CHRONOCARINATA: A simple model for predicting phenology

Daniel Miralles

Facultad de Agronomía UBA, CONICET e IFEVA
Av San Martin 4453 Buenos Aires ARGENTINA
miralles@agro.uba.ar

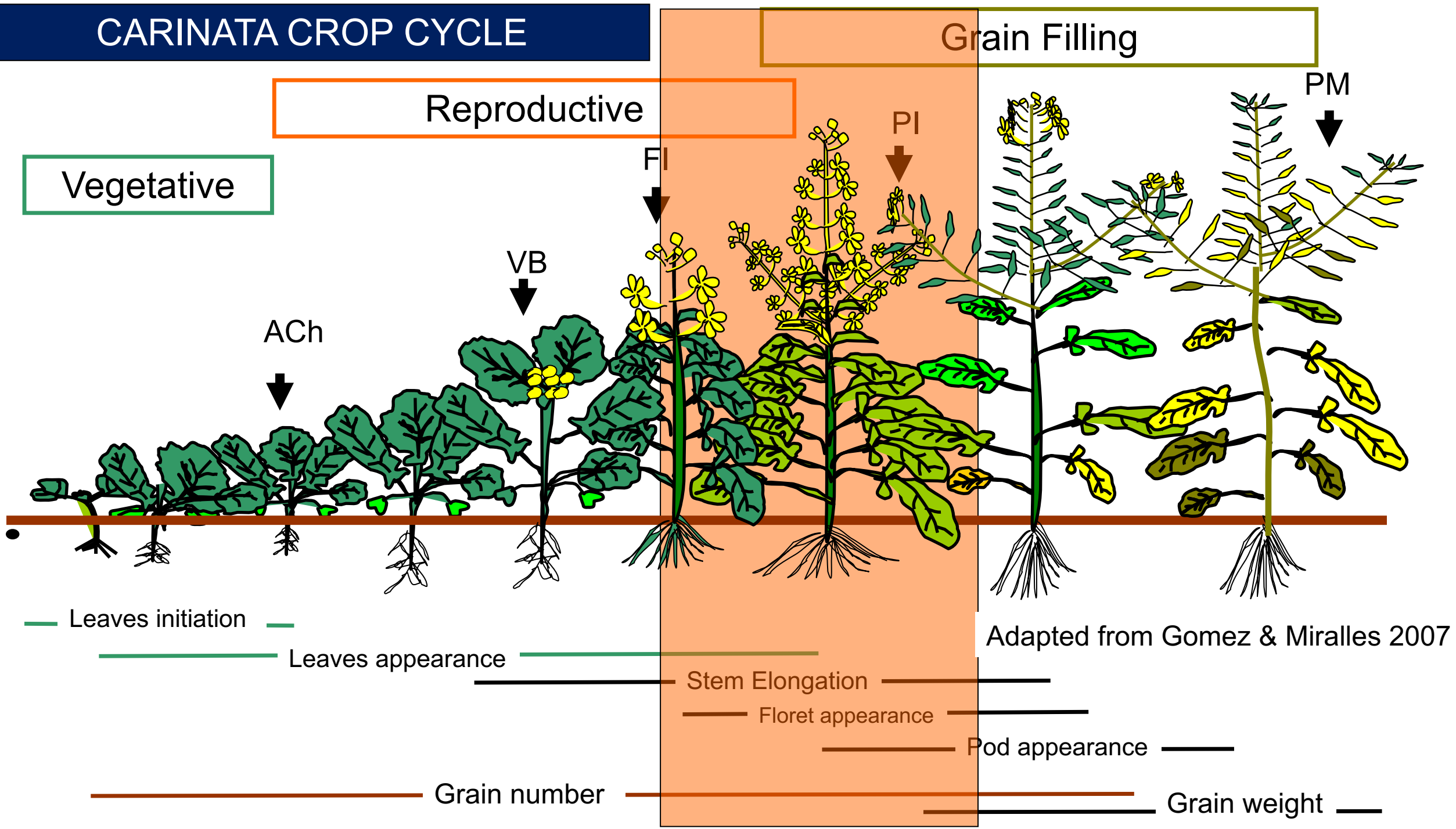
IXth Carinata Biomaterials Summit-April 26-27, 2022
University of Florida, Hilton, Gainesville, FL

CONICET

IFEVA

Facultad de AGRONOMÍA Universidad de Buenos Aires

CARINATA CROP CYCLE



THE IMPORTANCE OF KNOWING THE PHENOLOGY OF CARINATA

- Understand the phenology of the crop is the first step to introduce any crop in a new area.
- Characterize the adaptation of the crop to different environments
- Avoid the risk of Frost during different phases of the cycle and the heat shock during the grain filling.
- Locate the critical period, during which yield is defined, in the best environmental conditions.
- Avoid or minimize yield reductions due to delays in sowing dates.

¿WHAT ARE THE FACTORS THAT REGULATE THE DEVELOPMENT OF THE CROP?

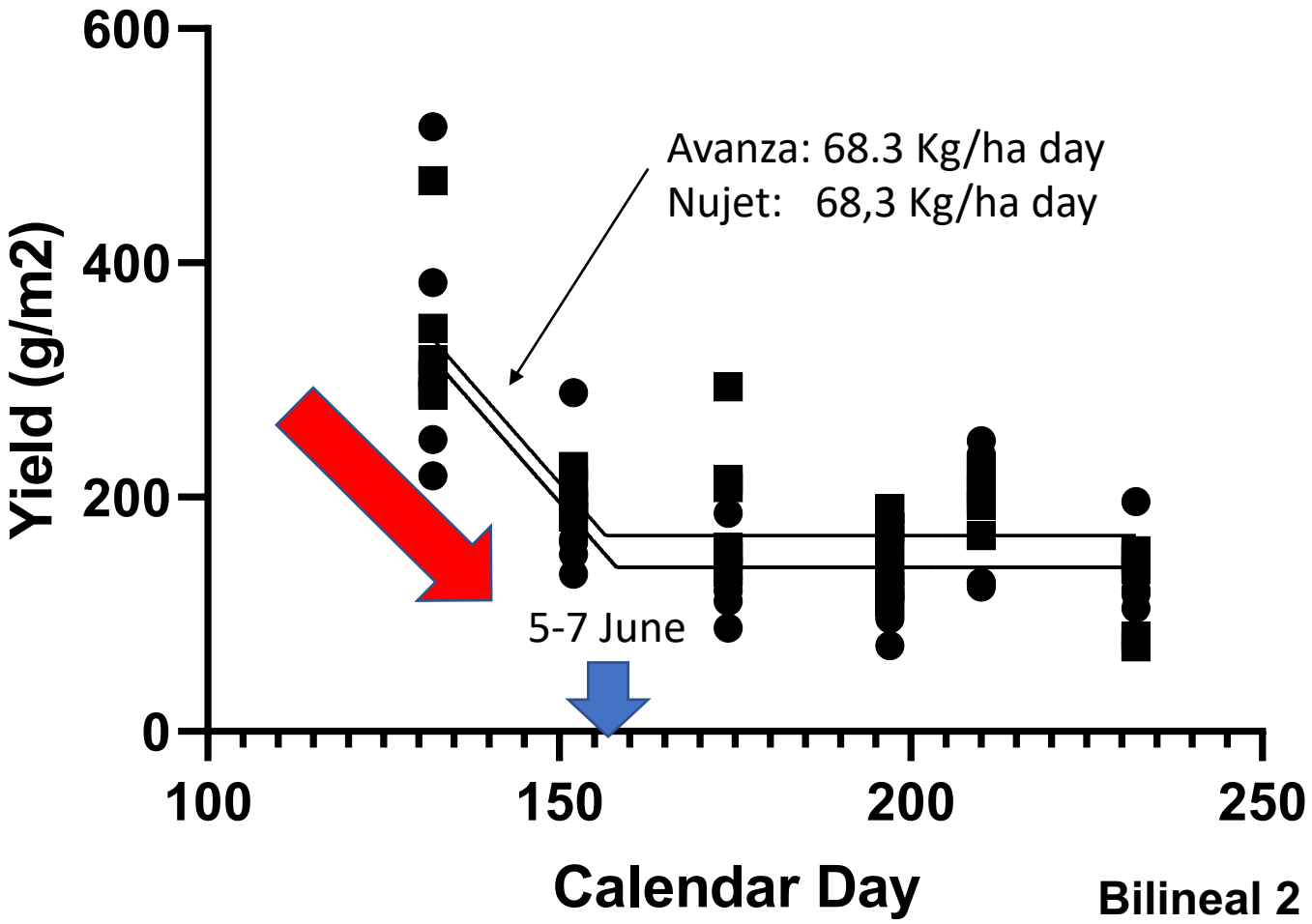
TEMPERATURE: Affects the crop during the whole cycle. The warmer temperature the shorter the cycle duration (measured in calendar days). For the duration of the cycle measured in Thermal Time (Degree days °Cd) normally a base temperature of 0-5 °C is assumed.

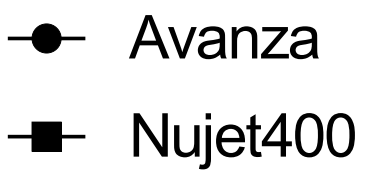
PHOTOPERIOD: *Brassica Carinata* can be considered a quantitative long day plant in relation to its response to photoperiod as the longer the daylength the shorter the cycle. Photoperiod response normally is evident from emergence to flowering initiation.

VERNALIZATION: Generally, this requirement appears in winter cultivars and during the vegetative phase. Optimal vernalization temperatures is from 4 to 9 °C.

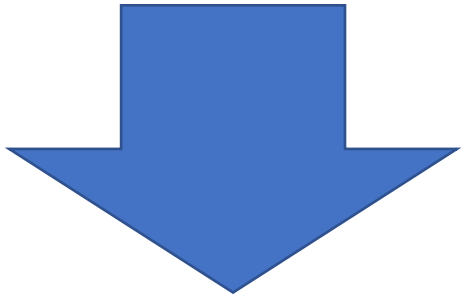
Yield losses by changes in sowing dates

Avanza & Nujet





Yield losses per day of delaying in sowing dates



Source: NUSEED-School of Agriculture UBA Agreement (2021)

Bilineal 2

Parameters±standard errors

Best-fit values	Avanza	Nujet400
Intercept	1221±258	1237±203
Slope	-6,833±1,8	-6,833±1,4
Inflexion Point	158±5	156±4

CHRONOCARINATA: A simple model for predicting phenology

OBJECTIVE: Design a simple model for predicting phenology in two genotypes of *Brassica Carinata* (Nujet 400 and Avanza 641) for a large number of locations in Argentina within the agreement between NUSEED company and the school of Agriculture of the University of Buenos Aires

METHODOLOGY: Six different sowing dates from May to August were carried out under field conditions at the experimental field of School of Agriculture University of Buenos Aires during 2021 growing season

12/5/2021	SD1	Early
1/6/2021	SD2	
23/6/2021	SD3	
16/7/2021	SD4	
29/7/2021	SD5	
20/8/2021	SD6	Late

Phenological stages were determined throughout the crop cycle in both Nujet 400 and Avanza 641 genotypes.

Duration was measured in calendar days and Thermal time (Degree days - °Cd -) using a Base temperature of 0°C.

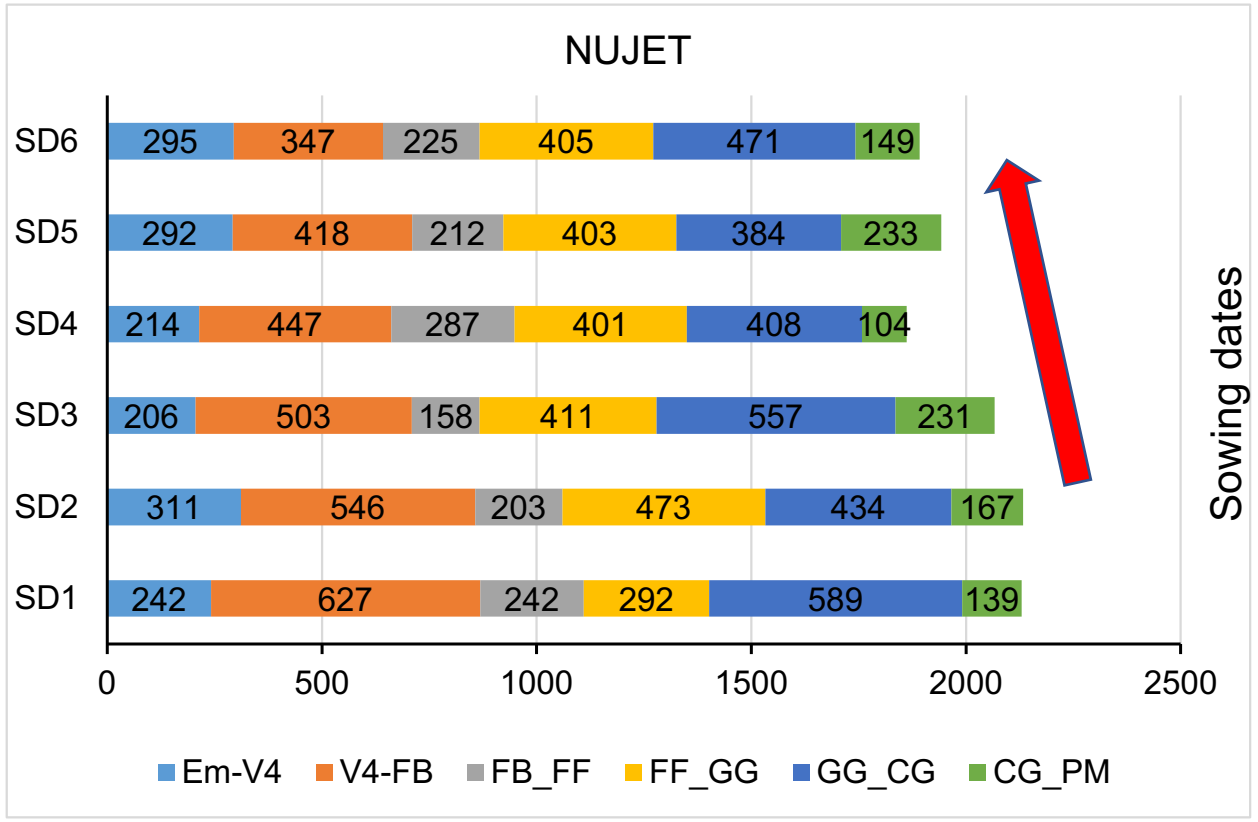
Yield and its components were also determined

Phenological Stages of Sowing, Emergence, Rosette (4 emerged leaves – V4), Floral Bud (FB), First Flowering (FF), First Fruiting Fr), Green grains (GG), Colored Grains (CG) and Physiological maturity (M).

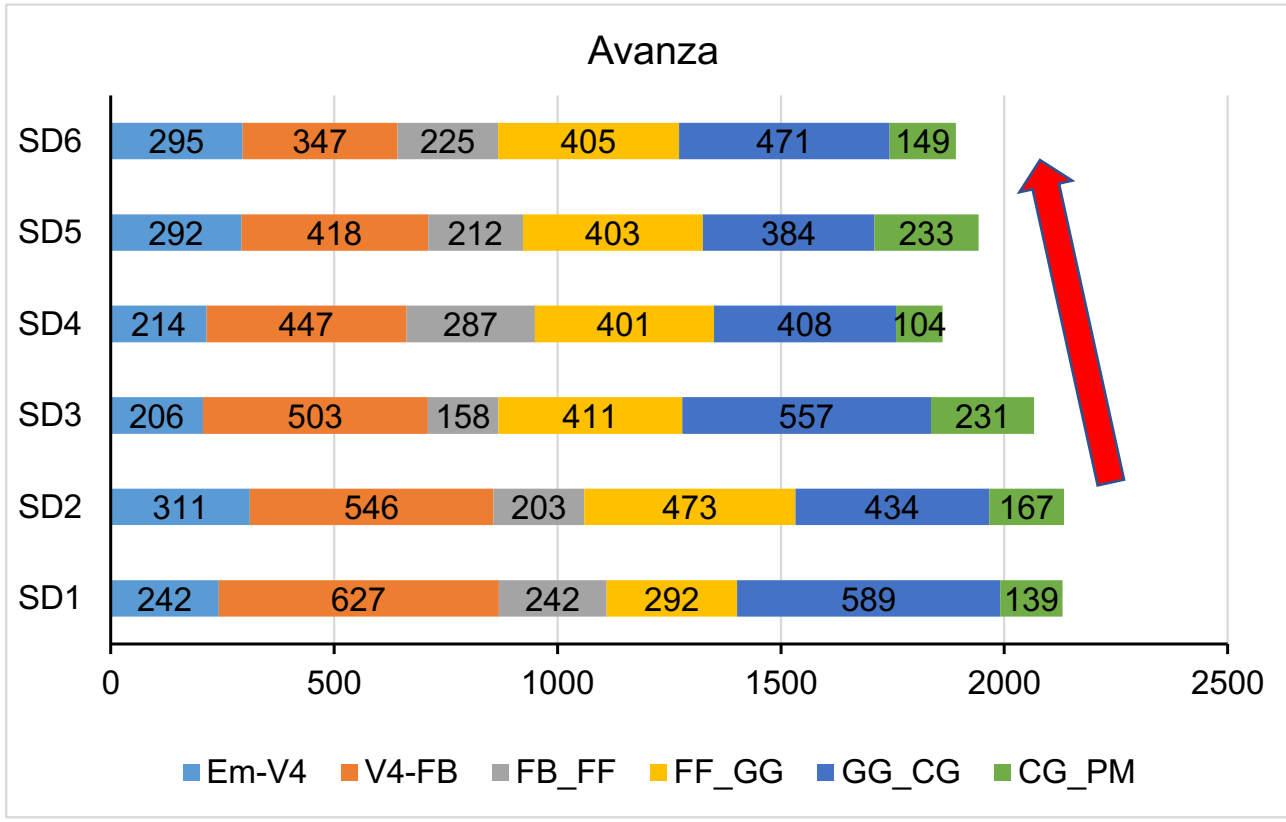
Agreement: NUSEED- School of Agriculture University of Buenos Aires

CHRONOCARINATA: A simple model for predicting phenology

CHRONOCARINATA: Steps to build the model



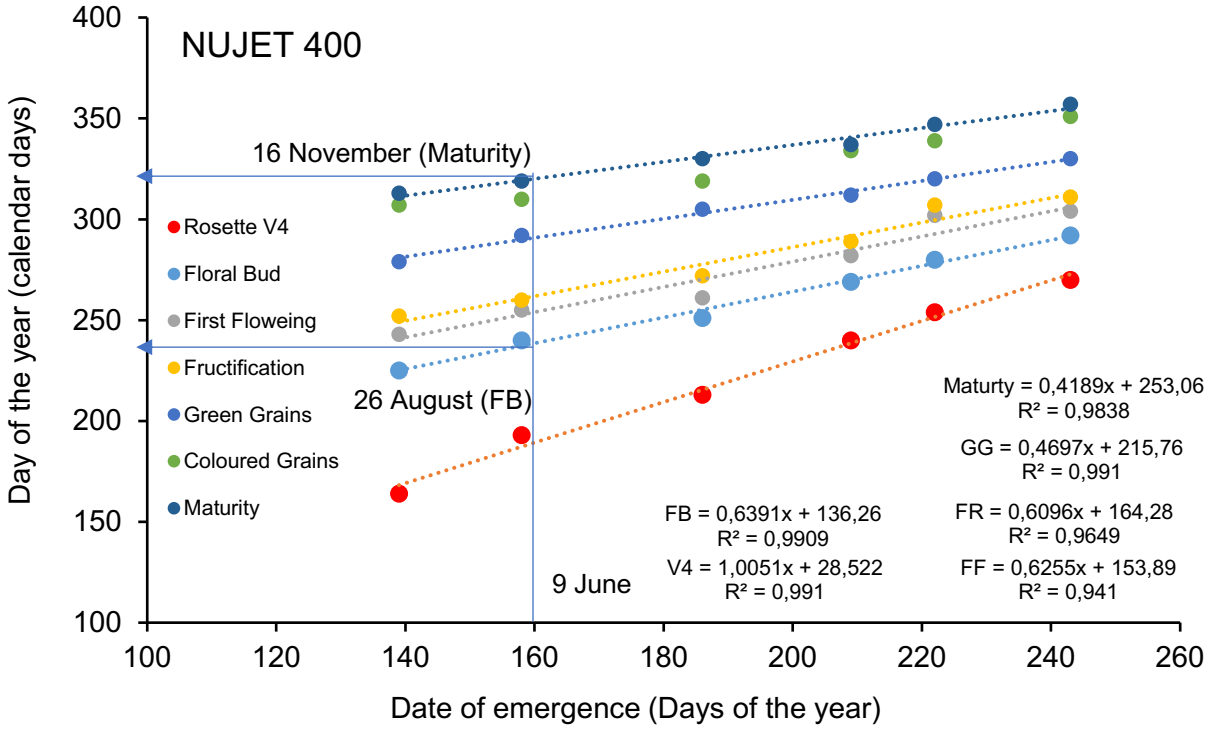
Sowing dates

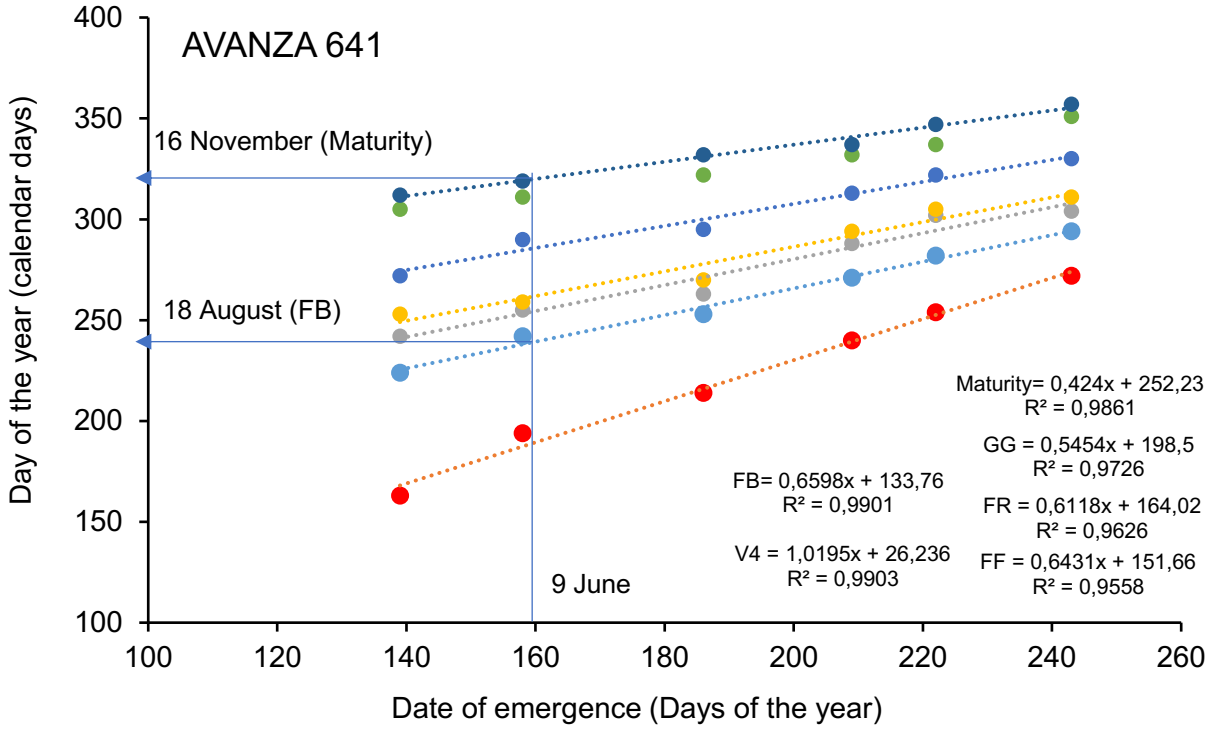


Degree days from emergence (°Cd)

The duration of the cycle was shortened as sowing dates was delayed.
Sowing dates were from: Middle may (12 May) to late August (20 August)

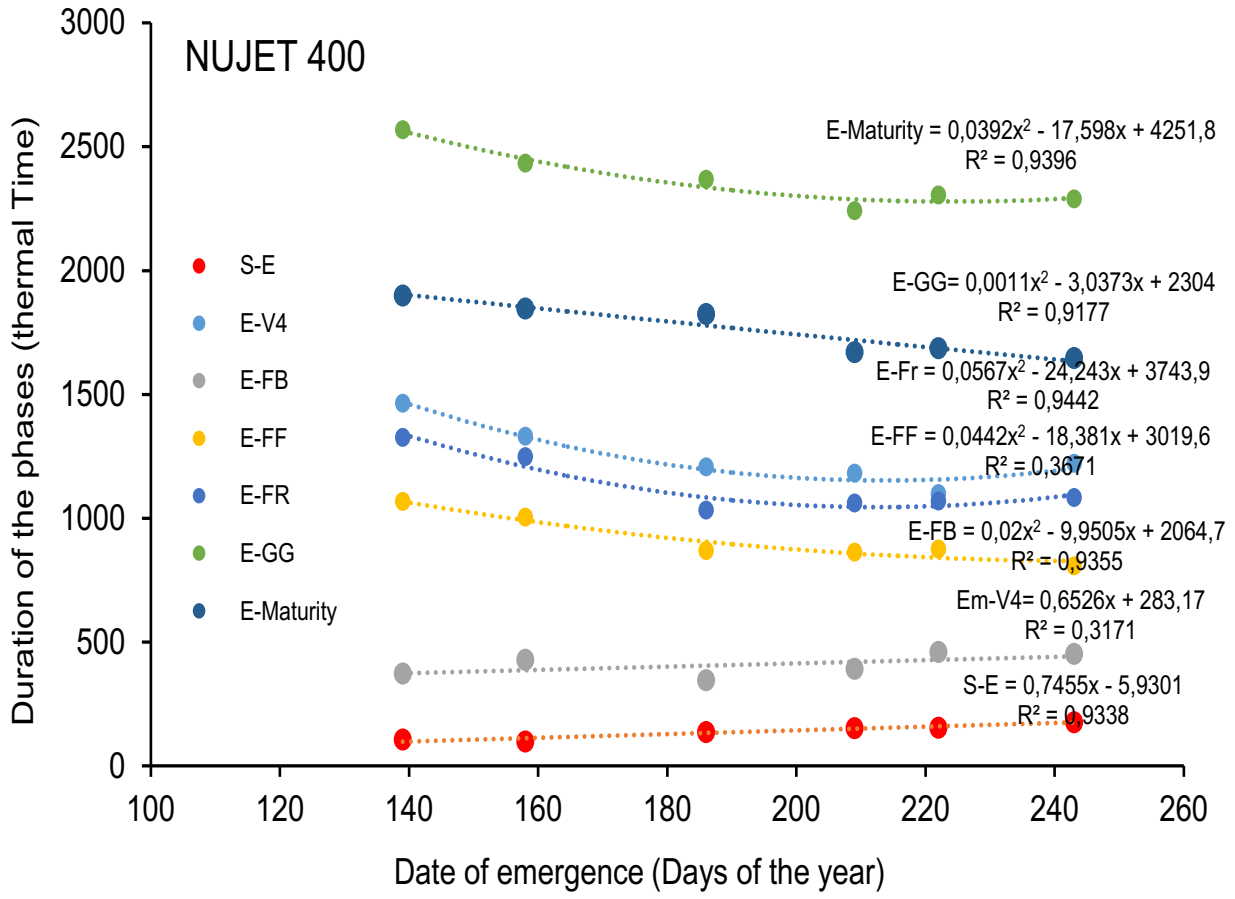
CHRONOCARINATA: Steps to build the model

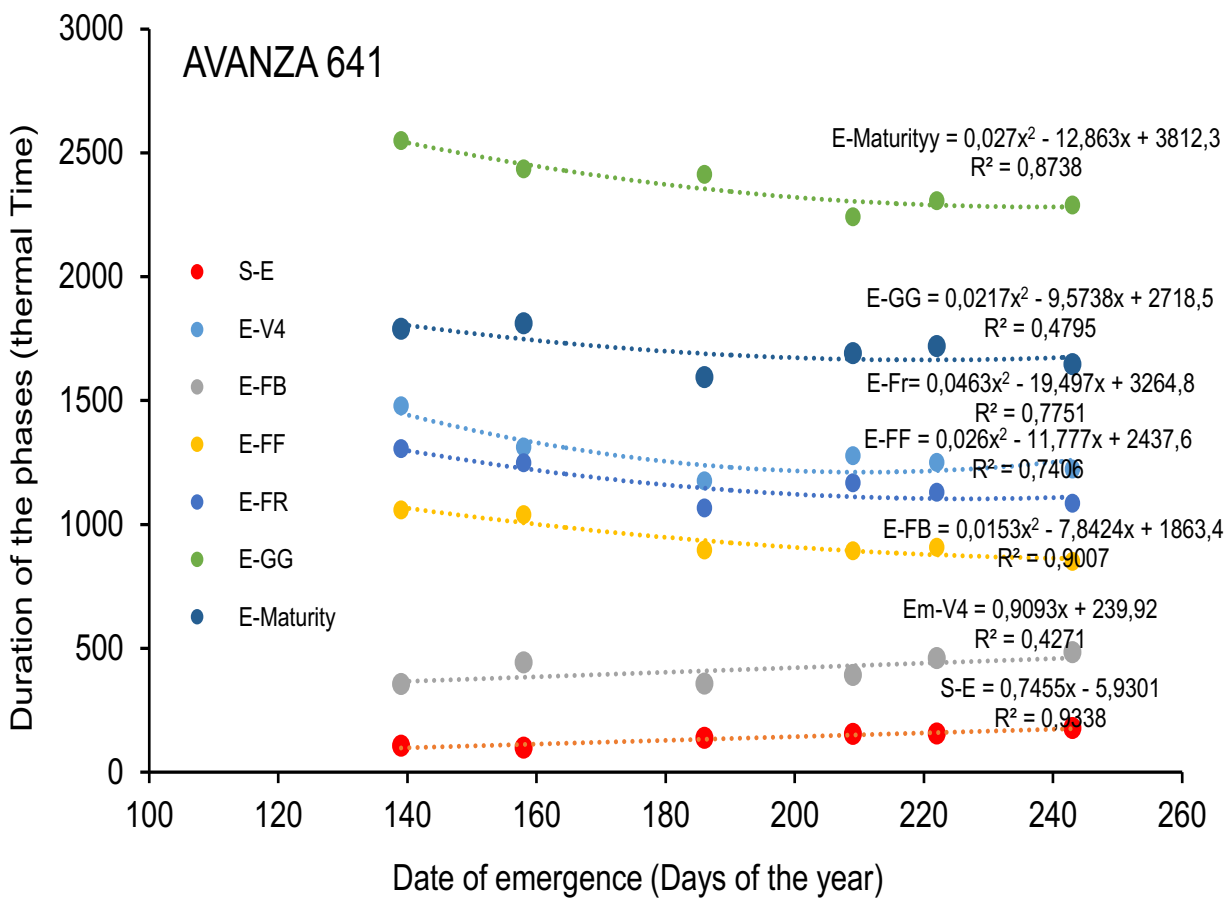




Both genotypes showed small differences in the duration of the phases that were registered throughout the crop cycle measured in calendars days and in thermal time.

CHRONOCARINATA: Steps to build the model





As the duration of the phases were measured in Thermal time, allowing independence from variations in temperature, we used a long-term climatic series to convert the thermal time value into calendar days.

CHRONOCARINATA: Model Callibration

How CHRONOCARINATA was built?

The algorithms ("inputs") for the cultivars AVANZA and NUJET were introduced into climatic series of 30 years of data for more than 250 locations of Argentina to obtain the interannual variability and predict the different phenological events. The "outputs" obtained were the dates of occurrence of the different phenological events measured in calendar days and in thermal time using a base temperature of 0°C.

The historical series of temperature for each locality were obtained from (NASA-POWER Project: National Aeronautics and Space Administration–Prediction of Worldwide Energy Resources). Frost risk from emergence to Rosette stage (four emerged leaves) and the soil useful water for the crop (up to 1 m depth soil) at different stages was also calculated. Additionally, “heat shock” was also calculates during the grain filling phase (after flowering time). The critical period for yield was also included into the program.

The model in this preliminary version is presented by an EXCEL program and in the future will be programmed to be used in a WEB site.

CHRONOCARINATA: ¿How does de model Look to be used?

Initial screen of the CRONOCARINATA model in Excel format

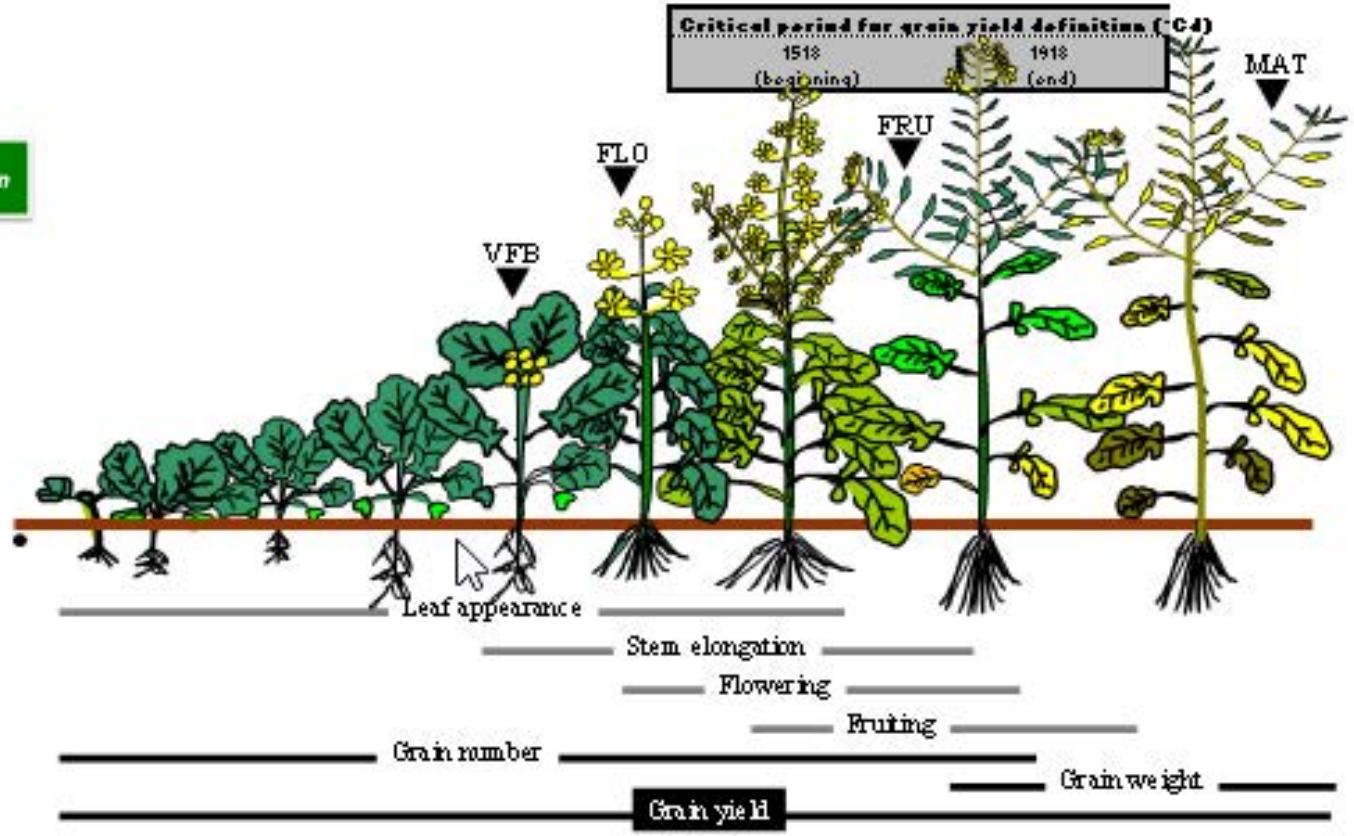
CHRONOCARINATA

.UBAagronomía · CONICET · IFEVA · nuSEED

Genotype	Avanza	
Location	Province	Site
	Buenos Aires	Adolfo Alsina
Sowing date	Month	Day
	April	3

Select your option

Stress	Probability (%)
Moderate fros	82%
Extreme fros	0%
Moderate heat sh	0%
Extreme heat she	0%



Abbreviations

Phenology (CETIOM scale; Arnoud, 1983)

V4: rosette with 4 emerged leaves; VFB: visible floral bud; FLO: first flowering; FRU: first fruiting; GG: green grains; CG: colored grains; MAT: maturity

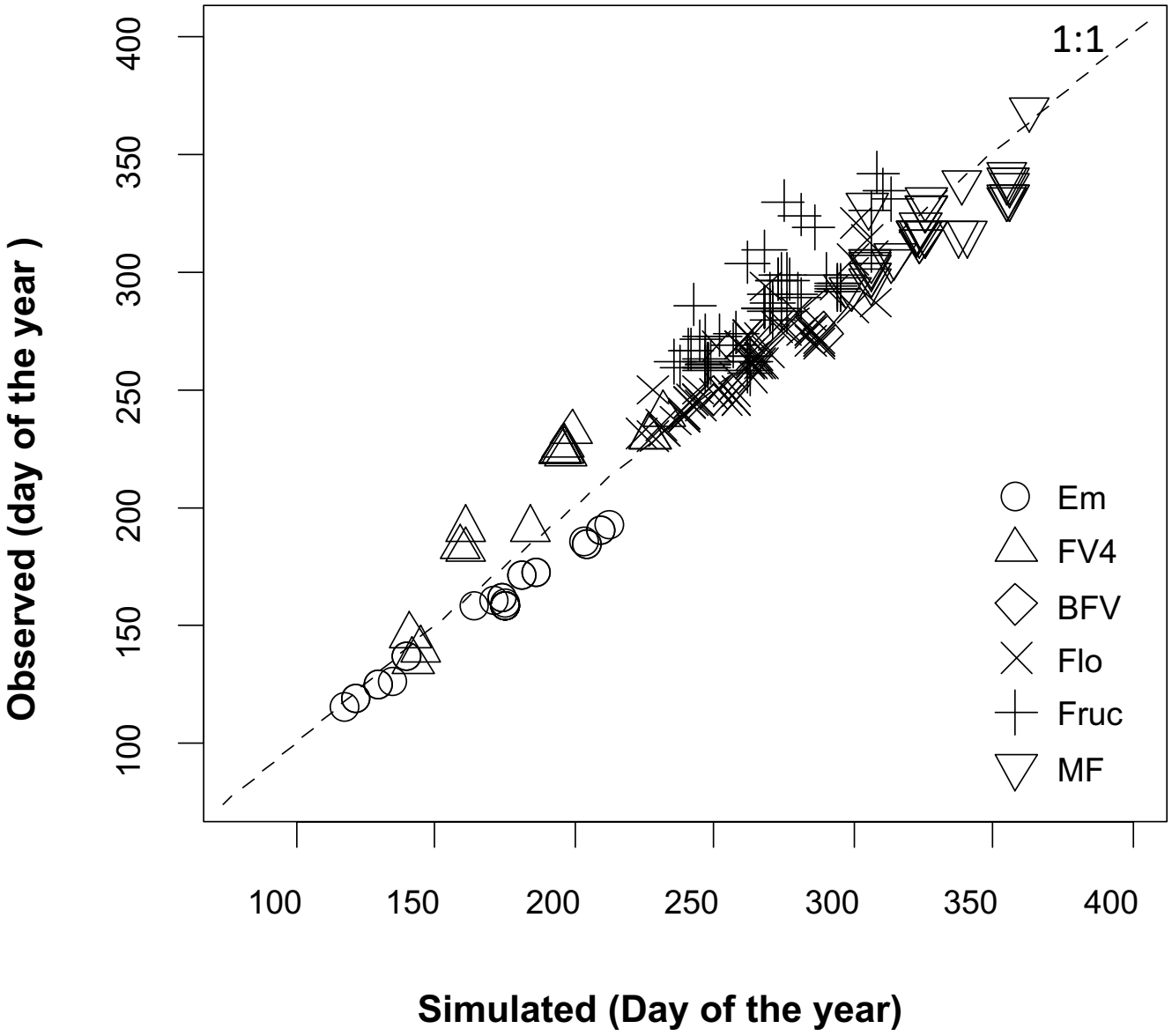
TT: thermal time from emergence (°Cd; base temperature: 0°C)

AWC: soil available water content (%)

+/- represents one standard deviation

	EME	+/-	V4	+/-	VFB	+/-	FLO	+/-	FRU	+/-	GG	+/-	CG	+/-	MAT	+/-
Date	11-abr	1	11-may	4	31-jul	11	29-ago	9	17-sep	8	####	7	14-nov	6	17-nov	6
TT from emergence (°Cd)			441	4	1148	3	1418	4	1643	6	1818	3	2548	7	2594	5
AWC (%)	52	19	67	21	63	20	61	21	56	20	58	19	57	19	56	16

CHRONOCARINATA: Validation of the model using independent data



The model was validated using independent data provided by NUSEED (Ing Orlando Vellaz). The independent data were originated in experiments carried out by the company between 2018 and 2021 for Avanza 641 and Nujet 400 in different locations of Argentina.

The model showed an error of prediction that was variable depending on the phenological phases. At first flowering the prediction error was of 9 days.

Stage	RMSE	RMSE (%)	bias	rcoeff	sb
Em	13.2	8	-11.9	99.2	142.3
V4	23.0	12	-19	91.7	361
FB	11.4	4	10.5	100	110.2
FF	9.2	4	0.2	88.8	0.036
FR	19.5	7	-15.3	82.2	232.8
Mat	12.8	4	8.4	85.7	70.3

CHRONOCARINATA: Next Steps for 2022/23

During 2022 growing season the experiments for phenology determination will be repeated for Nujet 400 and Avanza 641 as well as including new varieties provided by the NUSEED company

Experiments will be carried out in a wider range of sowing dates respect to 2021 and conduced under not biotic and abiotic limitation (similar that in 2021)

The data of both years 2021 and 2022 will be used together to built new algorithms and running those with 30 year of climatic data (from NASA POWER) in 250 locations of Argentina. This model, depending on the objective of the company, can be replicated in different countries. To do that it is necessary to have phenological experiments in those countries.

During 2023 the model (that is actually in an Excel format) will be programmed using PHP language to be available in a WEB site of the FAUBA domain with public free access (at least for the commercial cultivars) (*see http://cronosoja.agro.uba.ar/*).

Thanks for the attention

Teamwork: Daniel Miralles, Gonzalo Rivelli, Carina Ibañez, Maximiliano Rodriguez, Gabriela Abeledo, Deborah Rondanini

miralles@agro.uba.ar, rondanin@agro.uba.ar

Crop Ecophysiology

@grupotrigo.fauba/

https://www.instagram.com/grupotrigo.fauba/