
9/2/2019 Chloe LECLERC - Master Plant Biology option Quality of Specialized Plant Productions

Current pear production situation & challenges

Pears fruit *(Pyrus communis L.)*



A declining market

- lack of innovation
- disorders
- consumer loss of confidence

Limit post-harvest losses

Quality improvement to re-dynamize the sector

- plant breeding
- field and conservation practices
- Logistic & Marketing strategies

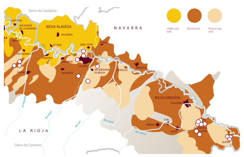
Pear Brown Heart

Operative Group of *Rincón de Soto*'s GOP project

Brown Heart (BH): etiology

- **Quality** : Loss of texture, off-flavors
- **Symptoms**: Flesh browning with some dry cavities
- **Multifactorial disorder:**

(Zerbini., 2002, Xuan *et al.*,2003; Deuchande *et al.*,2017)



Environment

Field practices

(Saquet *et al.*, 2017)

Storage conditions

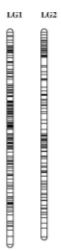
RH

Gases %

Biochemical basis

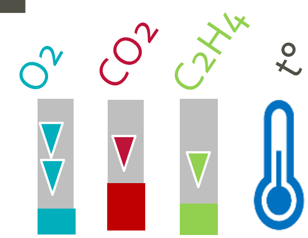
?

(Deuchande *et al.*,2016)



(Saba *et al.*,2016)

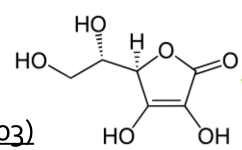
Genetics



Control

PREDICTIVE MARKERS NEEDED

Enzymatic browning : PPO



(Blanpied *et al.*, 1991, Franck *et al.*, 2003)

GOP objectives

Biochemical approach

- Measurement of variables
- Association with BH based on plant physiology knowledge
- Put in relation the pathways, order and evaluate the importance of each event modification

Statistical approach

- Quantification and qualification of the differences
- Screening co-regulations
- Principal component analysis and Modeling for predictors selection
- Probability of occurrence: level of the risk, reliability

Objectives

- Validate controversial knowledge about BH disorder
- Assess BH-plant organs minerals relationships and their evolution
- Investigate location factor in *Rincón de Soto*
- Study quality and physiological parameters
- Evaluate usefulness of the variables for BH prediction
- Determine thresholds values for the variables

Guideline and operative solutions

Material & Methods

Orchard repartition in PDO Rincon de Soto

Material & Methods

1 cv. 'Conference'

20 orchards

Field disorder prediction

Sampling date factor

Conservation monitoring

CO_2 (1%/5%) + duration factors + temperature

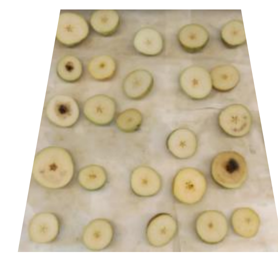
April — **May** — **100DAF** — **15BOH** — **OH**

4 months

7 months

0/14d **Cold stress**

Alterations

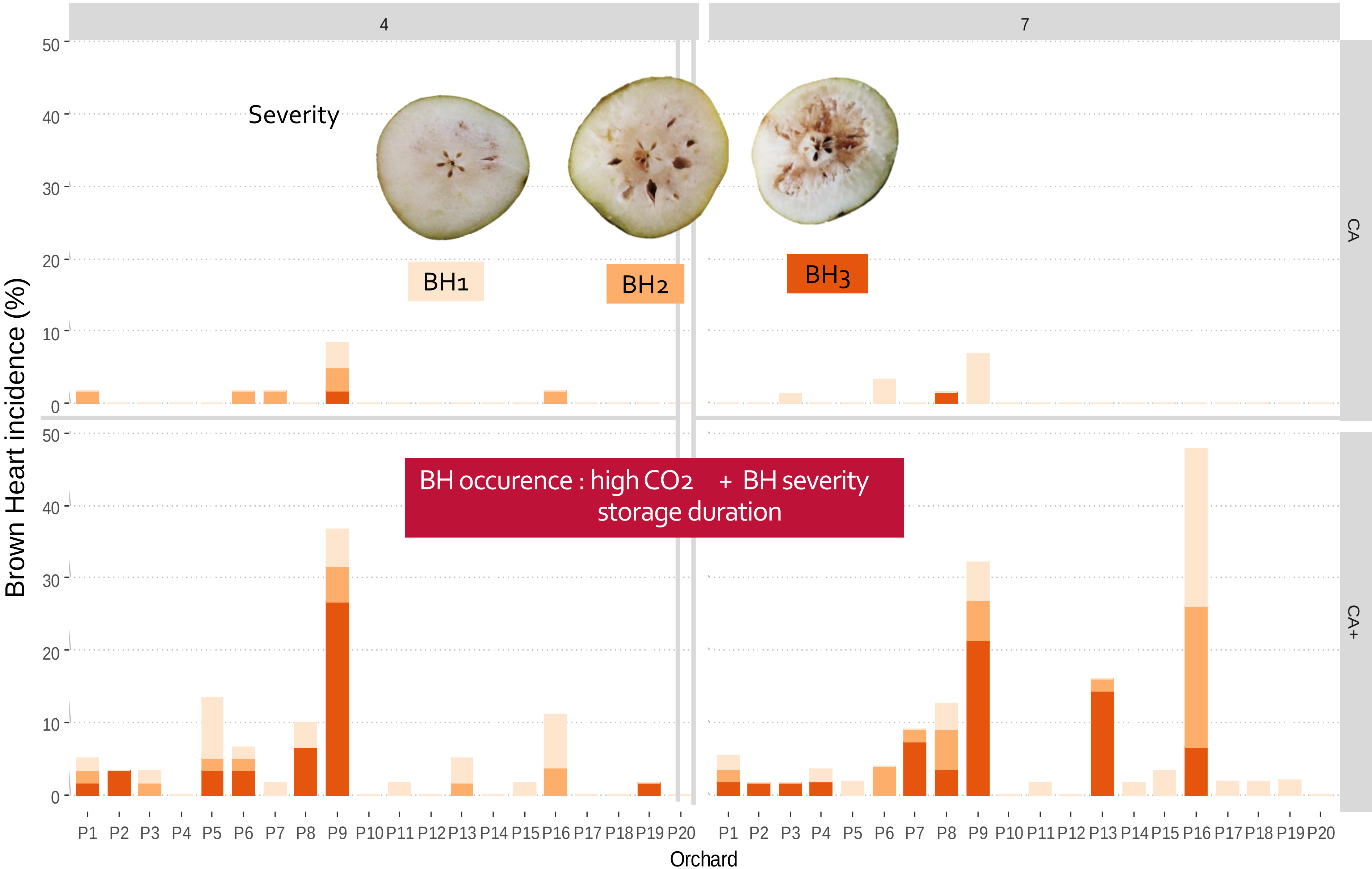


Minerals & climate

Harvest Maturity Indexes

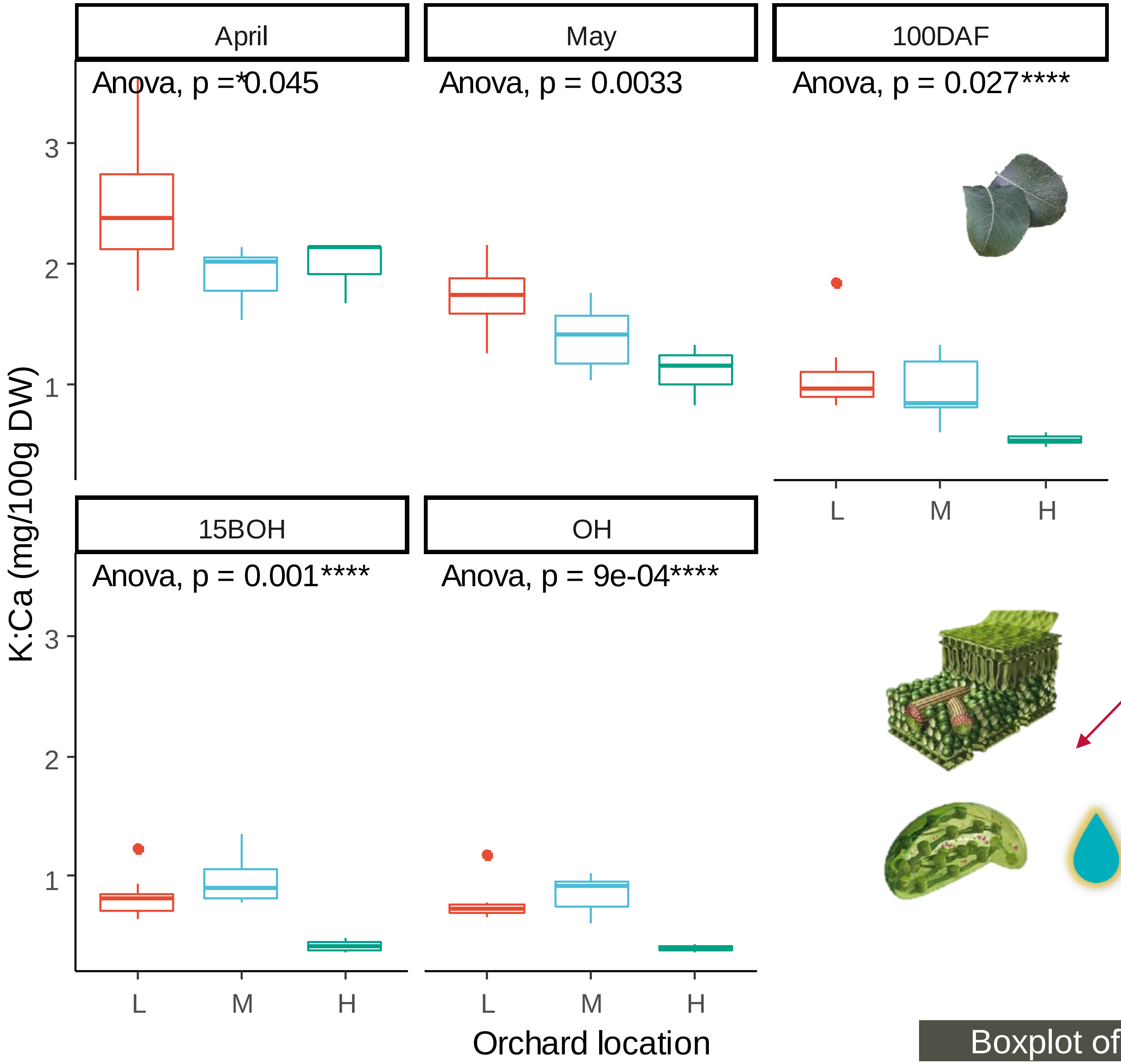
Modeling

Results



Brown Heart incidence (%) and severity for each orchard under standard CA and high CO_2 CA+ after 4 and 7 m
of storage. Means of 60 fruits.

Results



MINERAL MARKERS

- Variations : orchard
  plant organs
  sampling date
- Mainly micronutrients + K, Ca and Mg
- ANOVA significant ≠ cross interation:
  Ca,Zn, Mn , B, K/Ca
  B
- Na, Fe , Cu non-signf. en lien avc BH

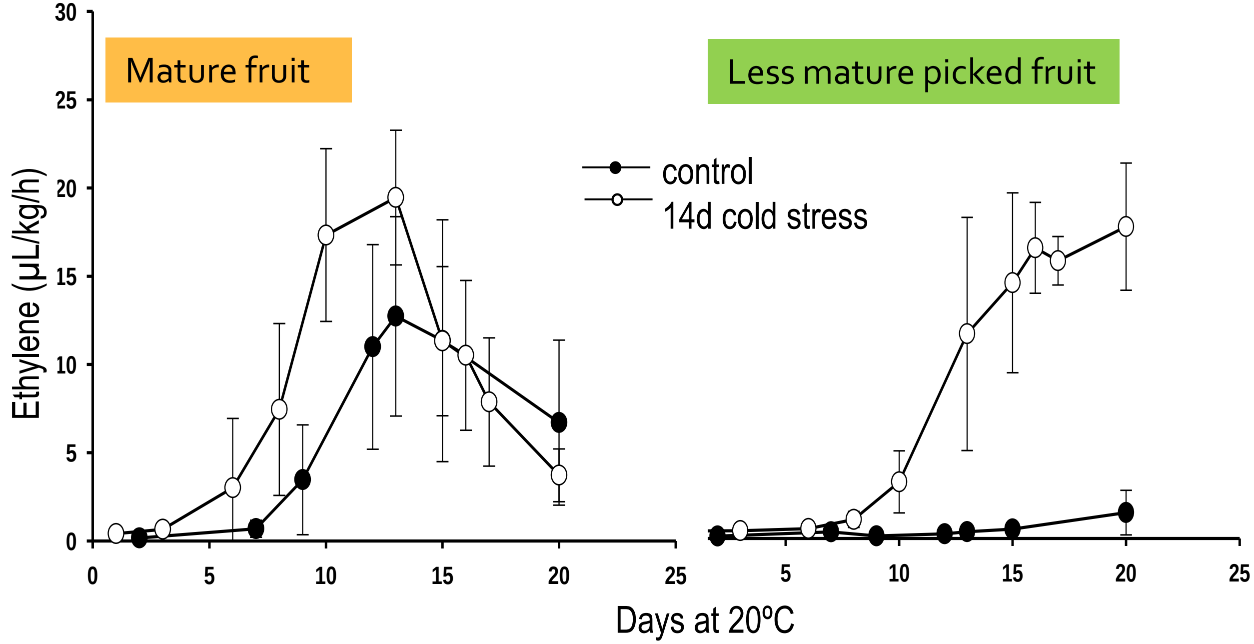
BH ocurrence linked to plant (hydro)nutrition

Boxplot of K:Ca ratio in 'Conference' tree leaf

Results

PHYSIOLOGICAL MARKERS

- Mature fruit more sensitive to cold stress : ethylene production triggered earlier
- High volumes produced at harvest indicate maturity



Ethylene production pattern of in reaction to cold stress

BH related to maturity stage at harvest

- Consistent with:

  chlorophyll absorbance (Dameter-color)

  sugar degradation (Starch Index)

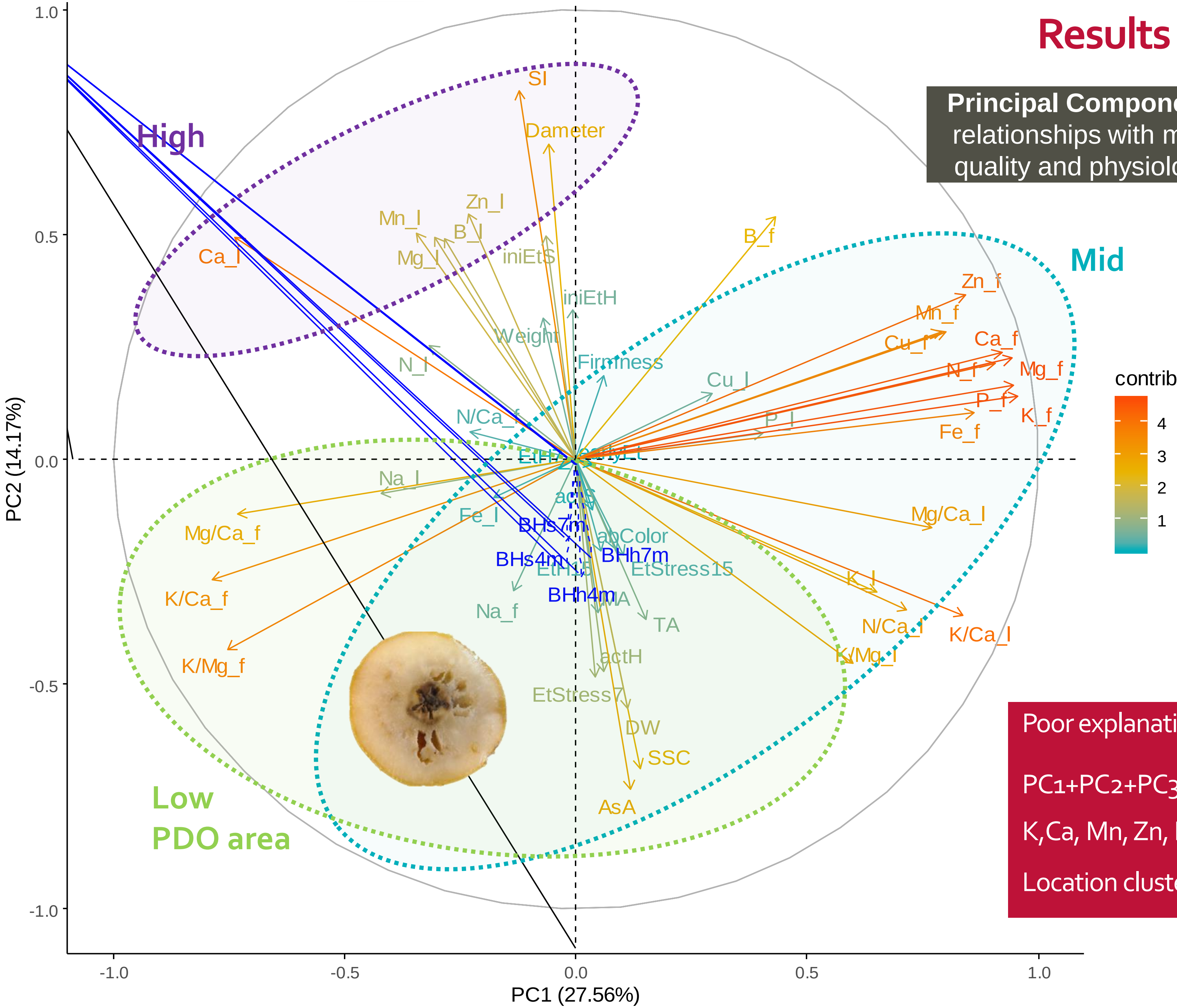
  fruit firmness

P16 high BH incidence

P20 BH-free

Results

Principal Component plot: BH relationships with mineralsf ruit quality and physiology indexes



Poor explanation: 20 indiv:

PC1+PC2+PC3=50.27%

K,Ca, Mn, Zn, Mg, B

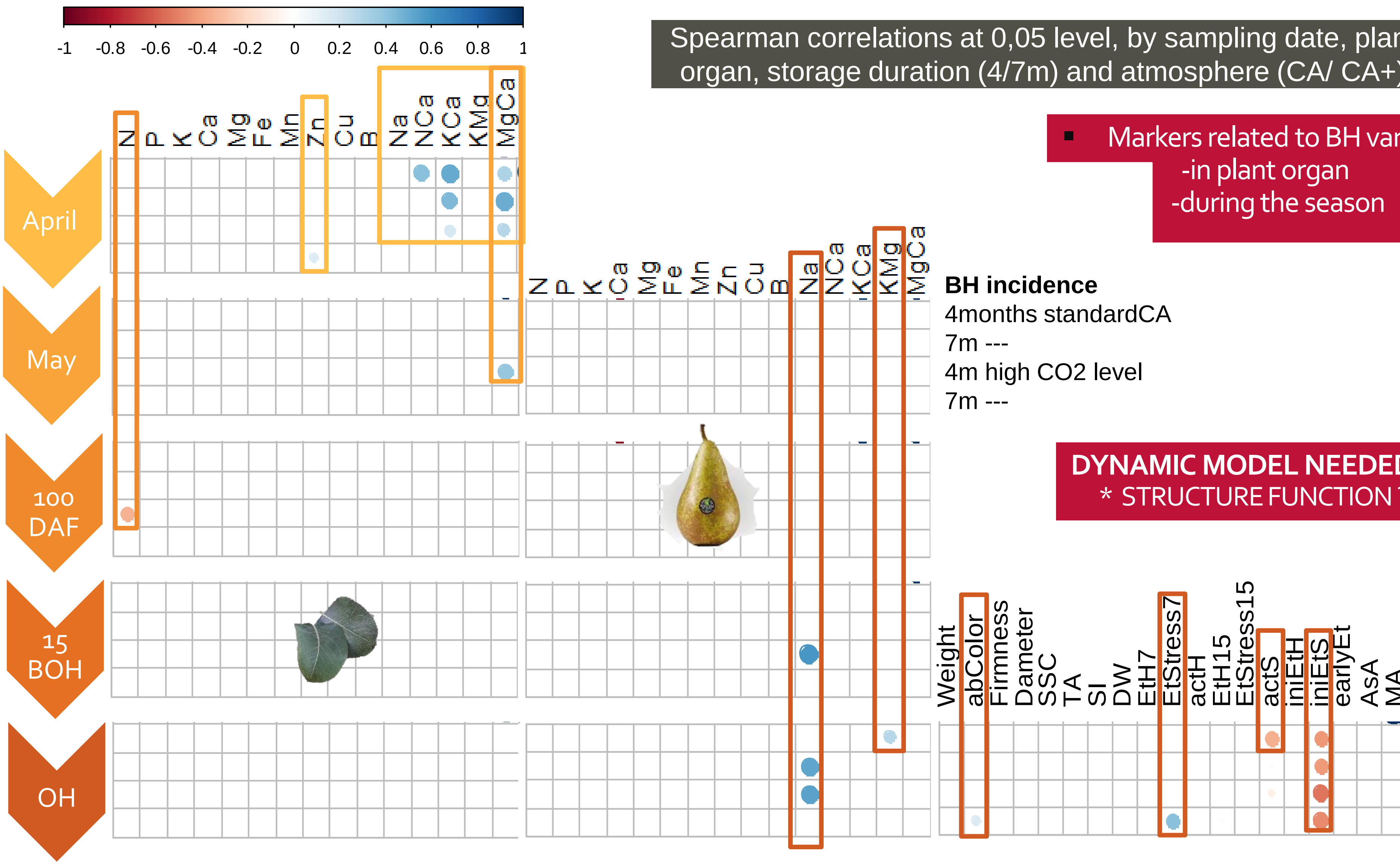
Location clustering

Results

Spearman correlations at 0,05 level, by sampling date, plant organ, storage duration (4/7m) and atmosphere (CA/ CA+)

- Markers related to BH vary
  - -in plant organ
  - -during the season

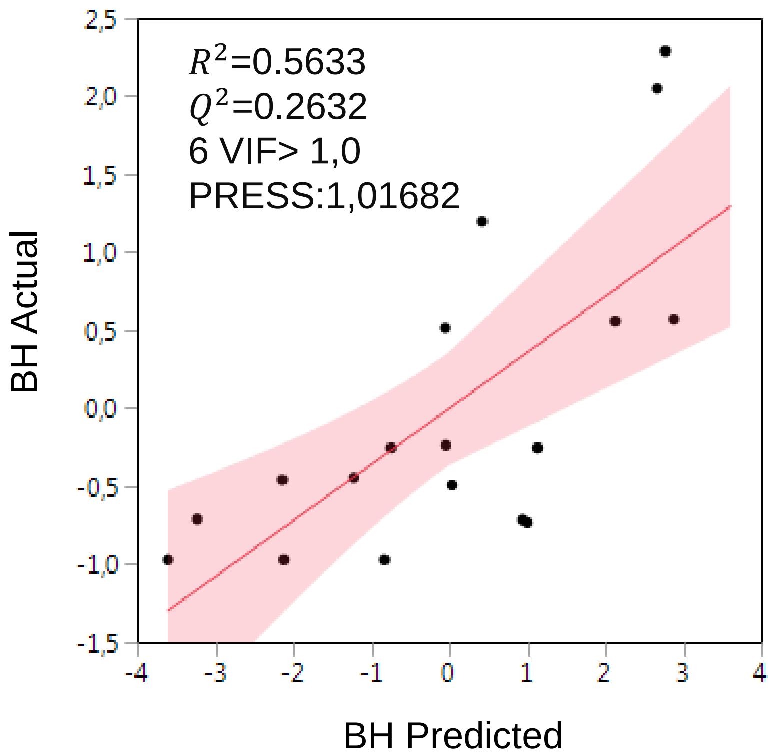
DYNAMIC MODEL NEEDED
*** STRUCTURE FUNCTION ?**



Modeling

53 variables -> 16 recurrent in models
coherence with biochemical approach

poor prediction abilities & accuracy
-> 2019 season re-orientation



April
- K/Mg/Ca (high)

May
- K/Mg/Ca (high)

100DAF
- N (excess)
- N/Ca (high)

15BOH
- Mg (low)
- Mg/Ca (high), Mn (low)

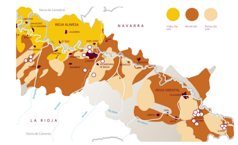
OH
- K, Mg, B, Zn, Fe (low)
- Na, Dameter (high) , Firmness, AsA, MA (low)

Post Harvest
- EtStress, EH15 (high)
- initEtStress (early)

Genetics

Practices

Growing environment



April

May

100 DAF

15 BOH

OH

4 sets of data: minerals
physico-biochemical
physiological
qualitative

2 tissues

5 sampling dates

AsA, MA

DAmeter

Firmness

EtStress >?

EH15 >?

initEtStress >?

N/Ca= ?

Mg/Ca, Mn>?

Mg/Ca, Mn>?

Na>?

Na>?

Action

K/Mg/Ca= ?

K/Mg/Ca< ?

K/Mg/Ca< ?

N>?

N<?

Action

Mg>?

Mg<?

K, Mg, B, Zn>?

K,Mg,B,Zn>?

Decision

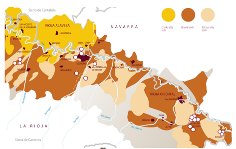
Logistics

Consummer satisfaction

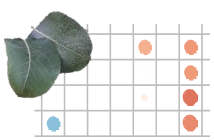
BH risk

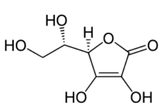
Perspectives: integrative models for tree of decision

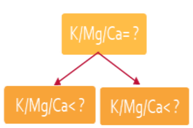
Conclusion & perspectives



O_2 CO_2







GOP 2018 main findings

- Plant nutrition and pedoclimate
- Maturity at harvest
- High CO_2
- Define predictors via modeling
- Determine thresholds
- Developp Decision Making Tool for guidance

2019 protocol

- Keep High La Rioja orchad as control
- Work at different maturity stage
- Atmosphere composition (CO_2+)
- Increase data
- Separate Damaged/Healty fruit for specific data
- Improve modeling techniques

Thank you for your attention

Bibliography

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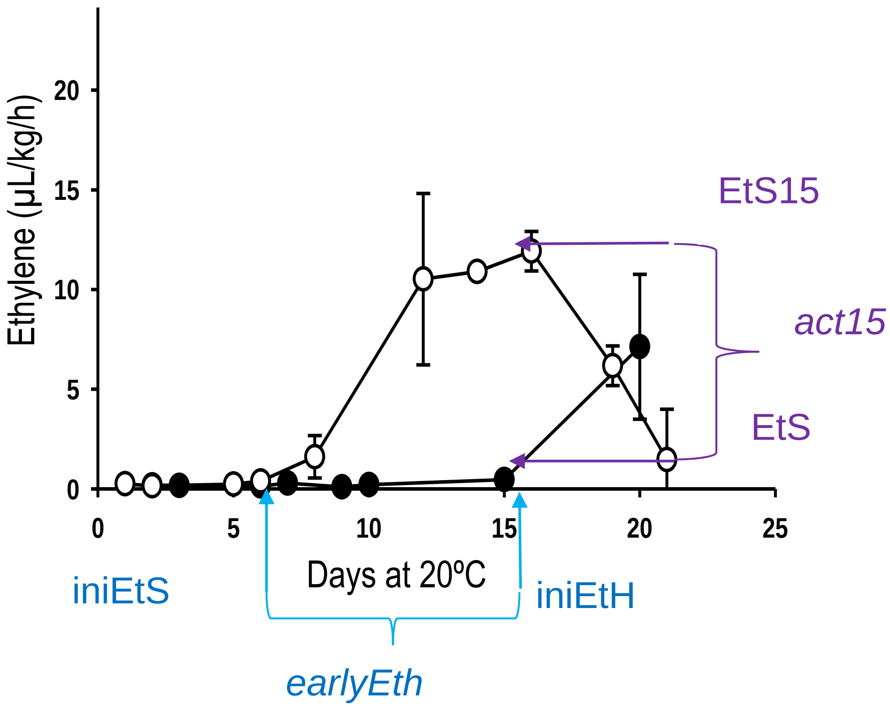
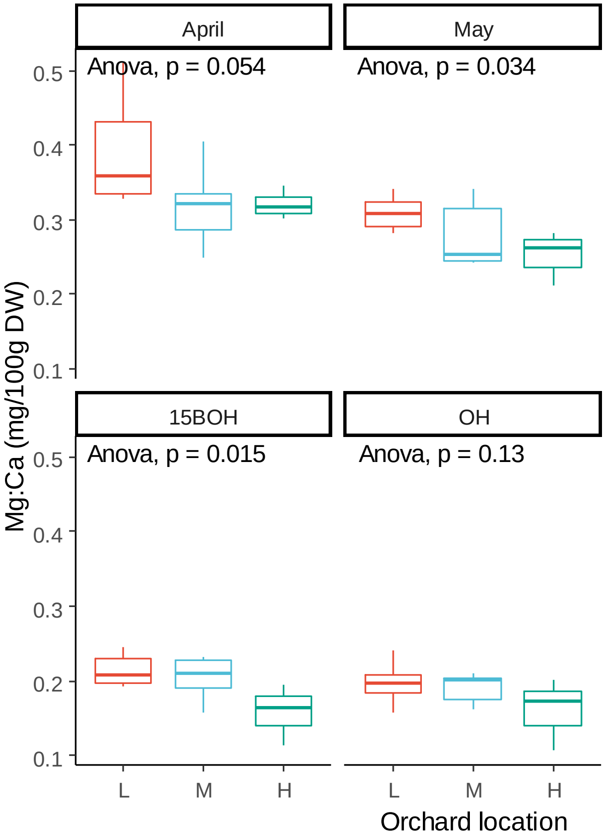
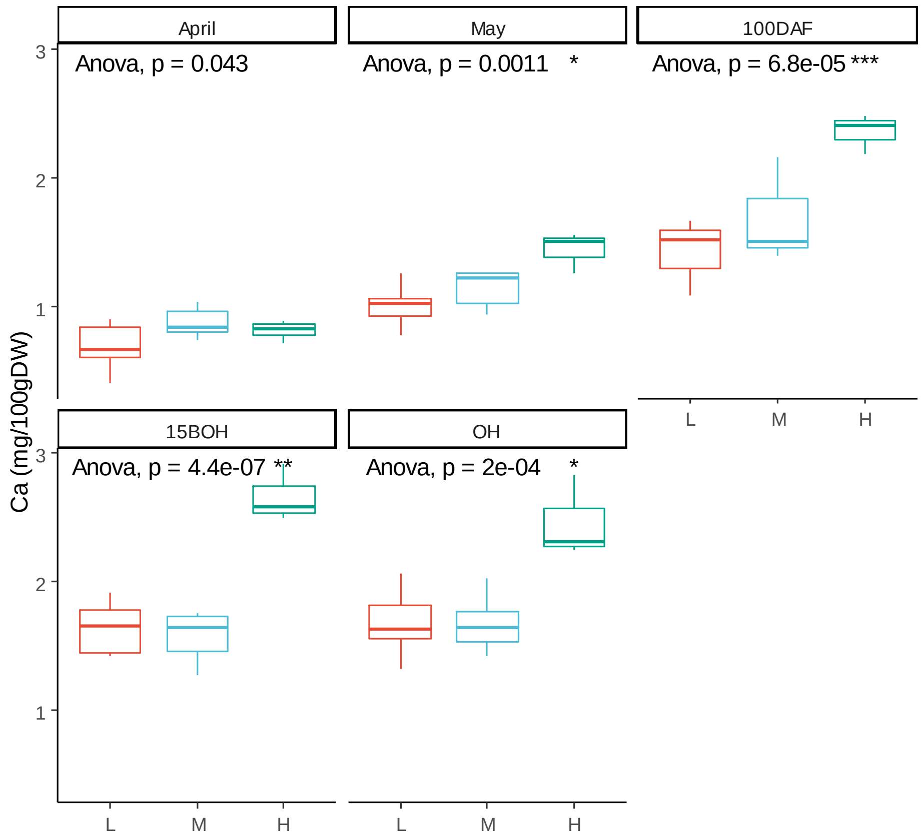
Annexes

Material & Methods

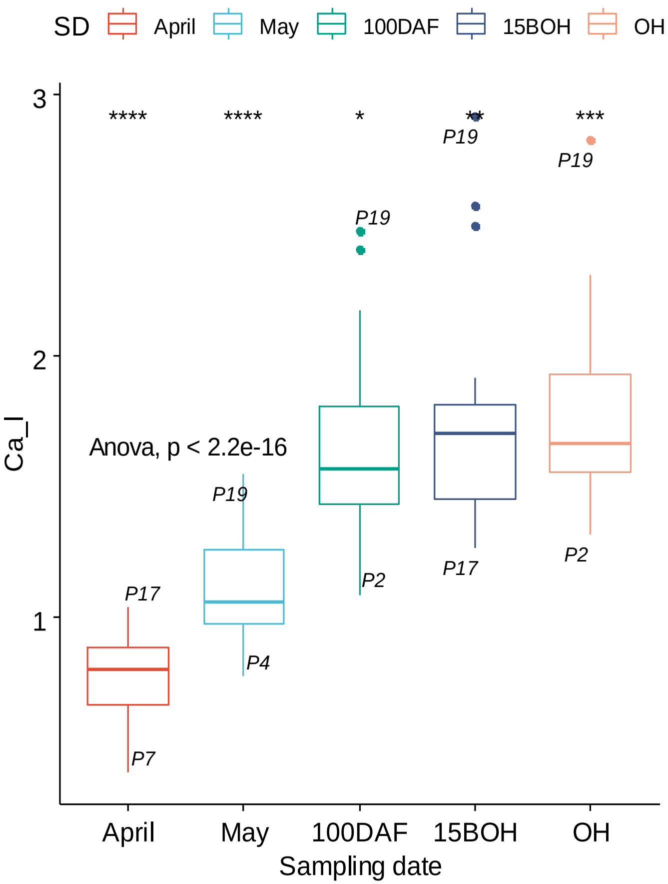


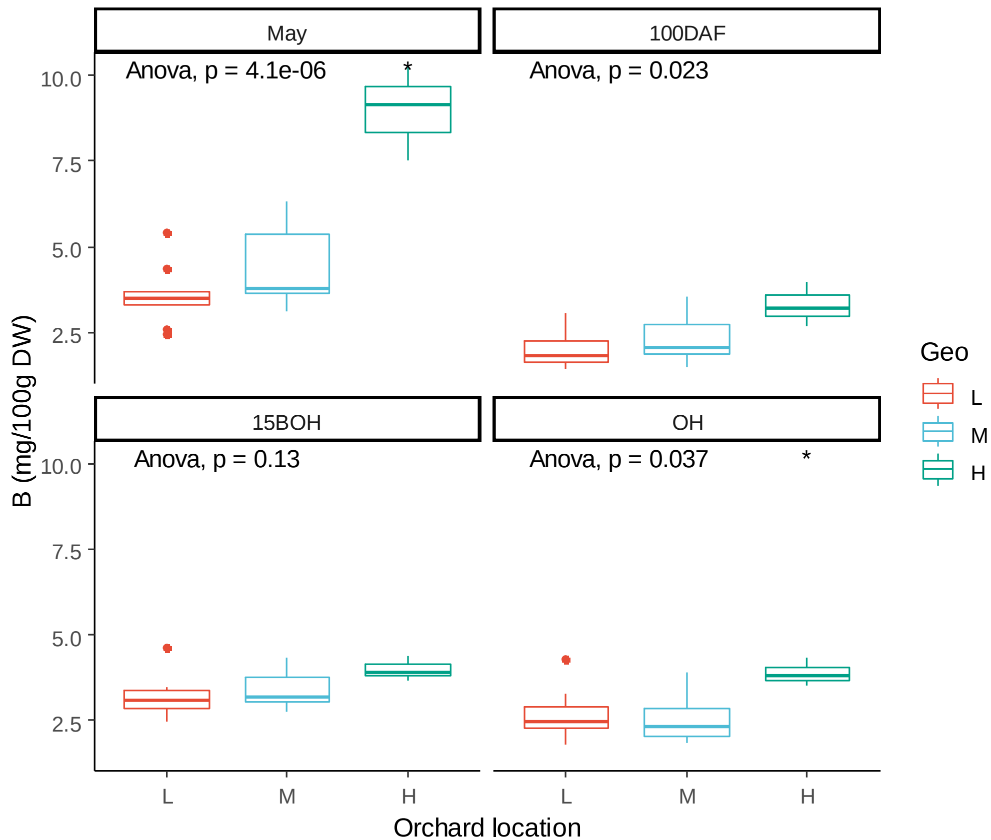
Results


April
May
100DAF
Anova, p = 0.054
Anova, p = 0.034
Anova, p = 0.005
15BOH
OH
Anova, p = 0.015
Anova, p = 0.13
Mg:Ca (mg/100g DW)
0.5
0.4
0.3
0.2
0.1
L
M
H
Orchard location


April
May
100DAF
Anova, p = 0.043
Anova, p = 0.0011 *
Anova, p = 6.8e-05 ***
15BOH
OH
Anova, p = 4.4e-07 **
Anova, p = 2e-04 *
Ca (mg/100gDW)
3
2
1
L
M
H

Results


SD April May 100DAF 15BOH OH
Ca_l
3
2
1
****
****
*
**
***
P19
P19
P19
P19
Anova, p < 2.2e-16
P17
P2
P17
P2
P17
P4
P7
April
May
100DAF
15BOH
OH
Sampling date


May
100DAF
Anova, p = 4.1e-06
*
Anova, p = 0.023
15BOH
OH
Anova, p = 0.13
Anova, p = 0.037
*
10.0
7.5
5.0
2.5
B (mg/100g DW)
Geo
L
M
H
L M H L M H
Orchard location

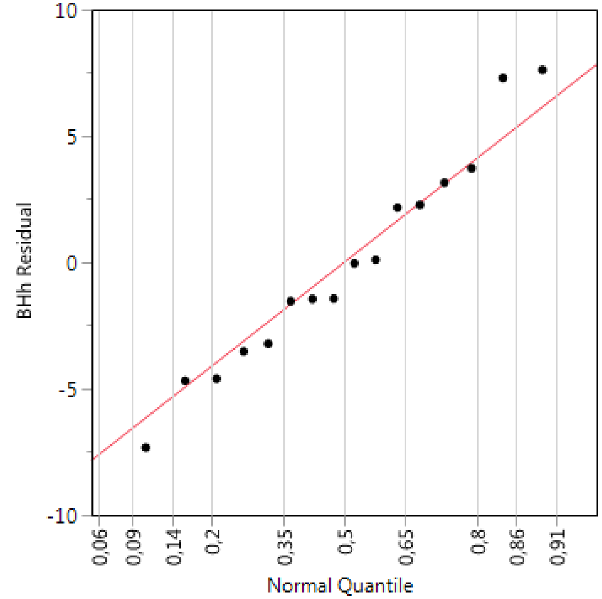
Results

Diagnostic plots, VIF, and predictive equation

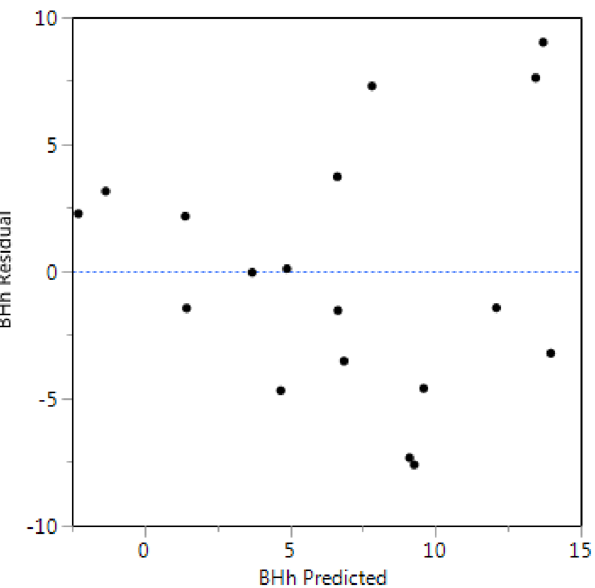
(JMP14 ® PRO)

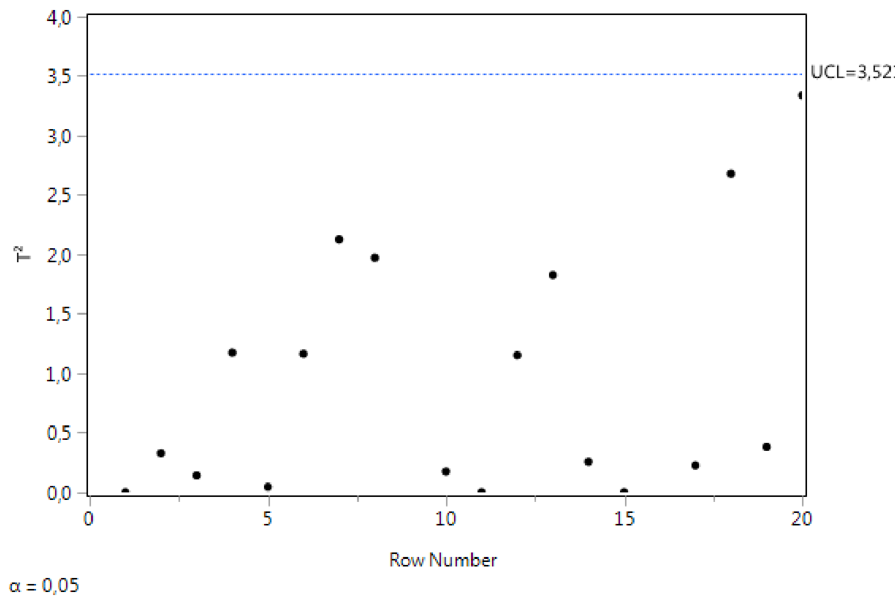
Variable Importance Table

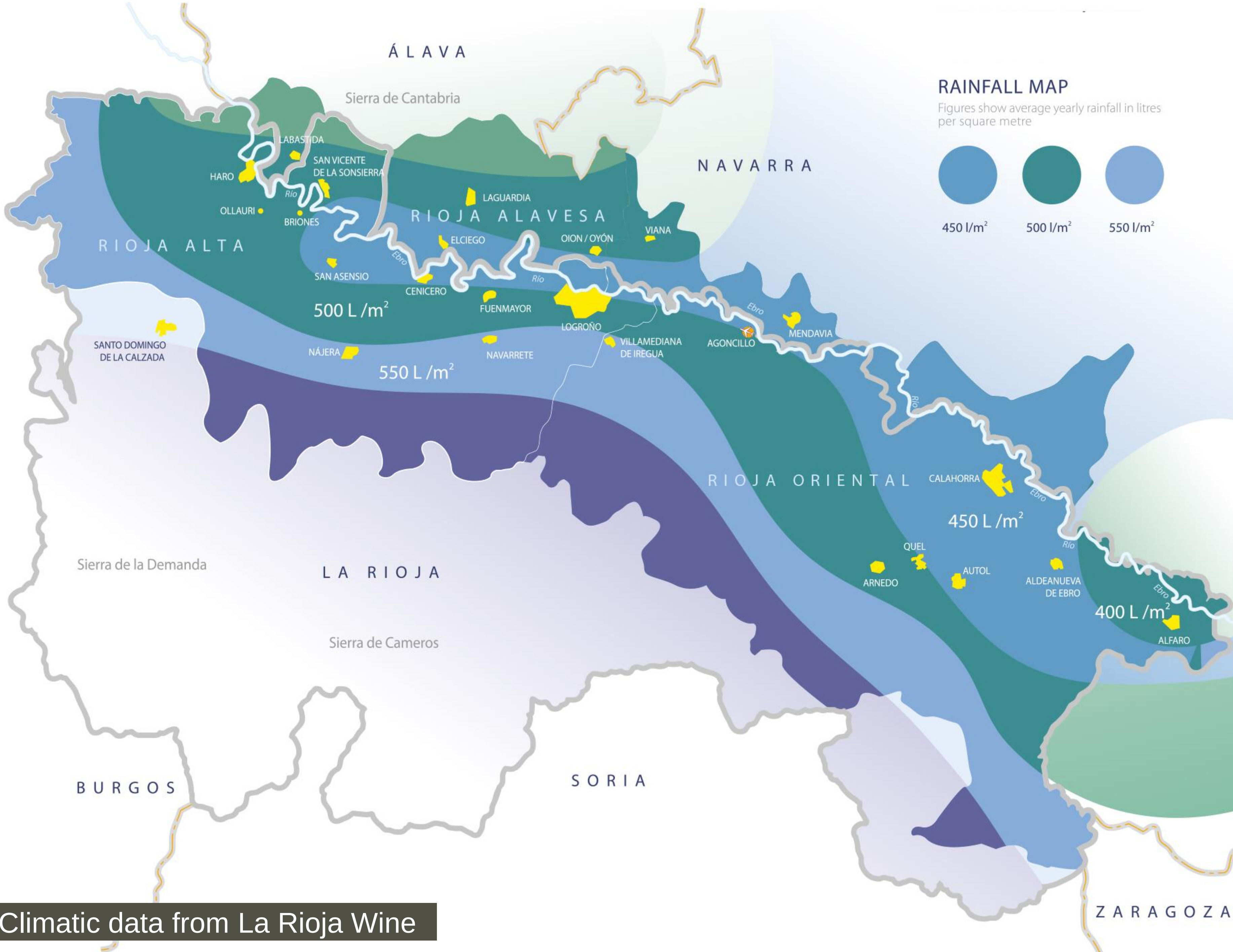
X	VIP
K_l	1,0689
Mg_l	0,1360
Mn_l	0,7656
Zn_l	0,8537
B_l	1,2233
KCa_l	0,7588
Fe_f	1,0041
Zn_f	0,9771
Cu_f	0,8217
KMg_f	0,0081
Dameter	0,7390
TA	0,8180
DW	0,4134
EtH7	1,6537
EtStress7	1,4001
iniEtS	1,6530



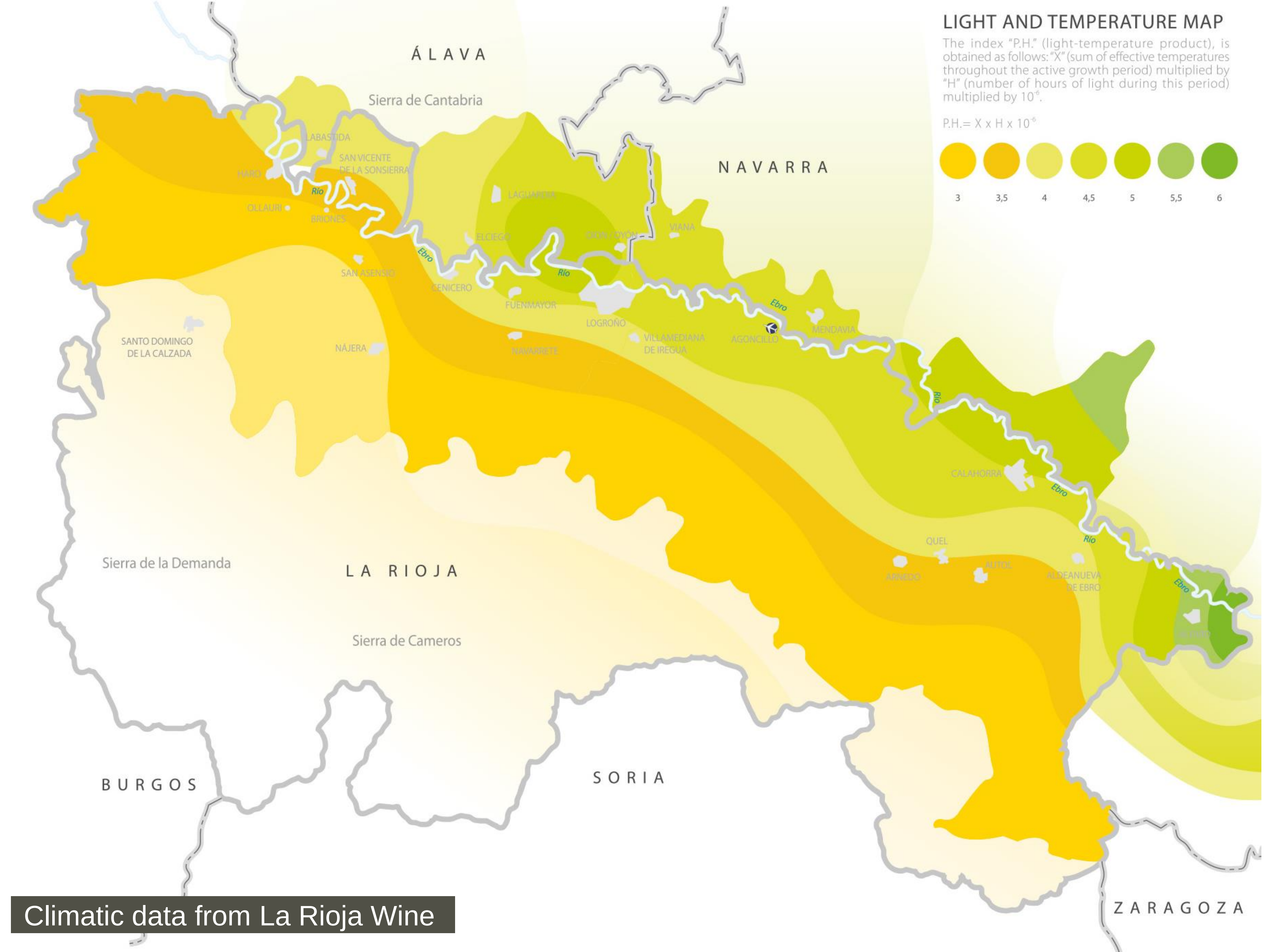
3,6821138755 • K_l
+ -1,80586061 • Mg_l
+ -0,009862555 • Mn_l
+ -0,006498653 • Zn_l
+ 0,3787757938 • B_l
+ 2,541959539 • KCa_l
+ -2,692742511 • Fe_f
+ -1,329395729 • Zn_f
+ 2,4223997953 • Cu_f
+ -0,003616933 • KMg_f
+ -6,239562025 • Dameter
+ 1,0267812184 • TA
+ -0,146529724 • DW
+ 2,5737021641 • EtH7
+ 0,4789182549 • EtStress7
+ -0,376269086 • iniEtS
+ 8,8171559028







Climatic data from La Rioja Wine



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