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Use of predictive models to evaluate the olive response to temperature in the Chaco Arido (Argentina): The cases of Catamarca and La Rioja

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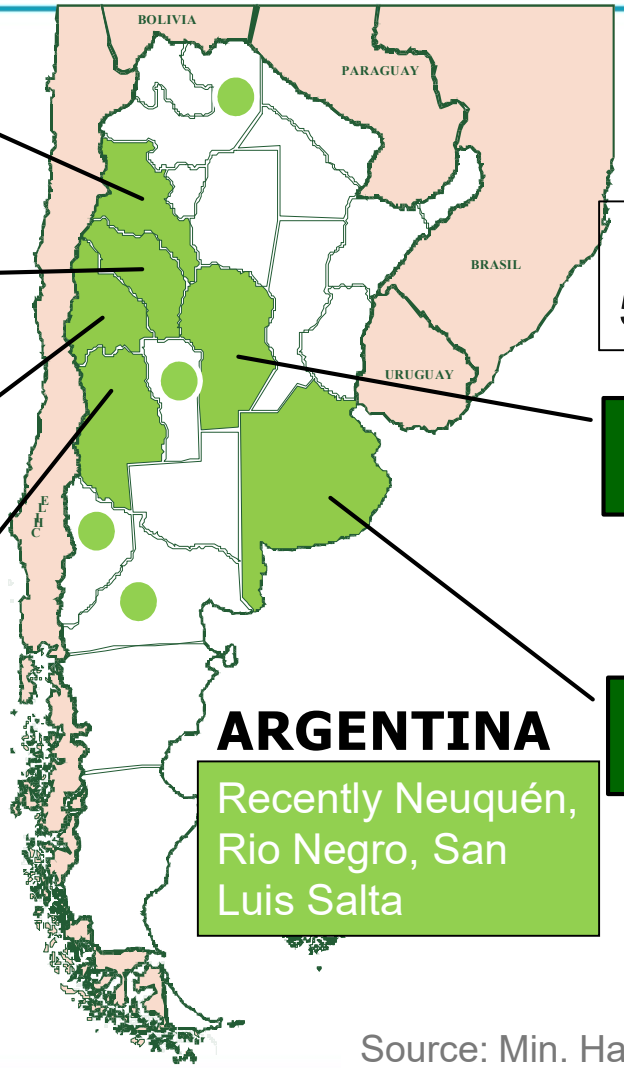
The olive production in Argentina

- The olive production began in Argentina in 1520: olive trees introduced from Spain. A four-hundred year old tree is shown below.

The olive production in Argentina

- The activity is characterized by periods of boom and retraction

Olive production in Argentina– Year 2016



Catamarca
18.700 ha

La Rioja
24.800 ha

San Juan
19.500 ha

Mendoza
20.600ha

65% olive oil
35% olive tables

19.000 tn olive oil
50.000 tn olive tables

Córdoba
5.000 ha

Buenos Aires
1.800 ha

Recently Neuquén, Rio Negro, San Luis Salta

TOTAL
92.800 ha

Source: Min. Hacienda y Finanzas Publicas - Argentina

Production System – Technological Level

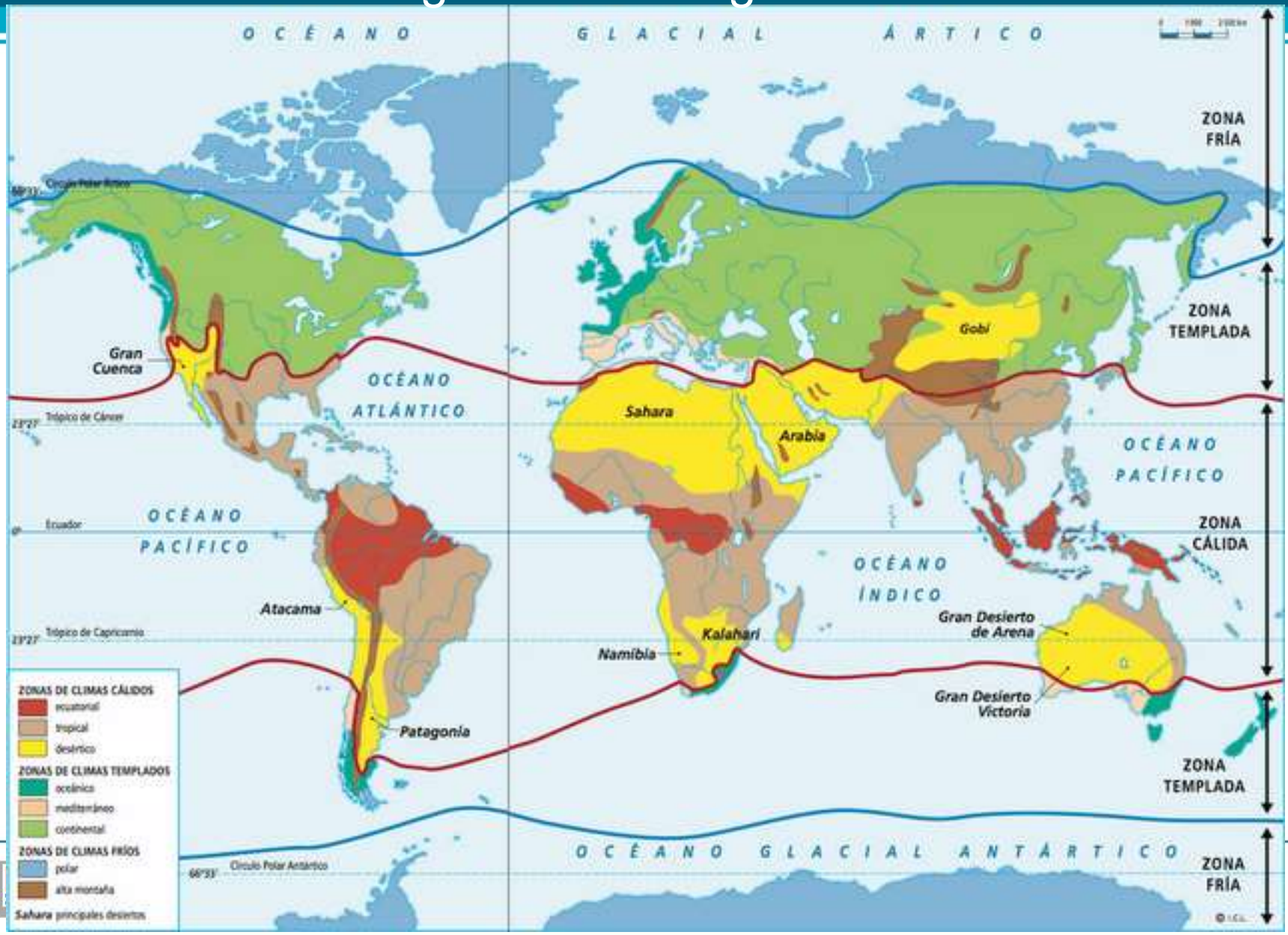
Aspect	Traditional	Business -Modern
Cultivar	Arauco Arbequina Manzanilla	Arbequina Coratina Manzanilla Barnea Picual
Tree spacing	10 m x 10 m 12 m x 12 m	8 m x 5 m 7 m x 5 m
Irrigation	Flooding or furrow	Drip
Control diseases	Low	Frecuently
Pruning practice	Sometimes between years	Annually
Harvesting	Manual	Mechanical (olive oil)

Production System – technological Level

TRADITIONAL : 30%

COMMERCIAL –MODERN: 70 %

Climate Characteristics
Argentina vs Origin Zones



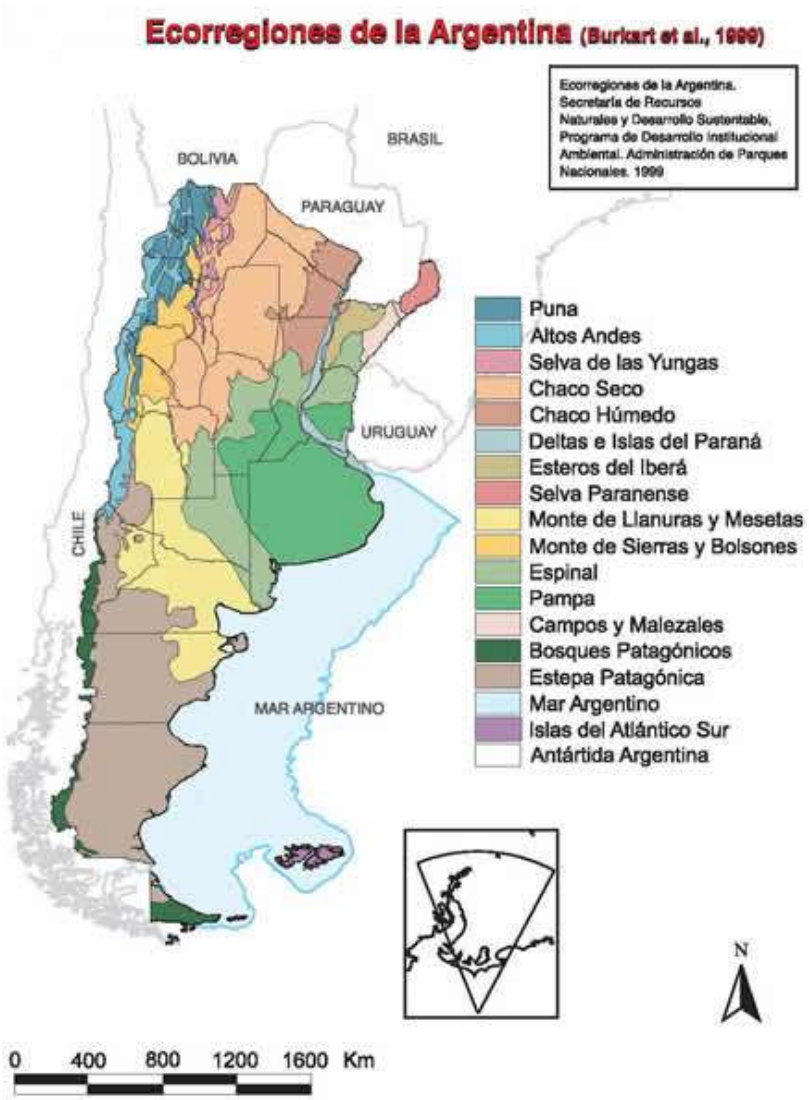
Orographic and Climate Characteristics

- Argentine olive regions

These are located in arid and semiarid zones (Chaco Arido and Monte) of the country, generally in oasis of irrigation. 90% of them are found in provinces bordering The Andes (Searles et al. 2012).

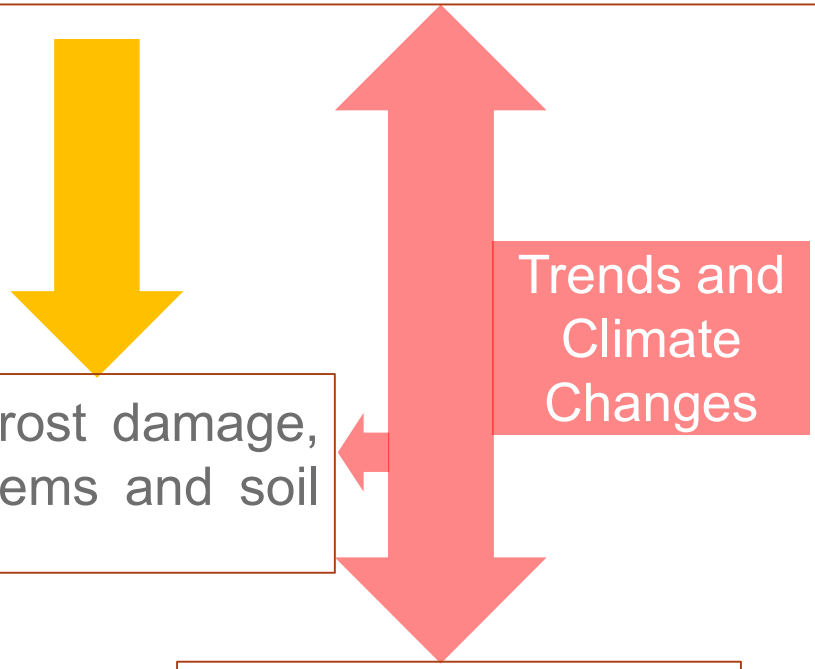
The arid and semi-arid zones of olive production are of continental regime with dry winters and rainy summers.

High temperatures in winter and cold fronts.



From the boom of the 90's and up to the present

Limited knowledge of varietal adaptation (agronomic and industrial) to zones under tax deferral regime.



Unproductive surface due to frost damage, poor flowering, diseases problems and soil problems.

Future scenarios

Conclusions of the climate change in Argentina (1960-2010) – Carril AF (2017)

1960-2010

- The annual average temperature increased between 0,5 and 1 ° C.
- The trend associated with global warming is modulated by local natural variations.
- The duration of the heat hours increased considerably in the North and in the East.
- The number of days with frost decreased.
- Accumulated precipitation (PP) increased, this tendency is modulated by local natural variations.
- The intensity and frequency of rainfall increased.
- Drier and longer periods in the North of Argentina.

2015-2039

- The increase in T ° would be 0.5 to 1 ° C, independent of the scenario (moderate or high amount of GHG emissions).
- The duration of the heat waves would increase 2 days.
- Prolongation of the dry winter period.
- The variation of the accumulated precipitation will not be important, if more intense extreme events would happen.

INTA Catamarca – La Rioja: contribution to olive production

- From 1956 to present

-Physical-chemical characterization of oils by production zone.

-Preservation and characterization of olive germplasm.

-Selection of materials adapted to zones of arid Chaco.

-From 2000, considering the lack of flowering in some cultivars, specific studies are carried out to understand the causes of it.

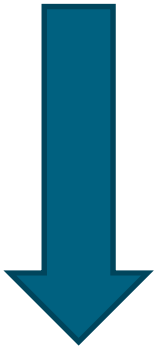
-In order to obtain information for the decision making of cultivar adaptation and studies associated with the forecast of responses and measures in the face of Climate Change.

Arbequina

Frantoio
Leccino

In this context, it was proposed to respond:

¿ Is the insufficient winter cold the cause of null or low flowering of Frantoio and Leccino in Catamarca and La Rioja - Argentina? ?



Possible methodology: geographical assays and available models.

Associated cultural measures: hormone assays of exogenous application.

OBJECTIVES

- Evaluate and if necessary, propose modifications to the model by De Melo-Abreu et al. (2004) in the prediction of the occurrence and date of full flowering of the Arbequina, Frantoio and Leccino cultivars in Catamarca y La Rioja (Argentina) to analyze the influence of chilling on flowering.

- Test the response of Frantoio trees to hydrogen cyanamide (HC) and benzyladenine (BA) to increased flowering in not inductive conditions

MATERIALS AND METHODS

Model description: De Melo Abreu et al. (2004)

Inputs:
T° Max and Min (daily)
Geographic location

To calculate:
- Number of chilling units (CU) until the end of endodormancy
- Thermal time (TT)

Cultivar – specific CU and TT
Temperature parameters: To, Tx, a, Tb

Outputs:
Normal or abnormal flowering

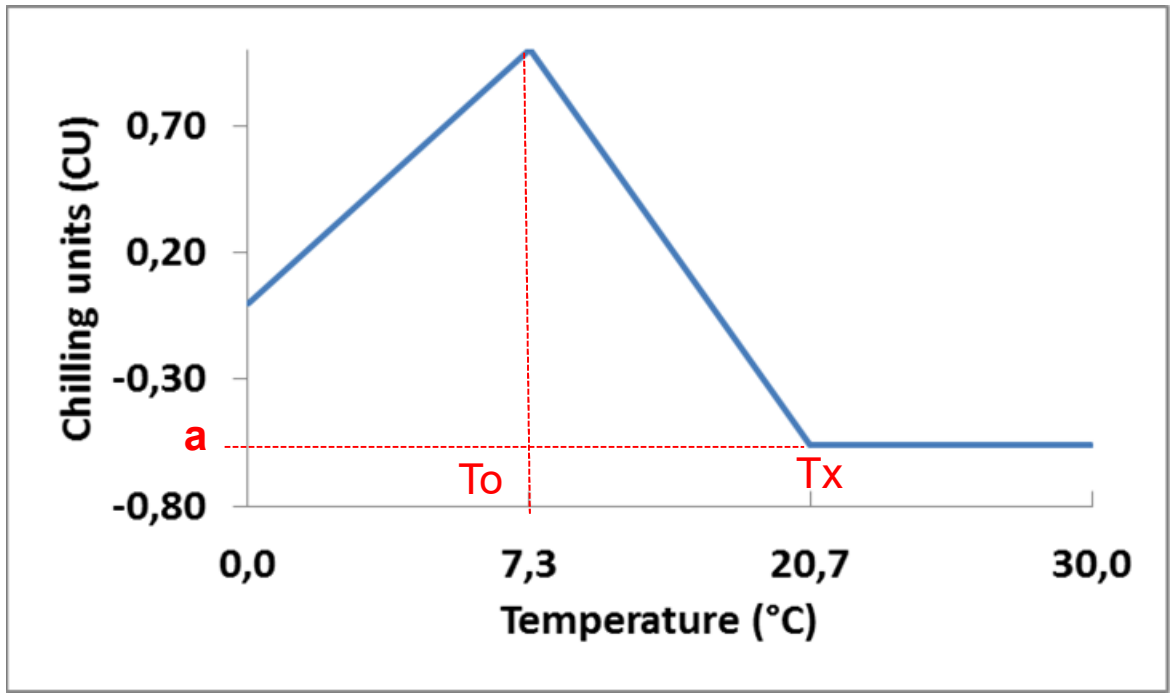
Abnormal flowering due to insufficient CU or TT

Southern Hemisphere
Start: DOY 91 – April 1

Northern Hemisphere
Start: DOY 275 – October 1

Southern Hemisphere
Last day: DOY 300 – October 27

Number of chilling units (CU) accummulated and Thermal Time (TT)



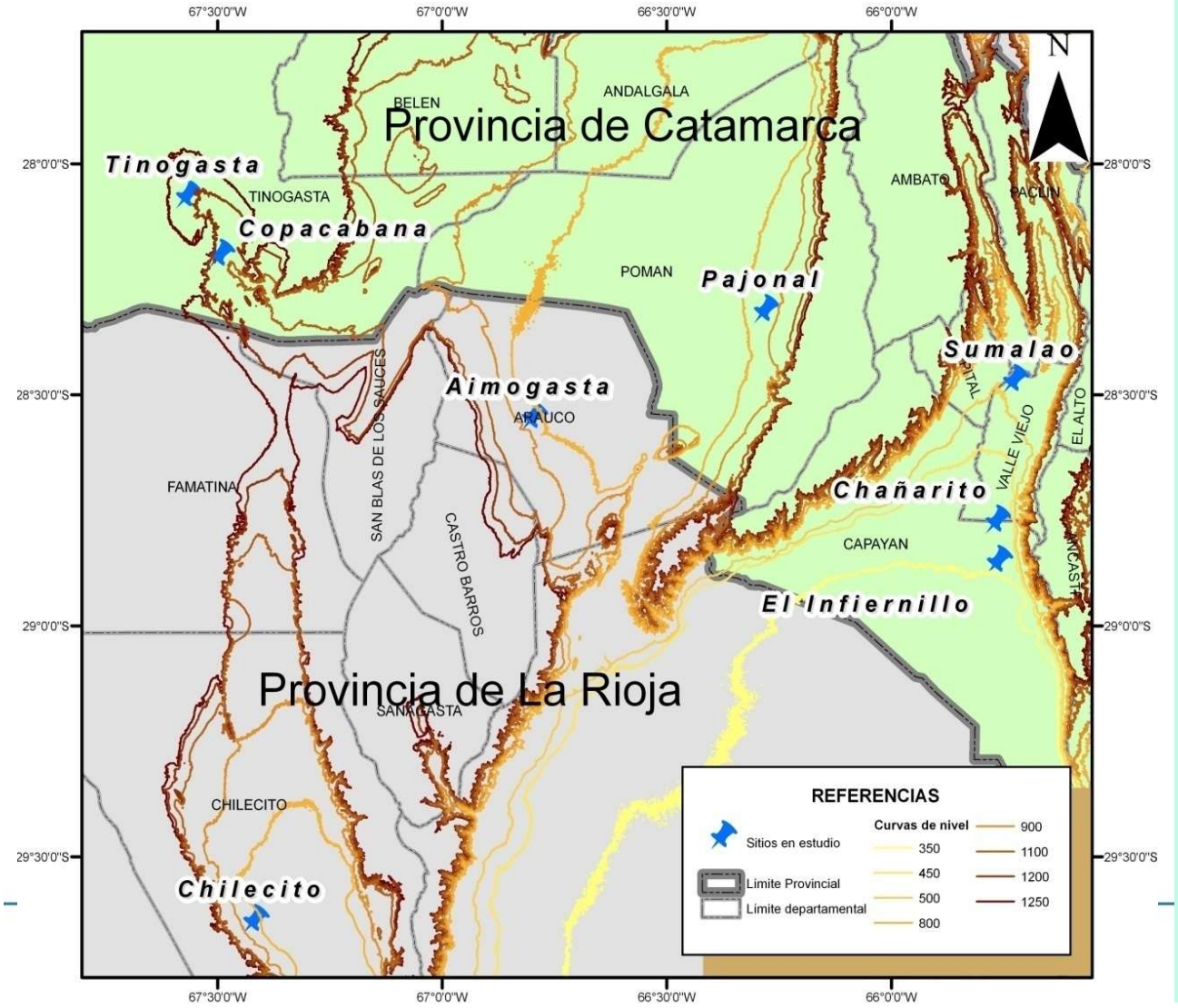
To optimum temperature for chilling accumulation = 7,3 °C

Tx air temperature above which chilling units are discounted = 20,7 °C

a is the rate at which chilling units are discounted when *Tx* is reached = 0,50 (0,56)

Tb= 9,1 ° C
Thermal time approach (Monteith,1977)

MATERIALS AND METHODS



Cultivars: Frantoio
Leccino
Arbequina

Years
2003 to 2008
Meteorological and phenological data

Date and intensity of flowering in 10 trees for cultivar (Microsatellite Molecular markers)

Sites: 8

Study site: Chañarito - Catamarca

Study site: Sumalao - Catamarca

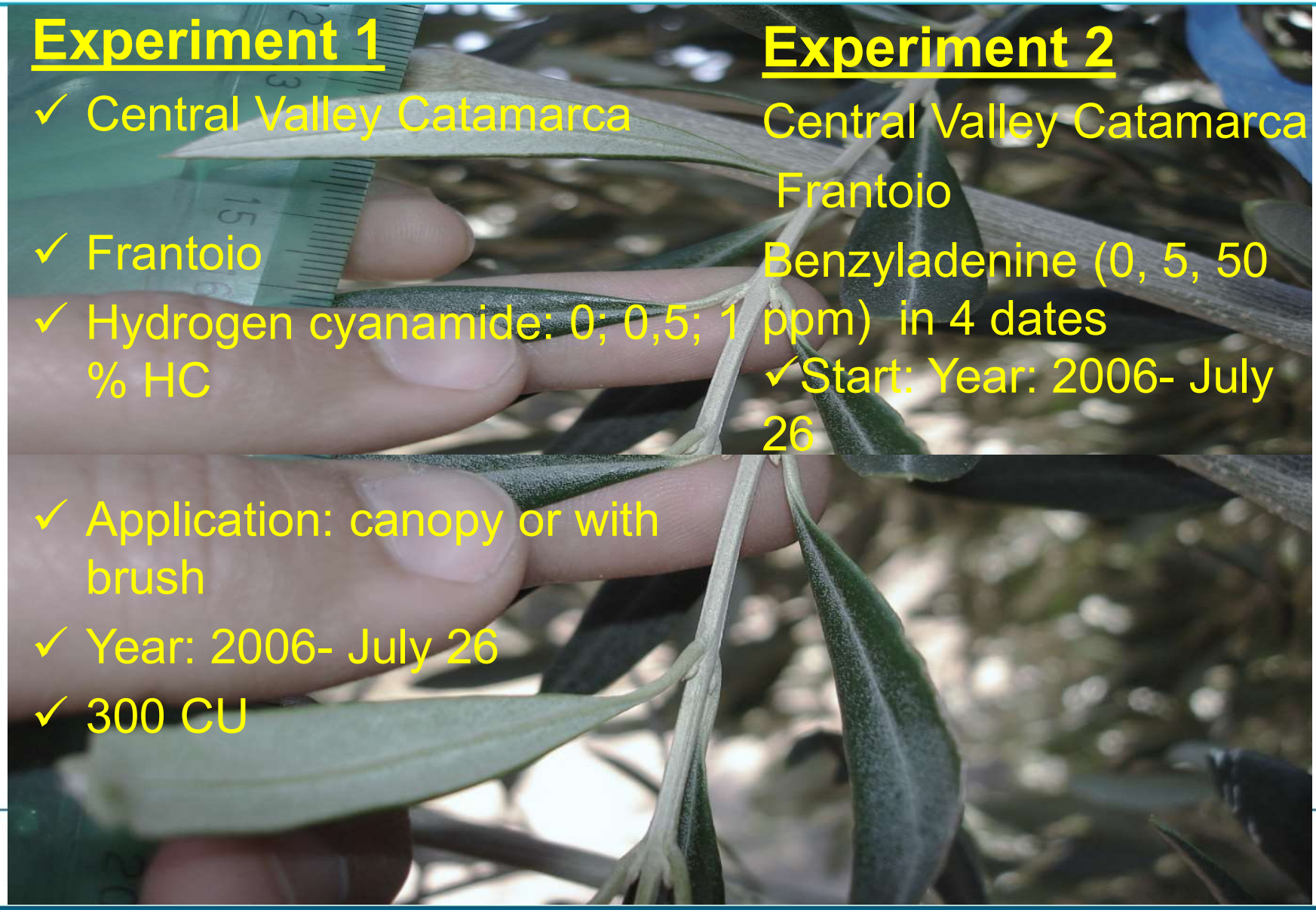
Study site: Aimogasta – La Rioja

Study site: Copacabana - Catamarca

Study site: Copacabana - Catamarca

Study site: Chilecito – La Rioja

Hormones applications



Experiment 1

- ✓ Central Valley Catamarca
- ✓ Frantoio
- ✓ Hydrogen cyanamide: 0; 0,5; 1 % HC
- ✓ Application: canopy or with brush
- ✓ Year: 2006- July 26
- ✓ 300 CU

Experiment 2

Central Valley Catamarca

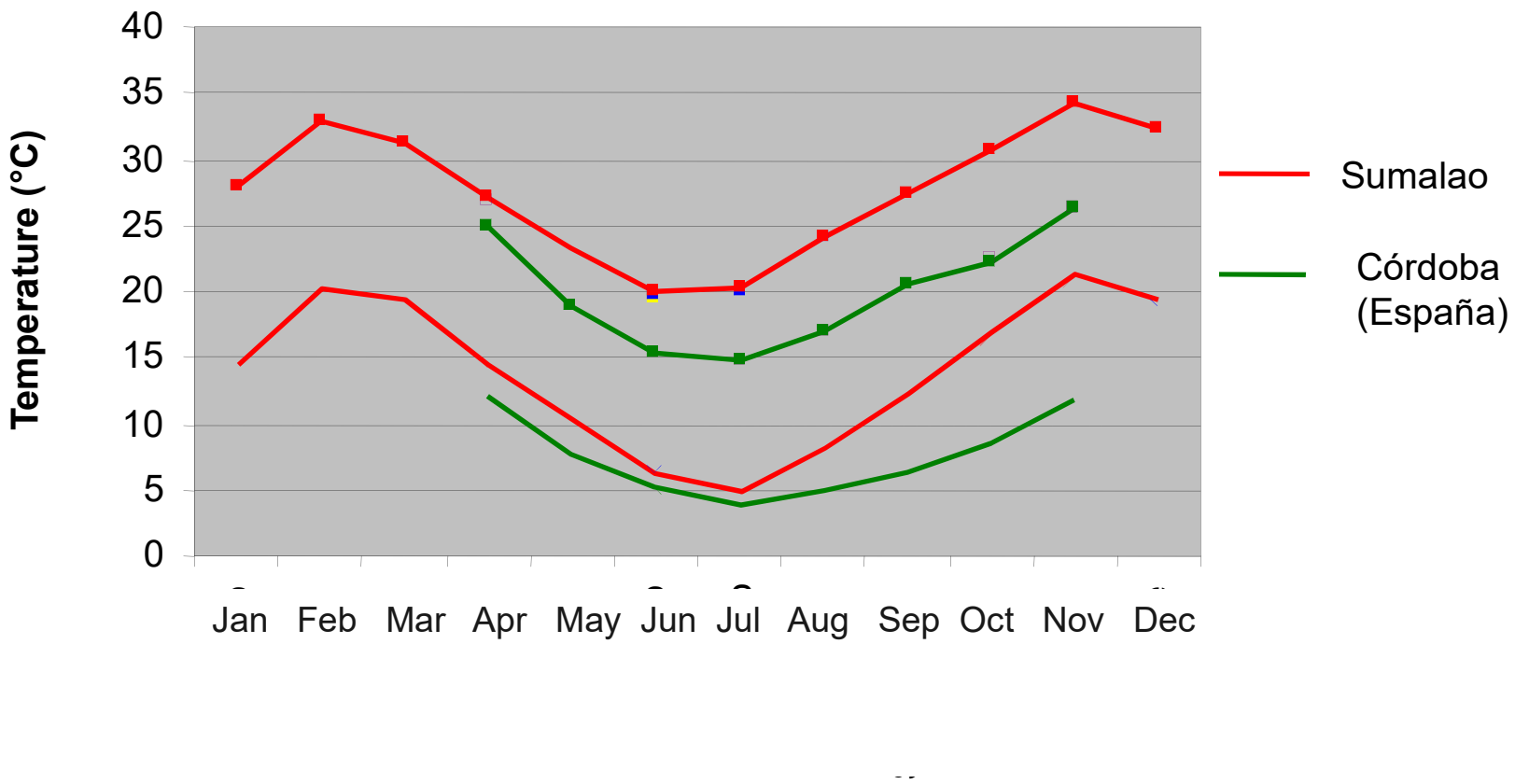
Frantoio

Benzyladenine (0, 5, 50 ppm) in 4 dates

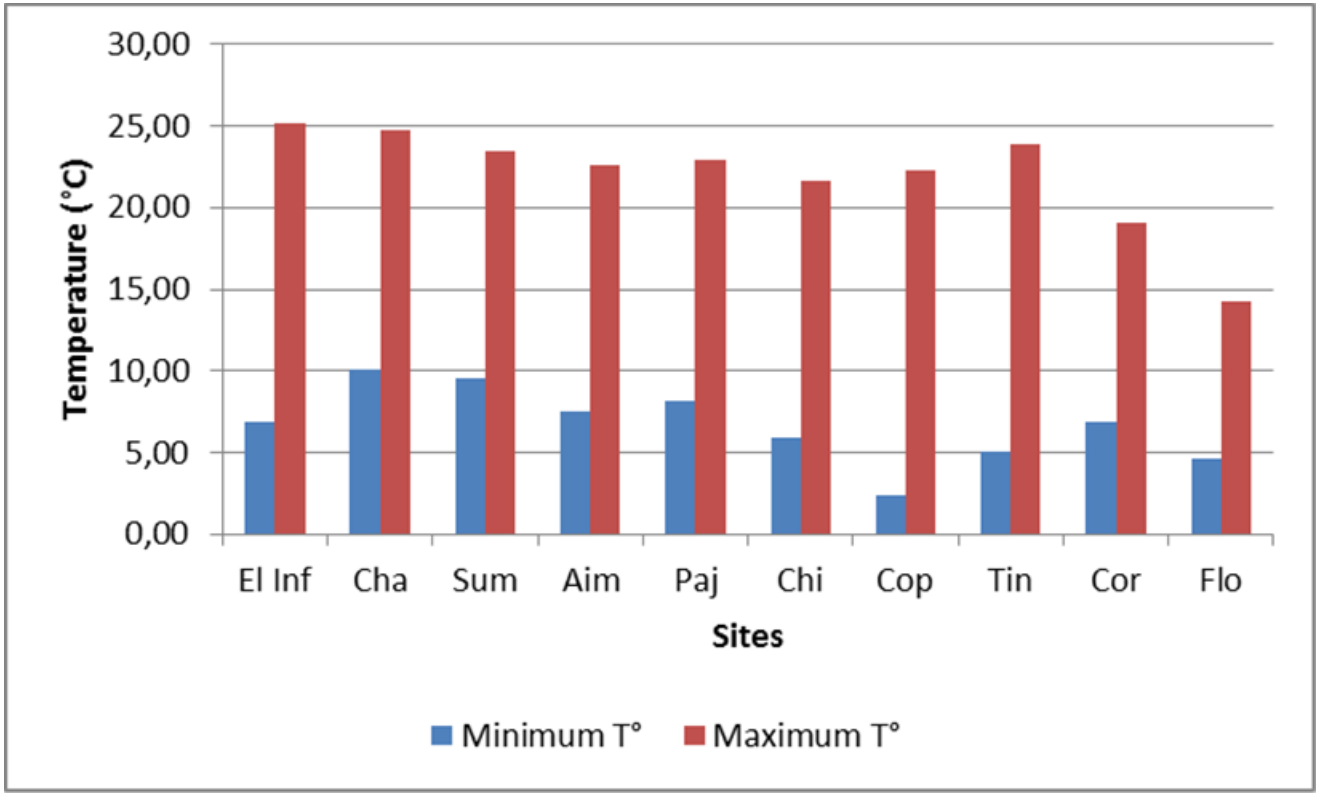
✓Start: Year: 2006- July 26

RESULTS

Monthly average maximum and minimum temperatures(2001-2005)



Thermal characteristics of study sites

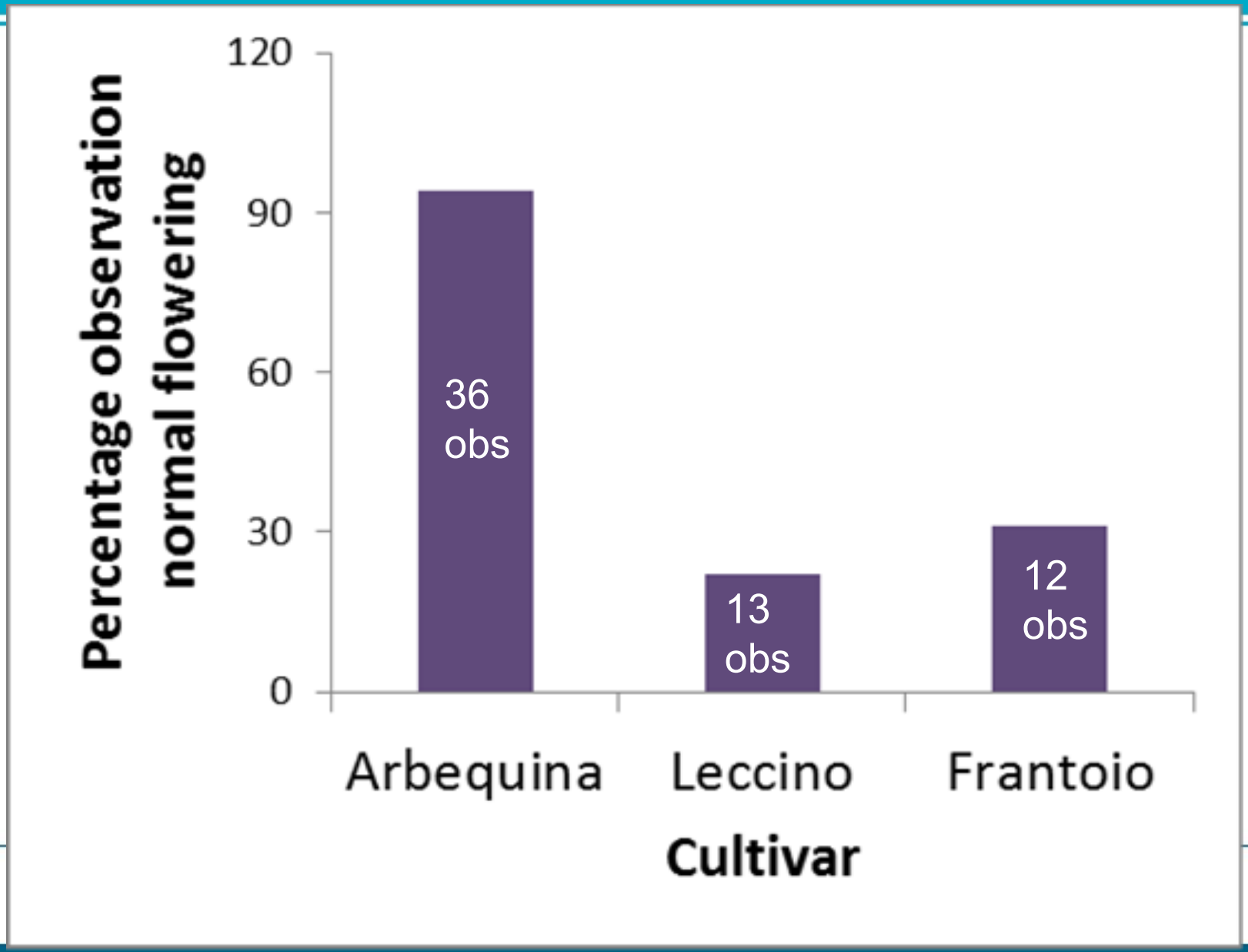


Site	Altitude (AMSL)	Frost (days)
El Inf	345	25.5
Cha	391	7
Sum	524	8.3
Aim	856	24
Paj	859	8
Chi	900	26
Cop	1100	65.3
Tin	1201	40.3
Cor	91	18.7
Flo	18	48.5

Cultivar-specific coeficients

Cultivar	Bud dormancy release CU (Chilling units)	Full flowering TT (Thermal time)
Arbequina	339	490
Leccino	612	483
Frantoio	671	468

Observed flowering



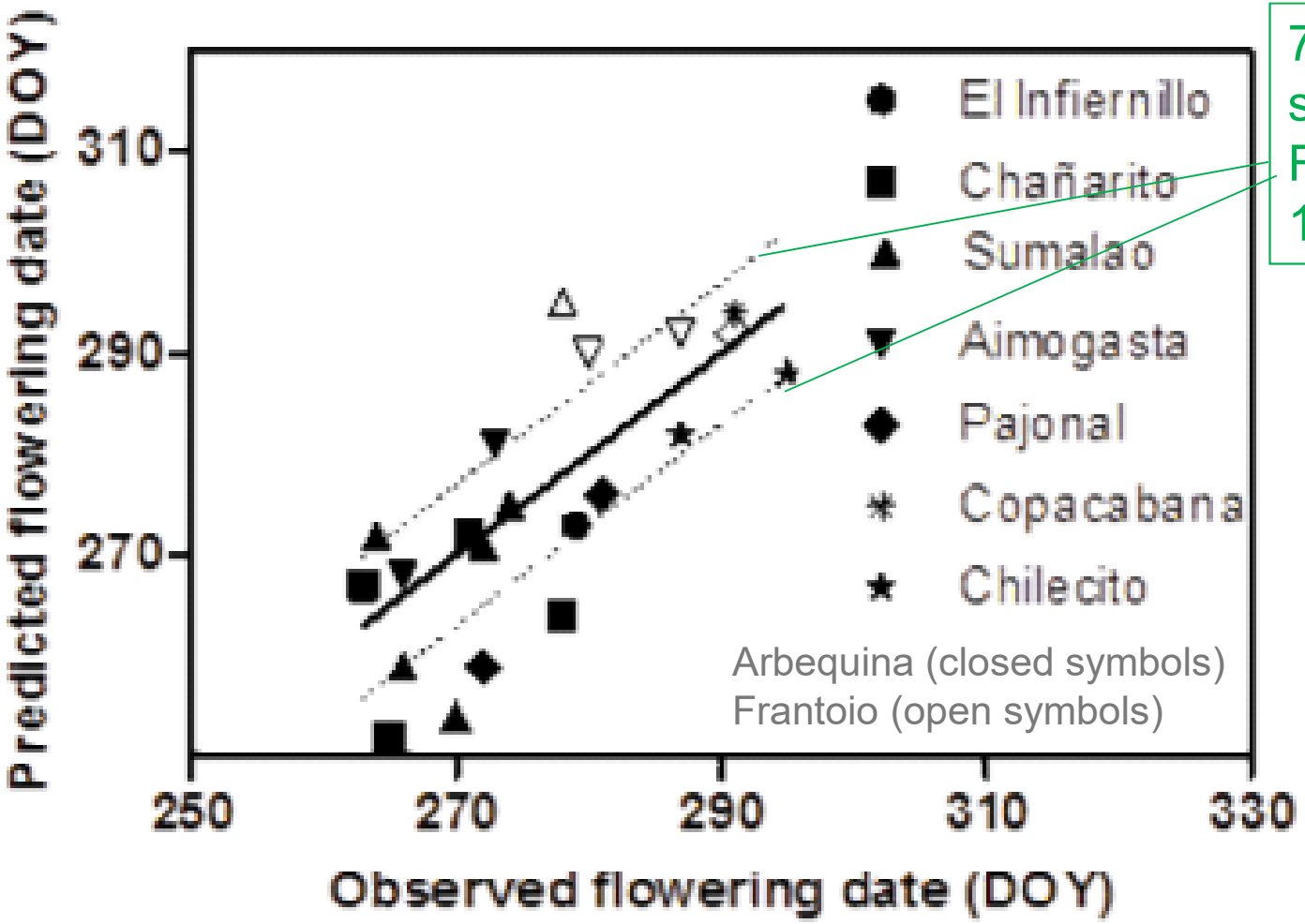
Model predictions: normal flowering ocurred or not for each cultivar

Cultivar	Cases (#)	Successes (%)
Arbequina	36	92
Leccino	13	61
Frantoio	12	83
Total	61	84

Most errors occurred when the model predicted normal flowering when it was not observed

740 CU

Predicted vs observed full flowering dates



7 days range (chi-square analisys) Freese (Vanclay 1994)

CONCLUSION

- The model proposed by De Melo- Abreu et al. (2004) is appropriate to predict the occurrence and date of flowering of Arbequina, Frantoio and Leccino in Catamarca y La Rioja.
-The accumulation CU for the cutivars Leccino and Frantoio is insufficient according to the algorithm used by the proposed model.
- High percentage of success for occurrence of flowering (92%).
- Need for adjustment in prediction of full flowering dates.
- Causes: Tb, a and upper threshold for TT.
- Leccino: 740 CU

- The model could be used as an aproximate tool to determine whether the temperature regime in a proposed new growing región in South America, or elsewhere, is adequate for olive flowering and production.

CONCLUSION

Hormones application

Neither benzyladenine or hidrogen cianamide application led flowering in Frantoio

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RESEARCH ARTICLE

OPEN ACCESS

Evaluation of olive flowering at low latitude sites in Argentina using a chilling requirement model

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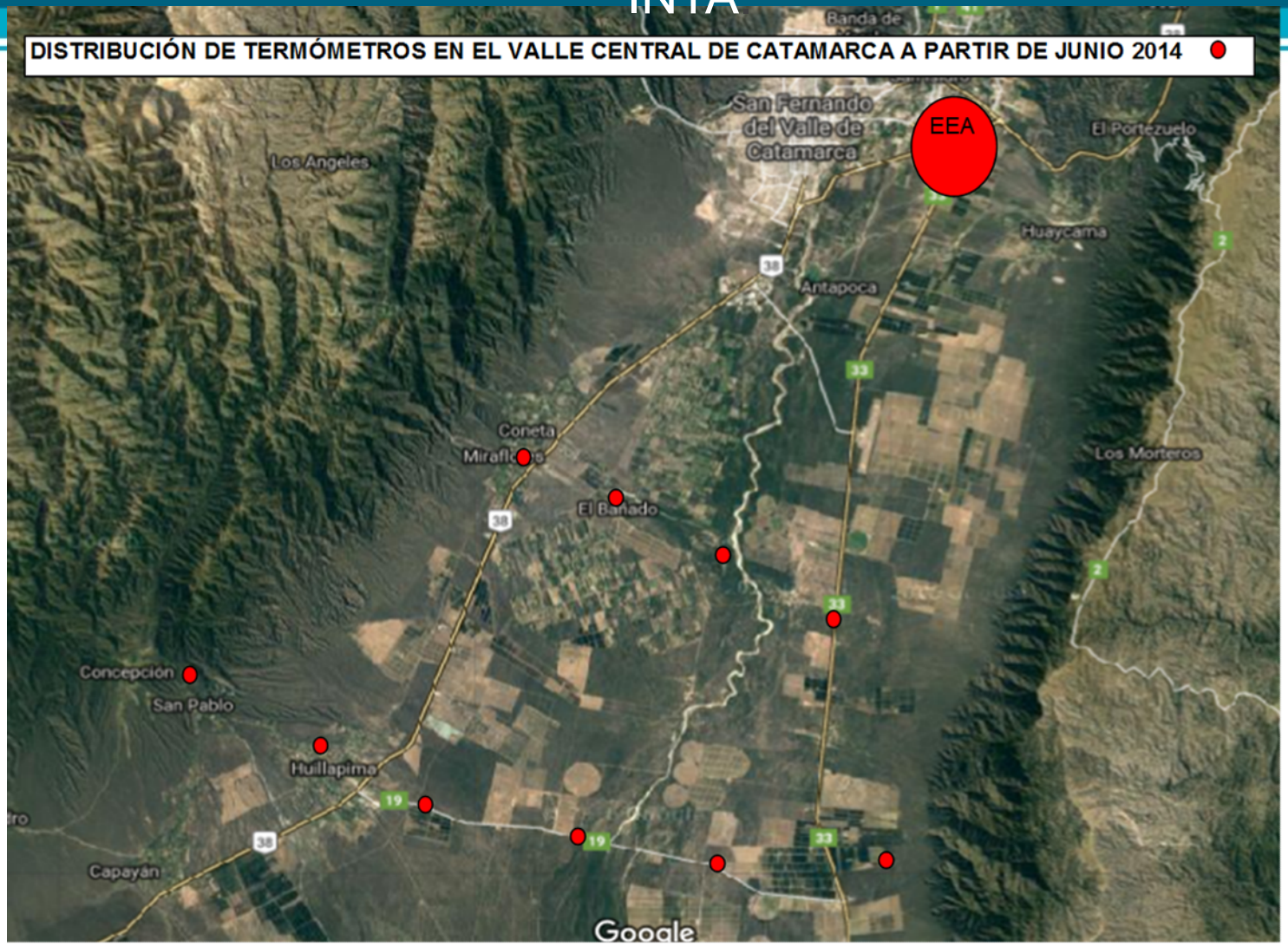
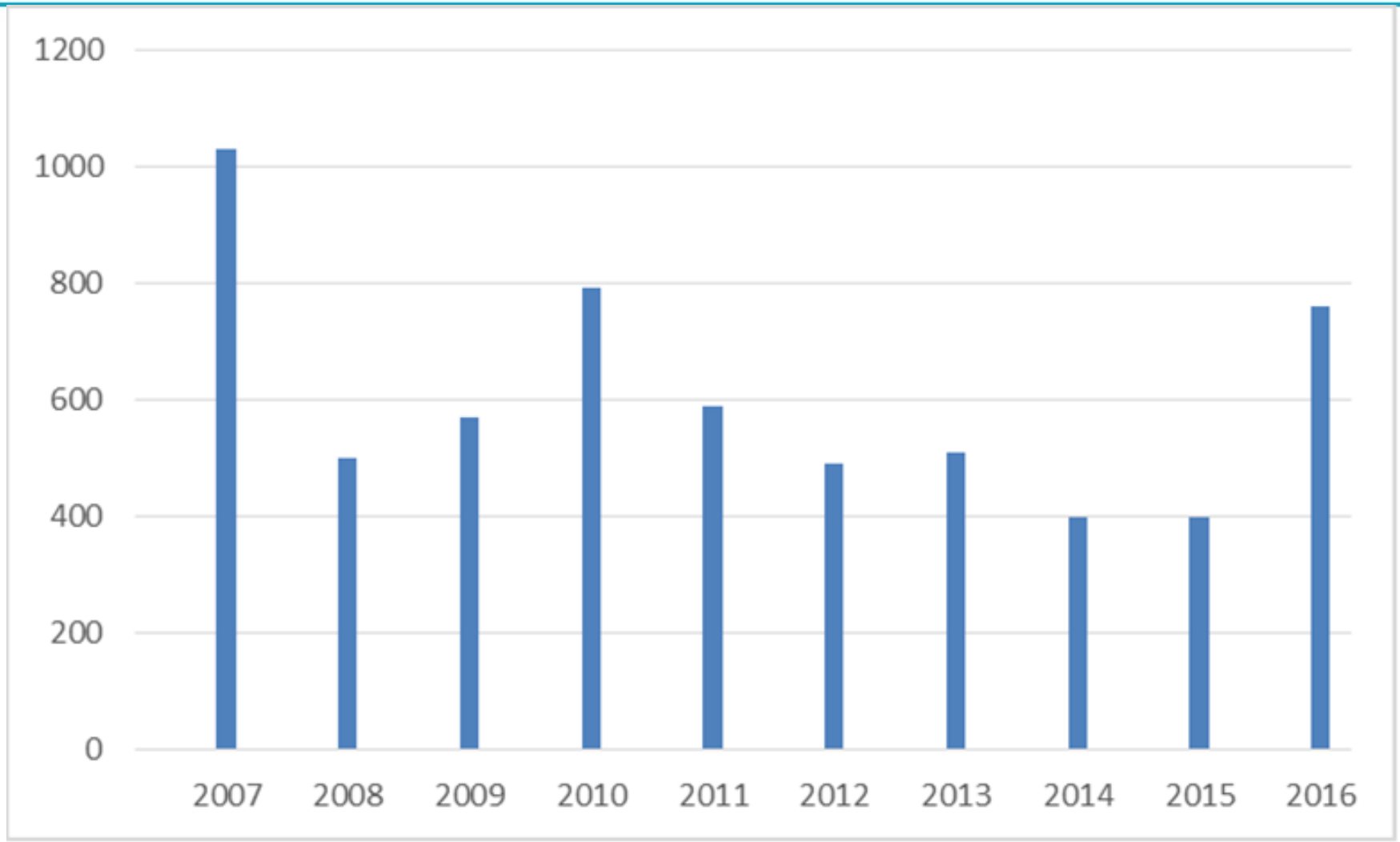
Agroclimatic delimitation studies with the use of models INTA



Amorena JA. (2017) not published

Sumalao: chilling unit (CU)



Amorena JA. (2017) not published

Next activities

- Continuity of work lines: agroclimatic delimitation olive cultivation- CU .
- Beggining of research lines of gene expression associated with response to winter thermal regimes.
- Need to strengthen models and basic information (climate and phenology).
- Need for cooperation for databases and tools.

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Thank you very much for your kind attention

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