Technical agreement NUSEED-FAUBA

Final Results from Experiments during 2023

July 2024

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Characterization of genotype NUJET 350

At the University of Buenos Aires, Nujet 350 was sown on <u>May 12, 2024</u>

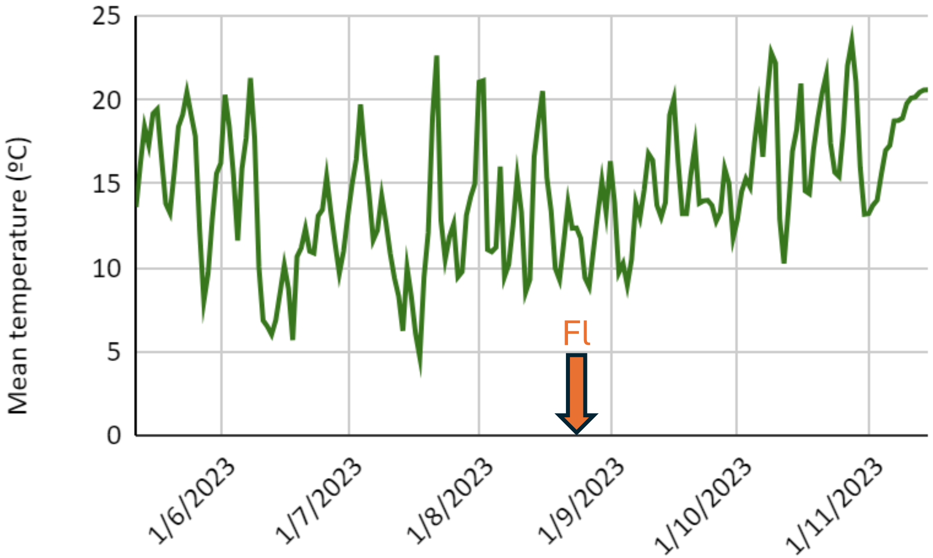
5 plots (6 rows, 0,2 m apart, 10 m length) at 100 pl/m^2 plant density, drip irrigated and fertilized with 100 kg N/ha

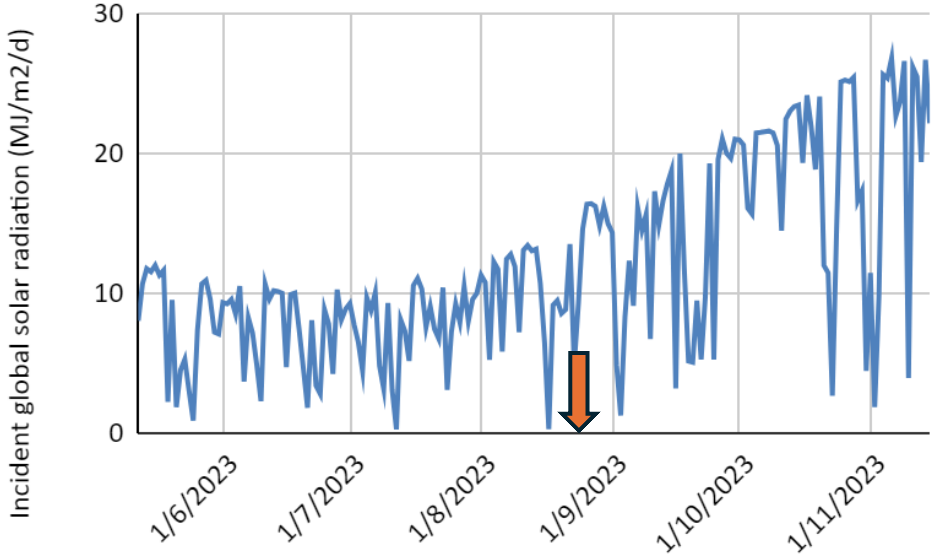
The beginning of Flowering was on August 21 (95 days after emergence) and **crop maturity on Nov 15** (181 DAE)

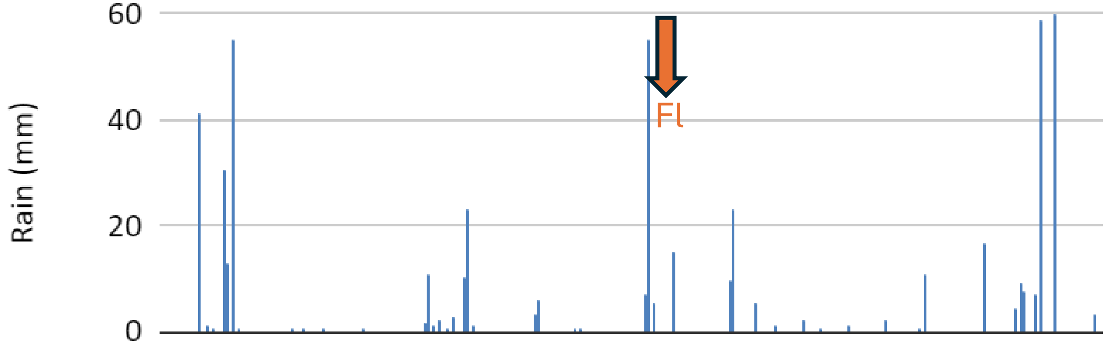
(about 50% of cycle duration was pre-flowering and 50% post-flowering)

Environment

2023 was normal-to-wet year. It was few mild frost (in mid June) and several heavy storms during reproductive stages, causing crop lodging (so plants were staked to prevent overturning). A period of very hot days was experienced during grain filling.







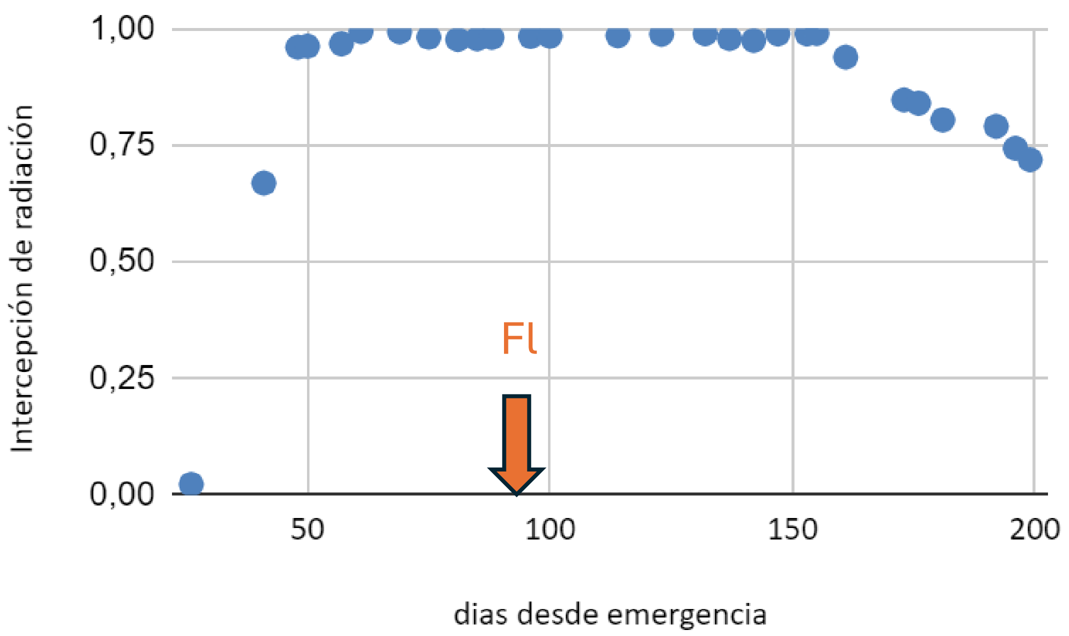
Diseases

By contrast to previous dry years, in 2023 we observed some level of *Sclerotinia* (despite of plant had been sprayed with kasugamicine fungicide at rosette stage). Less than 10% of the plants were diseased at harvest.

Canopy development

Nujet 350 quickly developed canopy, intercepting radiation efficiently during most of the crop cycle.

Critical Period (Kirkegaard et al 2018)
100-500 ºCd after flowering (from 29 Aug to 26 Sept)
29 days with a mean photothermal quotient of 0.87 MJ/m2/d/ºC



__**At the beginning of Flowering in August 21** (95 days after emergence)__ above-ground and root biomass were measured.

A simplified method for root sampling was used (uprooting the plants, without washing). This method is likely to slightly underestimate (as fine roots were not retained).

Dry biomass at flowering from roots was 62 ± 6 g/m^2 and above-ground biomass was 425 ± 52 g/m^2 (shoot/root=6.8)
Thus, aerial+root biomass at flowering was at least **5 t/ha**

Crop maturity (on Nov 15 ,181 DAE)

At harvest, it was variability among replicates (which is usual for canola and carinata). For ech plot, 3 subsampling were made, totalizing up to15 data point

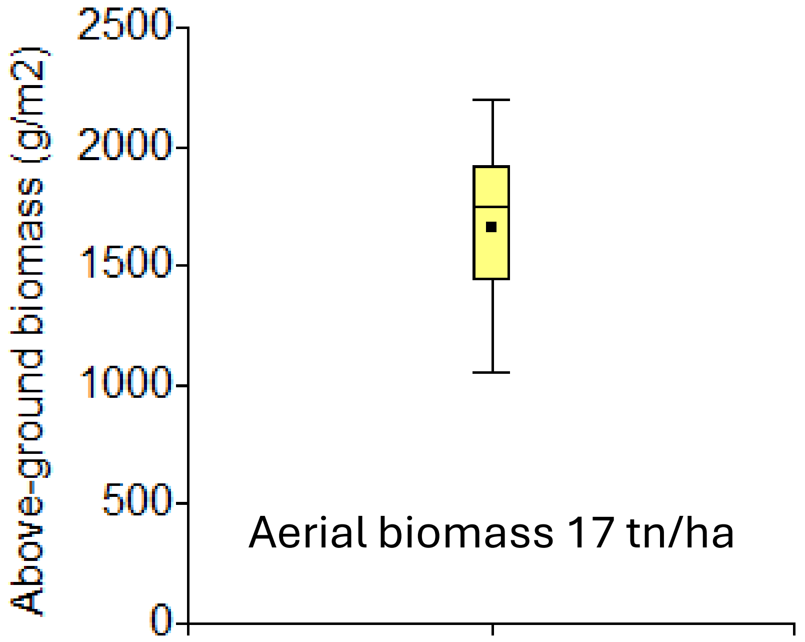
Post-flowering growth **quadrupled** the aerial biomass from flowering to harvest. Crop grew 12 t/ha in 86 days, at a high growth rate of 14 $g/m^2/d$

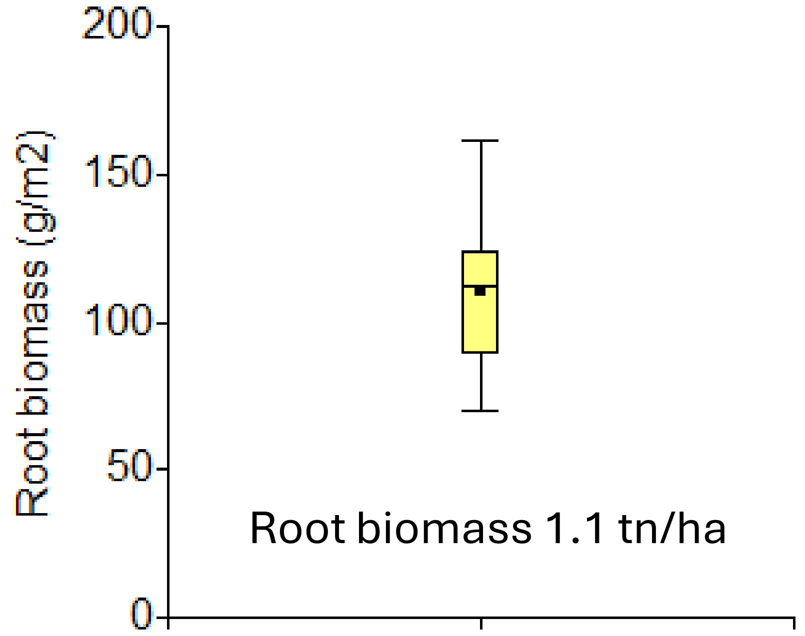
Dry biomass at harvest from roots was **110** ± 8 g/m^2 and above-ground biomass was **1664** ± 96 g/m^2, on average.
NOTE: (previous experiments: 120-160 g/m^2 roots + 900-1200 g/m^2 aerial)

Aerial+root biomass at harvest was at least 17 t/ha
(higher than the 10-14 tn/ha observed for Avanza and Nujet 400 in 2021 and 2022)

As aerial biomass was very high and root biomass was underestimate, **the aerial/root ratio=15 is overestimated** (is higher than 8-10 in previous experiments at FAUBA and 7.5-11 in Uruguay according to Mazzilli & Ernst, 2021)

About 13.5 t/ha of dry biomass remains in the plot
(1.1 roots + 12.4 from straw)



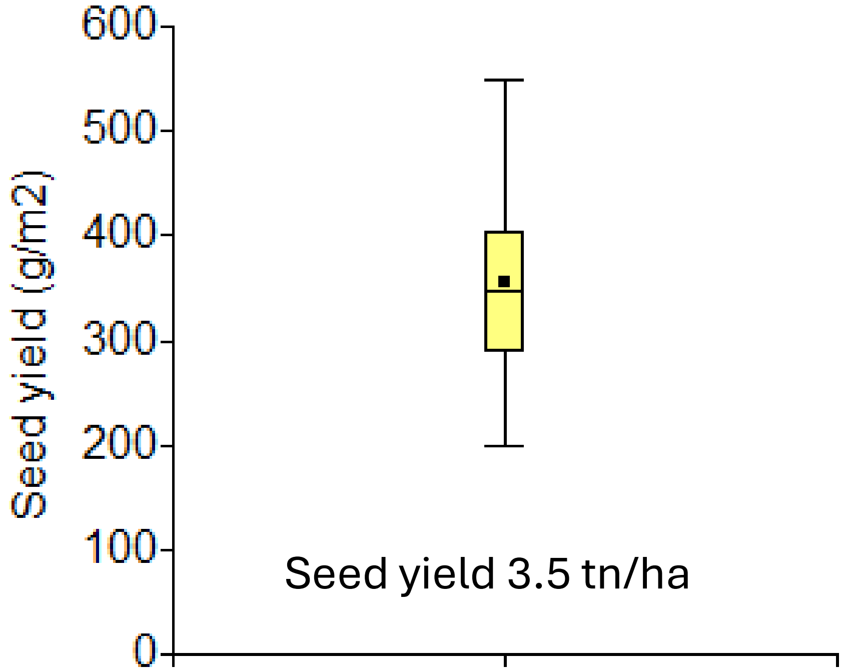


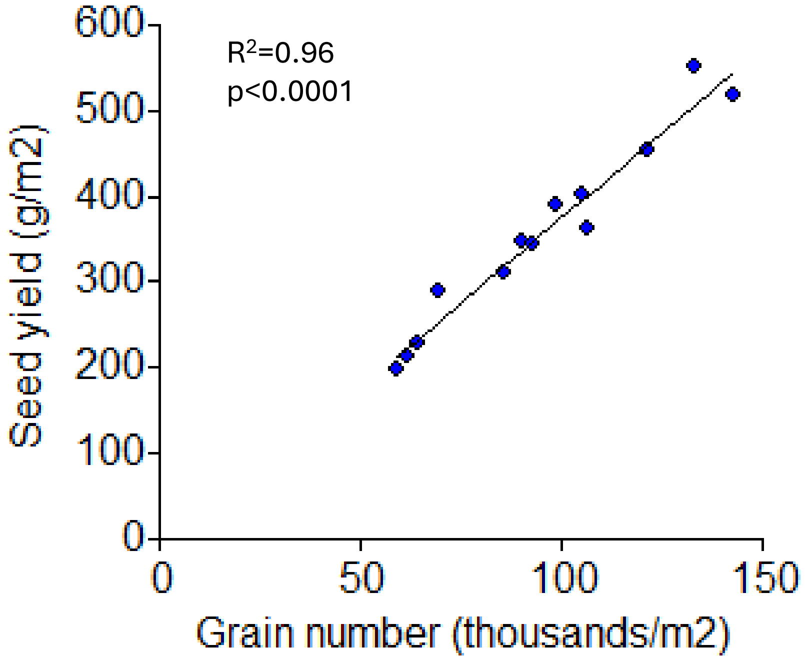
Seed yield

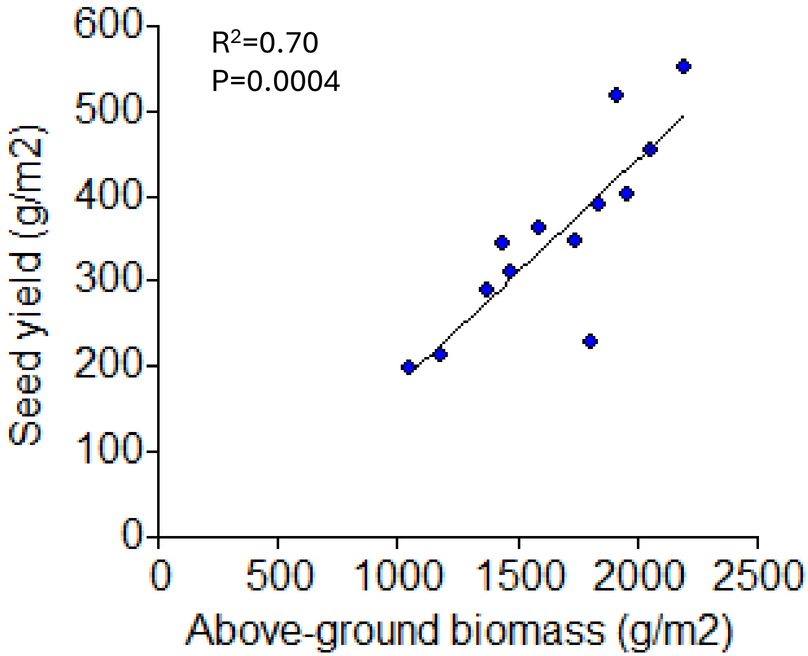
Seed yield was 3.5 t/ha, on average
(range from 2 to 5.5 t/ha)
much higher than Nujet 400 and Avanza in previous years (2-2.3 t/ha)

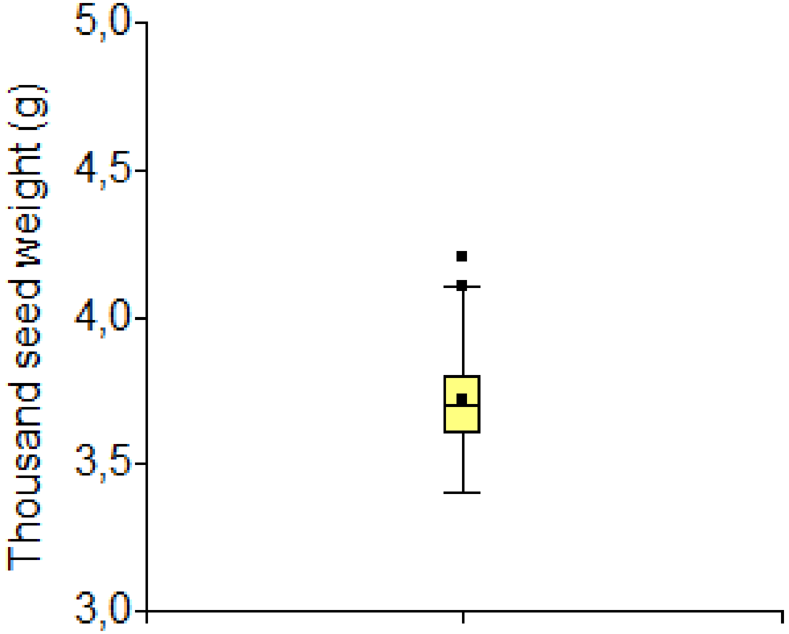
High seed yield observed in Nujet 350 is related to:
-high seed number
-high aerial biomass

Harvest index was 0.21 (similar to 0.18-0.20 observed previously)
Thousand seed weight was 3.7 g (similar to 3.6 g observed previously)





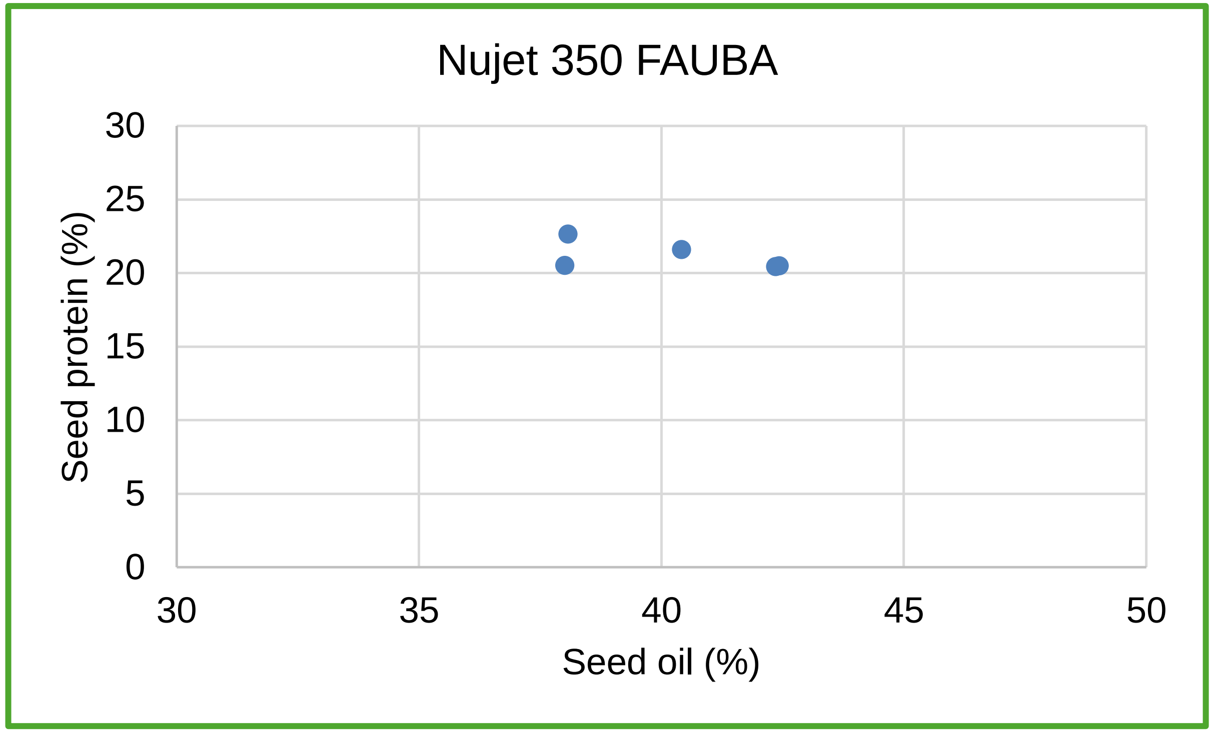




Seed Oil and Protein

Nujet 350 – FAUBA 2023

Seed oil averaged **40.2 ± 0.8** % (range 38-42.4 %)
Seed protein averaged 21.1 ± 0.4 % (range 20.4-22.6 %)



The oil content <u>was lower</u> than that observed for Avanza 641 (49-51%) and Nujet 400 (45-47%) in 2021 and 2022 at FAUBA

But, due to the high seed yield, **<u>oil yield for Nujet 350 was higher</u>** than Nujet 400 and Avanza 641

	Grain yield (t/ha)	Seed oil %	Oil yield (t/ha)
Avanza 641	2.3	**51**	1.2
Nujet 400	2.0	47	0.9
Nujet 350	**3.5**	40	**1.4**

Phenology: Calibration of different genotypes

Different genotypes were calibrated at the School of Agriculture for predicting phenology.
Genotypes were sown at different sowing dates and phenological stages were measured during the crop cycle:

Sowing dates at the experimental field of School of Agriculture FAUBA were: 24 April 2023; 12 May 2023, 31May 2023, 15 June 2023, 29 June 2023, 25 July 2023 and 12 August 2023.

Genotypes: E87, E95 and NUJET 350

Phenological stages measured were: Emergence, Rossete (V4), Visible floret Bud (BFV), Beginning of flowering (IFL), beginning of fructification (IFR), Green visible fruits (GVF), Colored grains (GC) and mature grains (GM).

Data were analyzed using PRISMA software 8.0 and termal time from sowing to emergence and from emergence to different stages were measured in Thermal time using T base=0°C. With the exception of the phase Emergence from V4 that was insensitive to photoperiod, the rest of the phases were fit using lineal regressions.

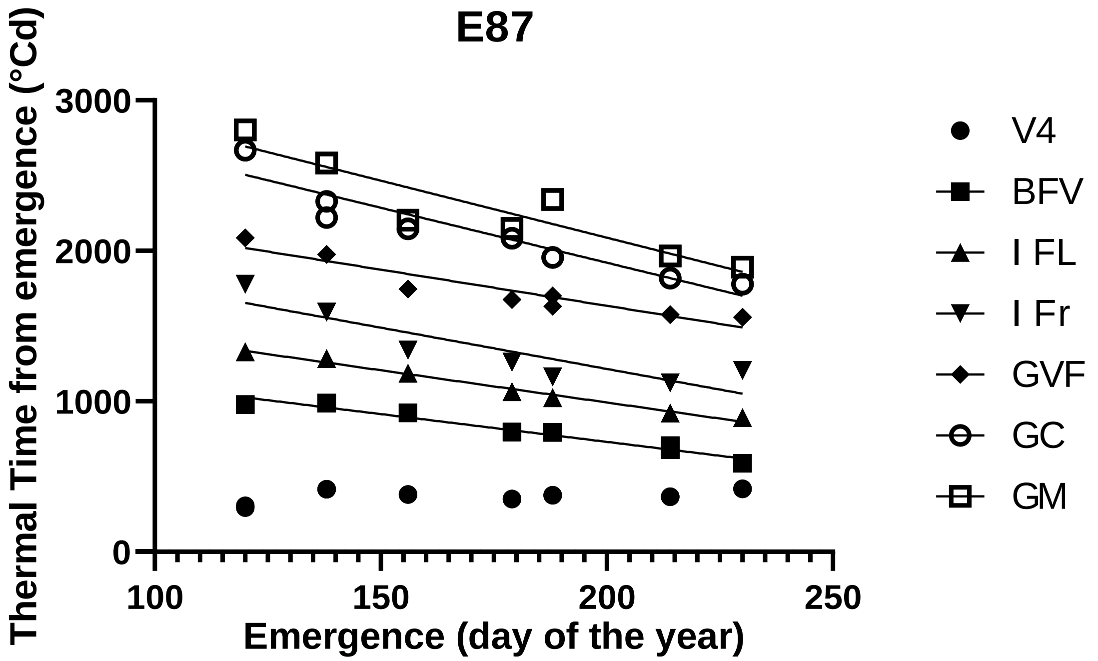
All the stages were characterized as thermal time and days of the year from emergence.

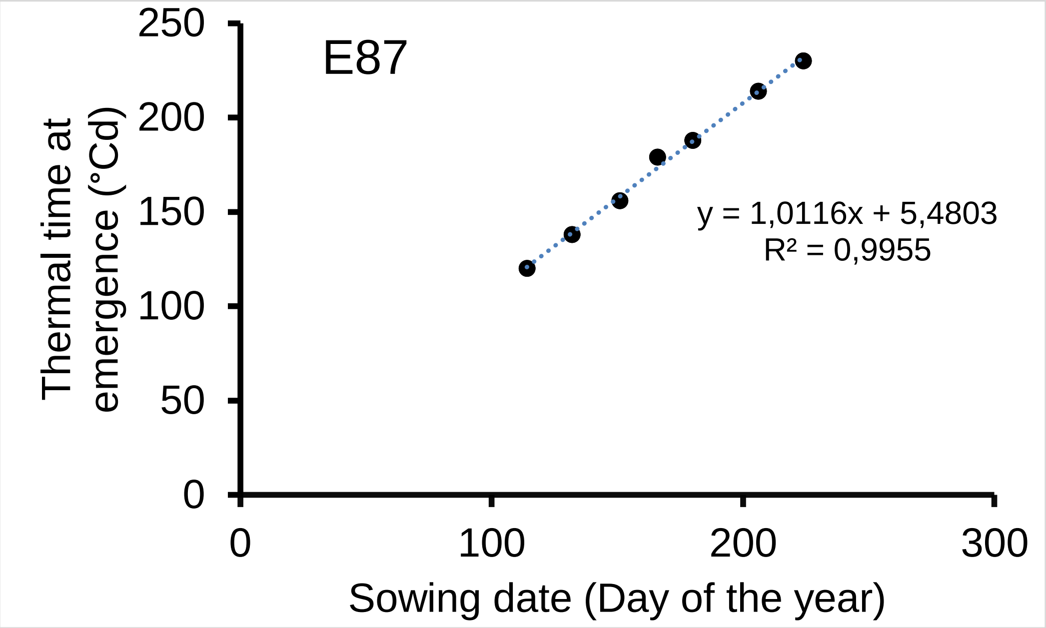
Phenology: Calibration of different genotypes

Different sowing dates at FAUBA

Phenology: Calibration of different genotypes

Phenology: Calibration of different genotypes (Thermal Time)

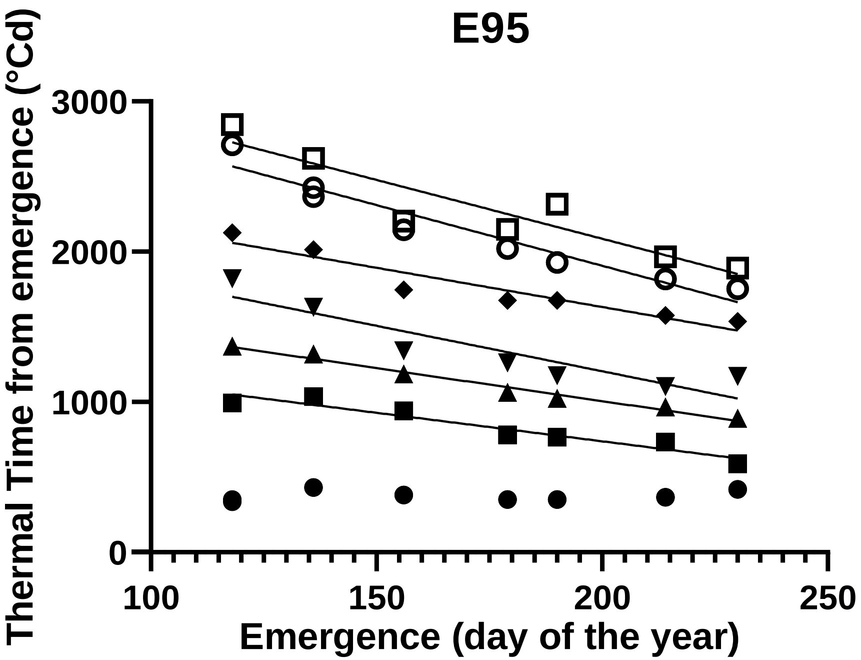


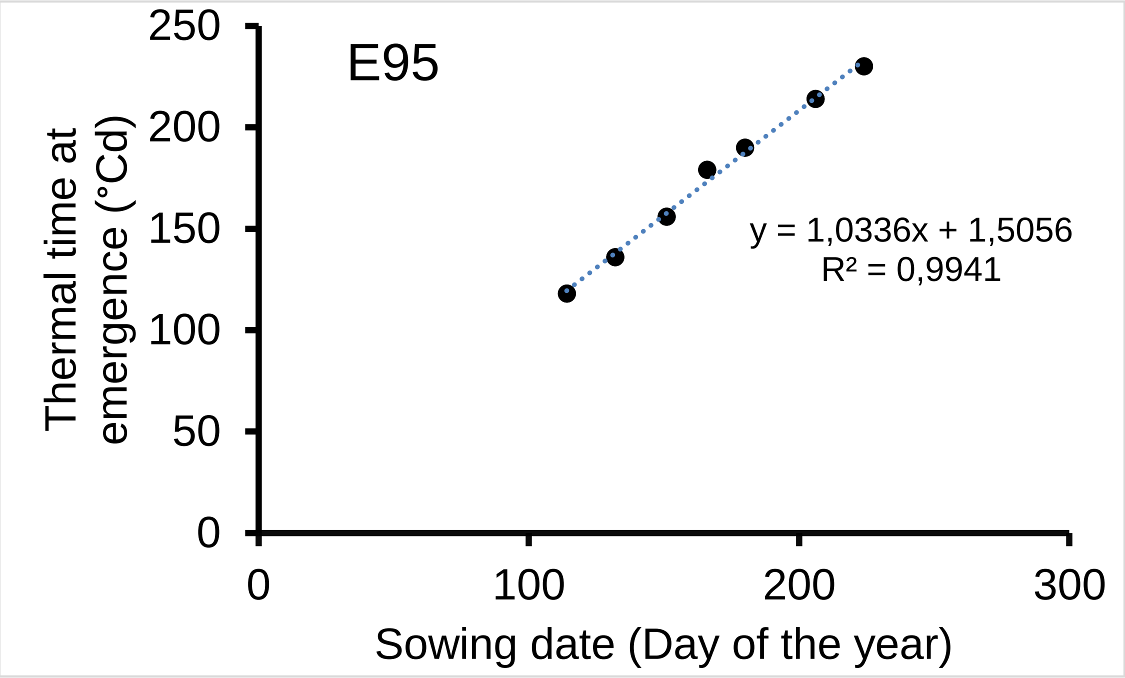


Em-V4 (Rossete)= 377 °Cd

E87	BFV	I FL	I Fr	GVF	GC	GM
Slope	-3,692	-4,281	-5,483	-4,8	-7,301	-7,573
Y-intercept	1469	1849	2312	2595	3381	3602
95% Confidence Intervals						
Slope	-4,187 to -3,198	-4,593 to -3,969	-7,221 to -3,745	-5,844 to -3,757	-8,847 to -5,754	-9,589 to -5,558
Y-intercept	1381 to 1558	1793 to 1905	2001 to 2623	2408 to 2782	3105 to 3658	3242 to 3963
Goodness of Fit						
R square	0,9566	0,9868	0,7975	0,8933	0,8981	0,8481

Phenology: Calibration of different genotypes (Thermal Time)

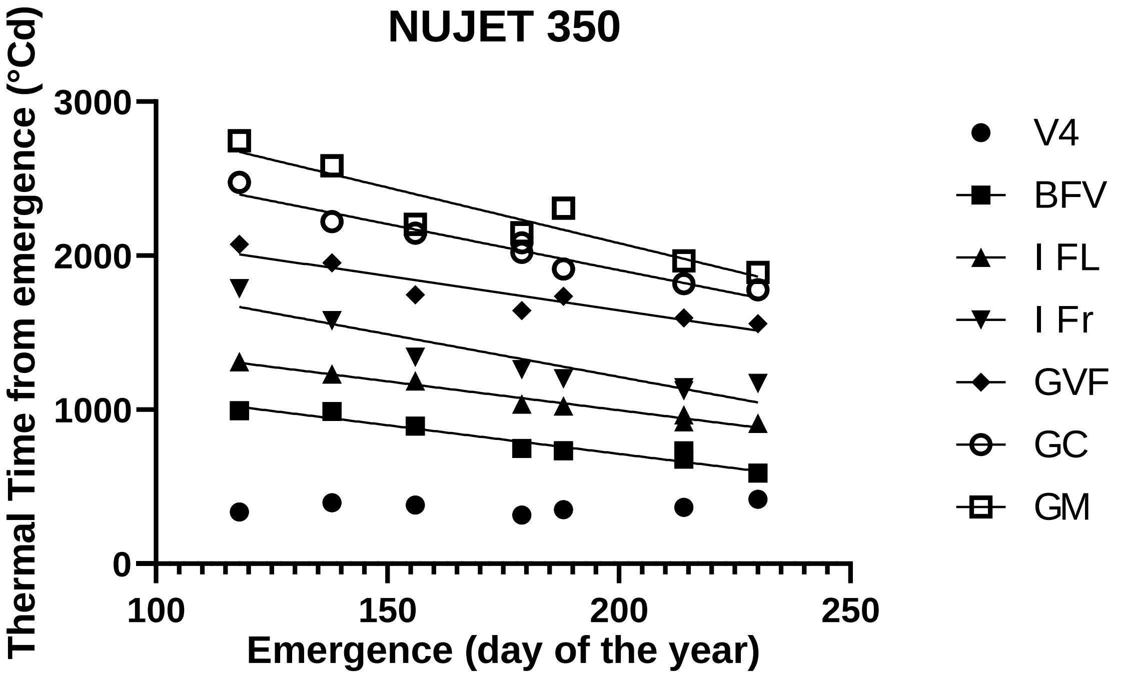


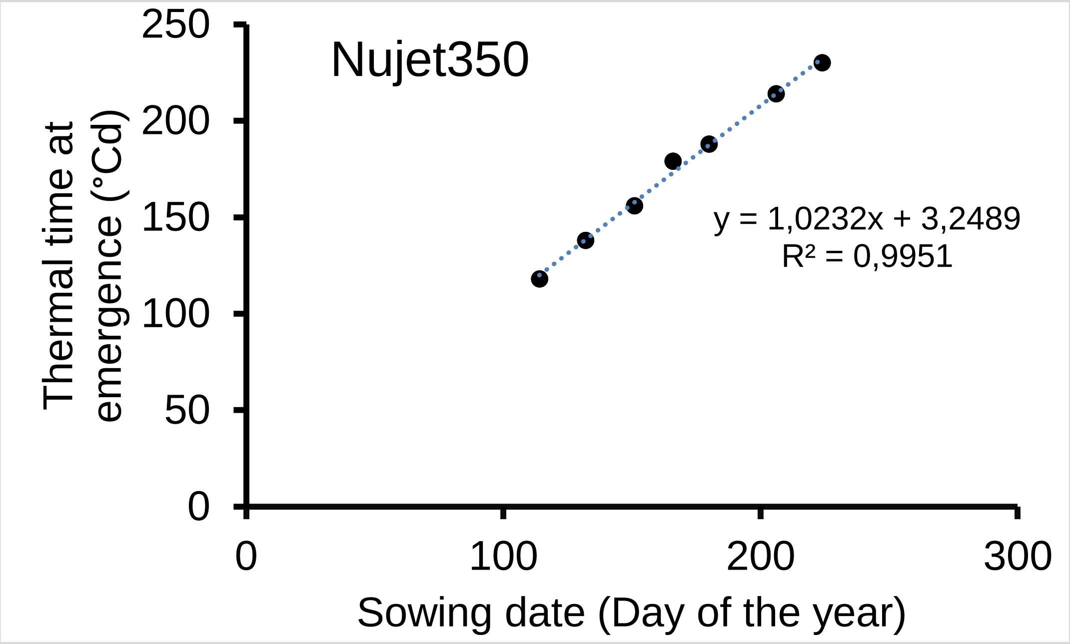


Em-V4 (Rossete)= 377 °Cd

E95	BFV	I FL	I Fr	GVF	GC	GM
Slope	-3,793	-4,396	-6,046	-5,216	-8,074	-7,821
Y-intercept	1497	1885	2414	2675	3521	3651
95% Confidence Intervals						
Slope	-4,498 to -3,088	-4,781 to -4,010	-7,685 to -4,406	-6,271 to -4,161	-9,490 to -6,658	-9,828 to -5,813
Y-intercept	1371 to 1623	1816 to 1954	2121 to 2707	2487 to 2864	3268 to 3775	3292 to 4010
Goodness of Fit						
R square	0,9196	0,9809	0,8433	0,9063	0,9278	0,8572

Phenology: Calibration of different genotypes (Thermal Time)





Em-V4 (Rossete)= 366 °Cd

NUJET 350	BFV	I FL	I Fr	GVF	GC	GM
Slope	-3,793	-4,396	-6,046	-5,216	-8,074	-7,821
Y-intercept	1497	1885	2414	2675	3521	3651
95% Confidence Intervals						
Slope	-4,498 to -3,088	-4,781 to -4,010	-7,685 to -4,406	-6,271 to -4,161	-9,490 to -6,658	-9,828 to -5,813
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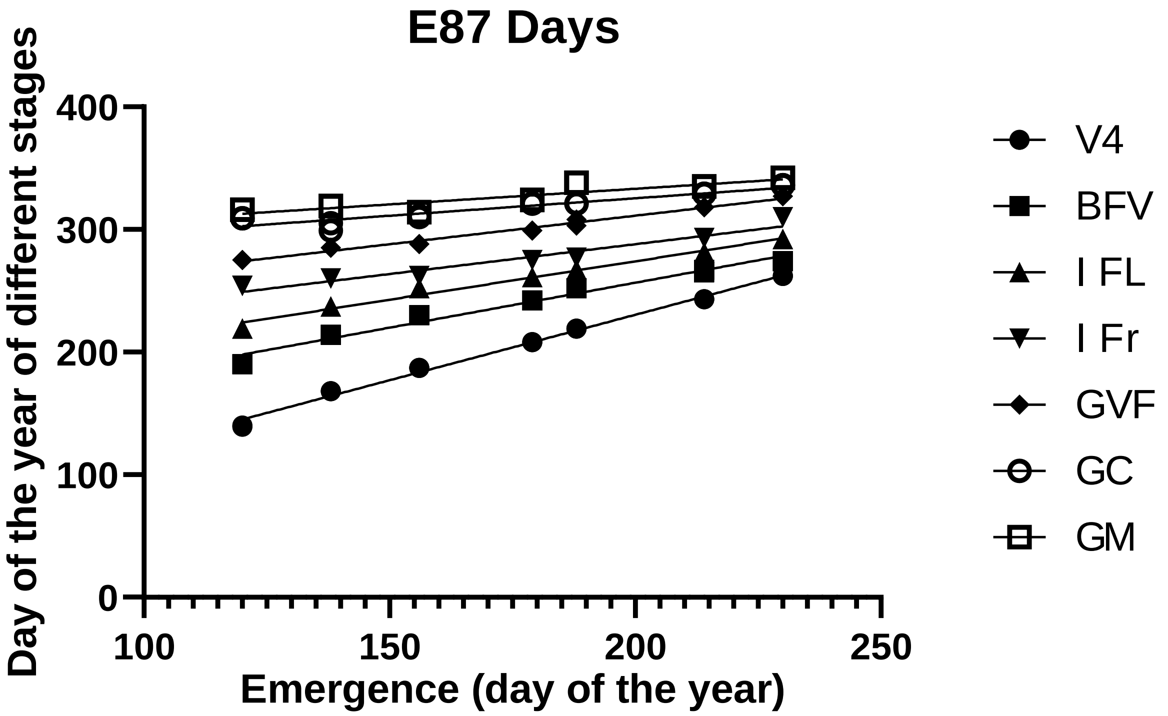
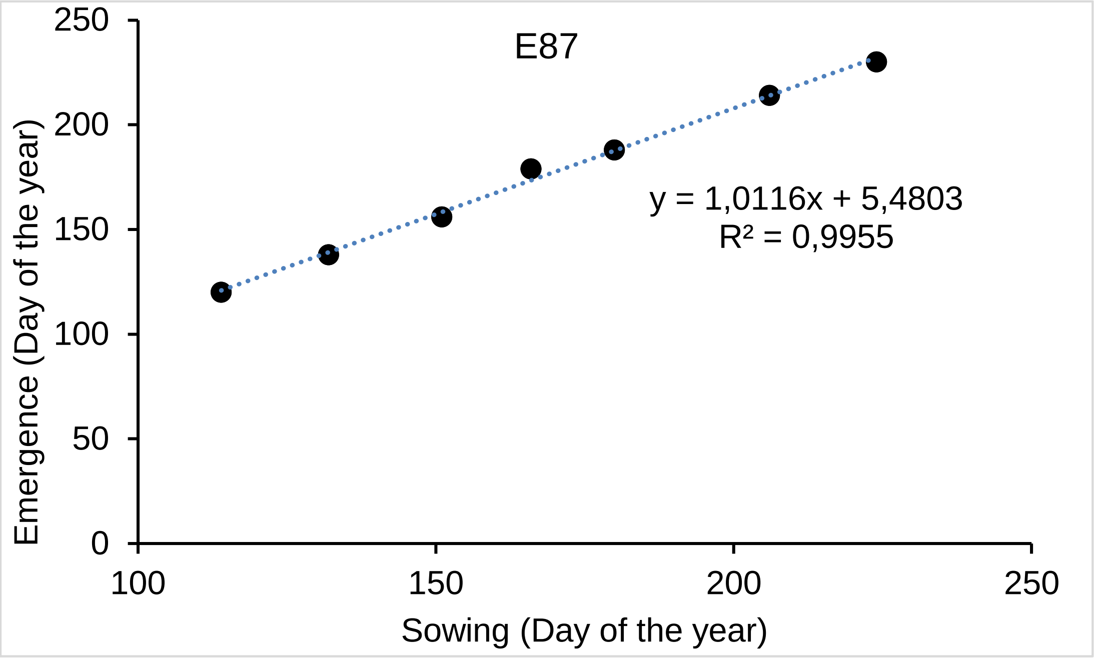
Goodness of Fit						
R square	0,9196	0,9809	0,8433	0,9063	0,9278	0,8572

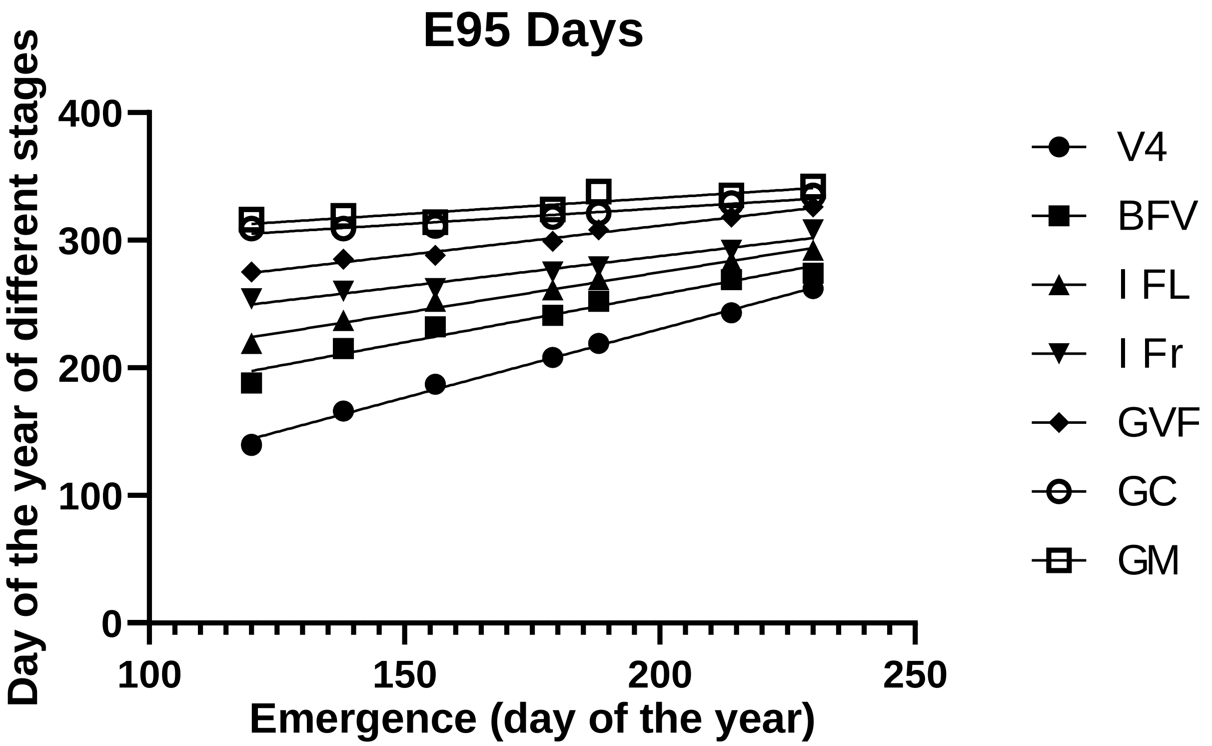
Phenology: Calibration of different genotypes (Days)

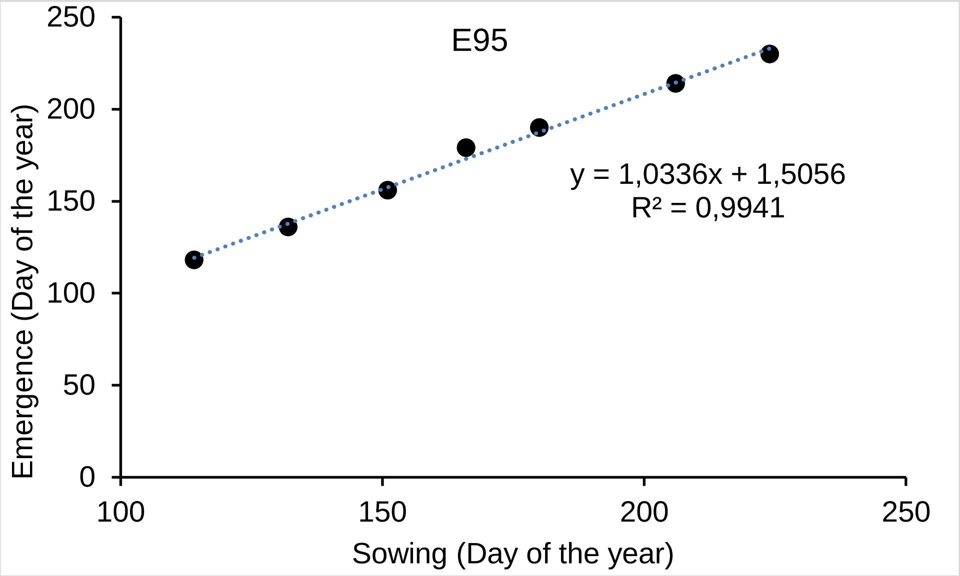




E87	V4	BFV	I FL	I Fr	GVF	GC	GM
Best-fit values							
Slope	1,067	0,7327	0,6253	0,486	0,4652	0,2846	0,2547
Y-intercept	17,01	110,1	149	190,8	218,2	268,6	282,3
Goodness of Fit							
R square	0,994	0,9724	0,9835	0,9402	0,9851	0,8885	0,7962

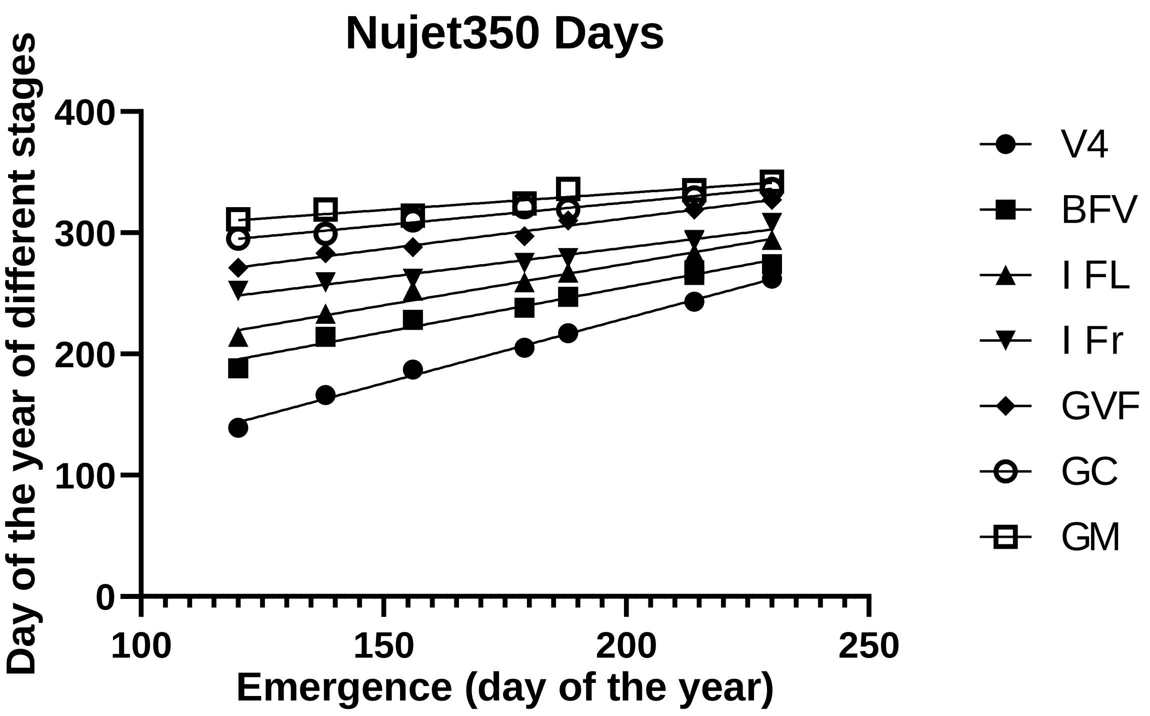
Phenology: Calibration of different genotypes (Days)

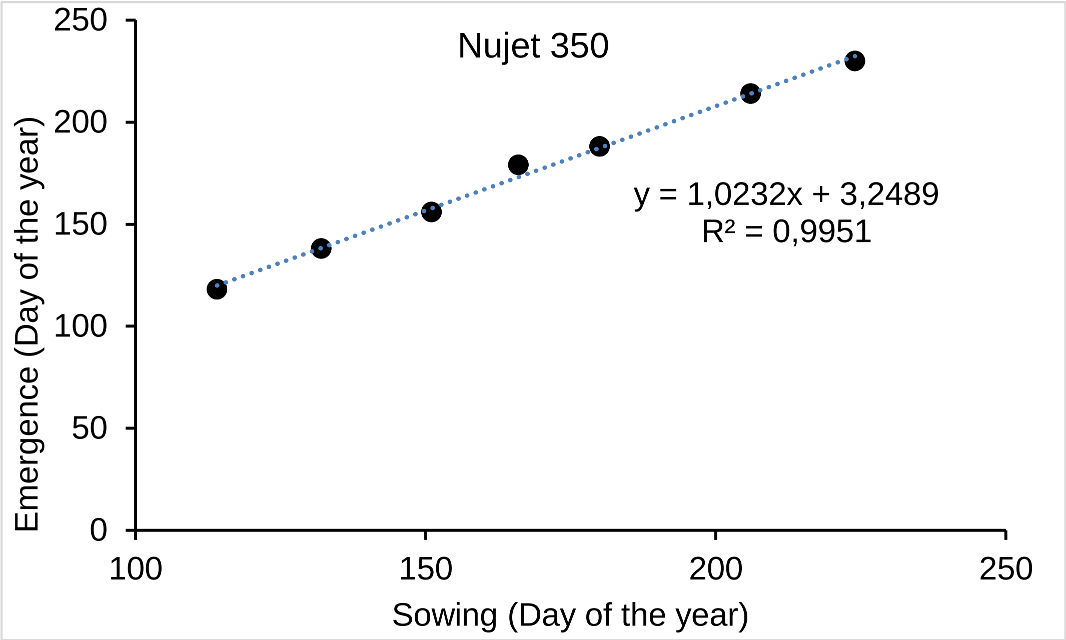




E95	V4	BFV	I FL	I Fr	GVF	GC	GM
Best-fit values							
Slope	1,075	0,7483	0,6363	0,473	0,4628	0,2492	0,2547
Y-intercept	15,36	107,8	147,6	192,9	218,9	275,2	282,3
Goodness of Fit							
R square	0,9952	0,9616	0,9843	0,9537	0,9868	0,9428	0,7962

Phenology: Calibration of different genotypes (Days)

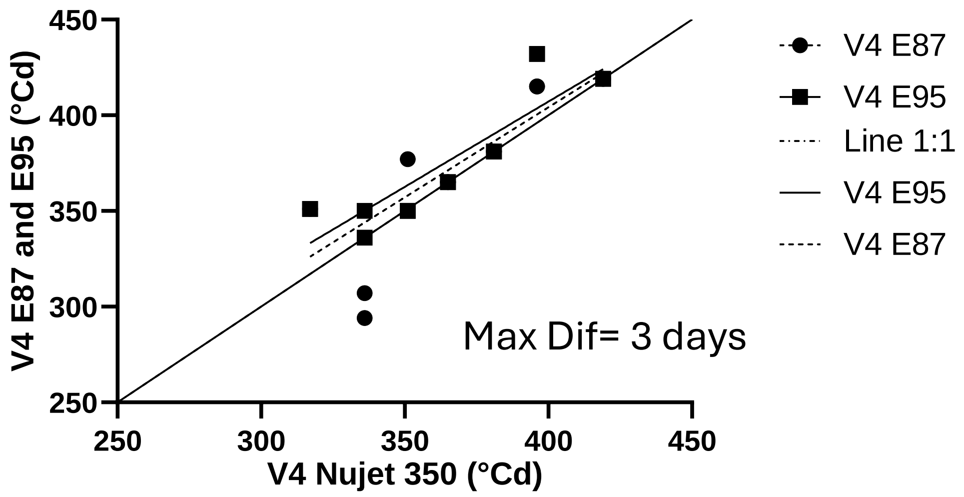




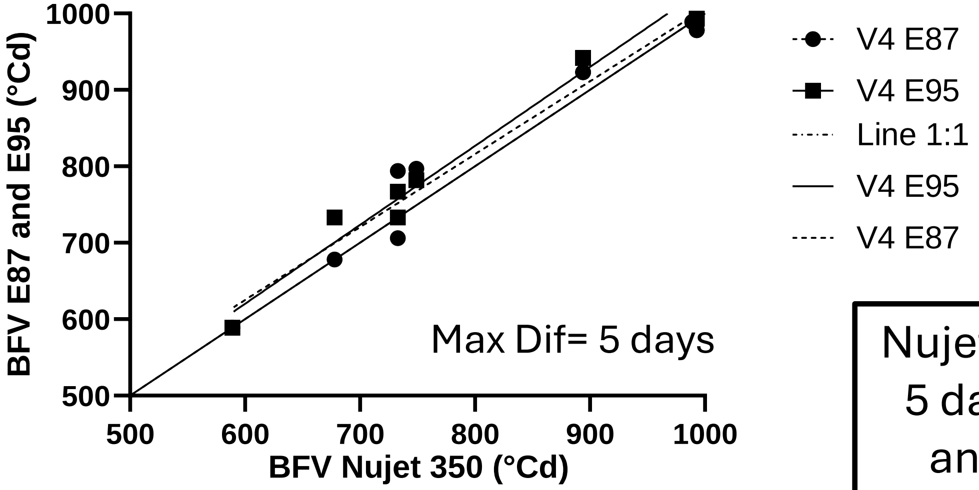
Nujet 350	**V4**	**BFV**	**I FL**	**I Fr**	**GVF**	**GC**	**GM**
Best-fit values							
Slope	1,074	0,7438	0,6848	0,4947	0,5056	0,3747	0,2809
Y-intercept	14,76	106,4	137,4	188,9	210,8	250,1	276,7
Goodness of Fit							
R square	0,9946	0,9749	0,978	0,9673	0,9819	0,9775	0,8717

Phenology: Comparison Nujet350 vs E87 and E95

Nujet350 vs E87 and E95 V4

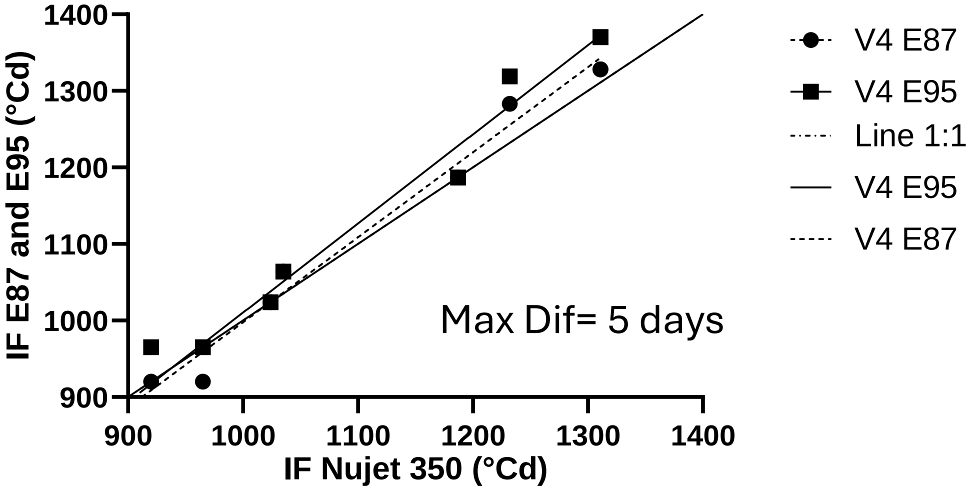


Nujet350 vs E87 and E95 BFV

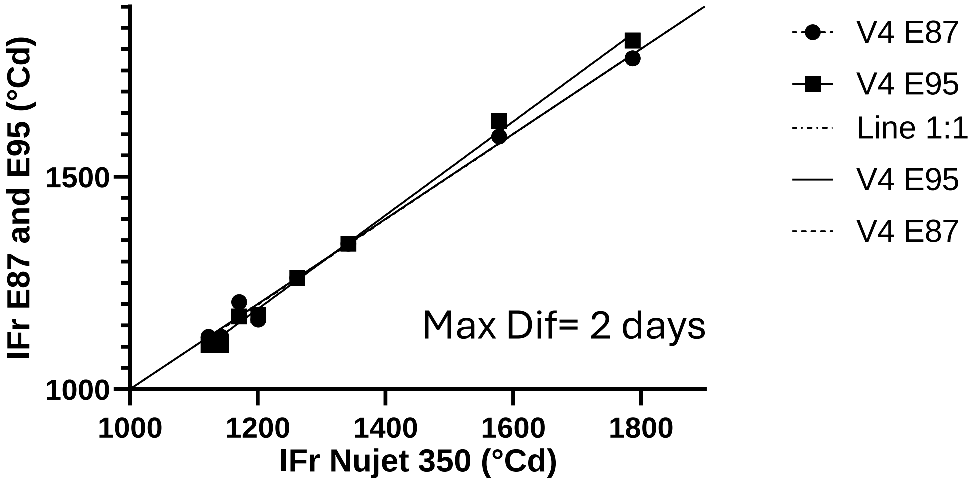


Nujet 350 was from 2 to 5 days earlier tan E87 and E95 genotypes depending on the phase.

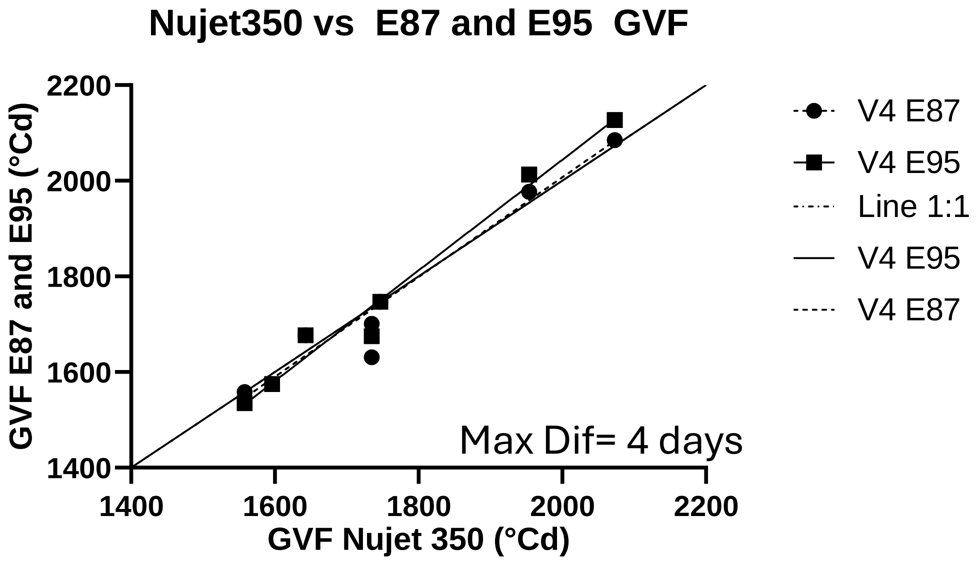
Nujet350 vs E87 and E95 IF

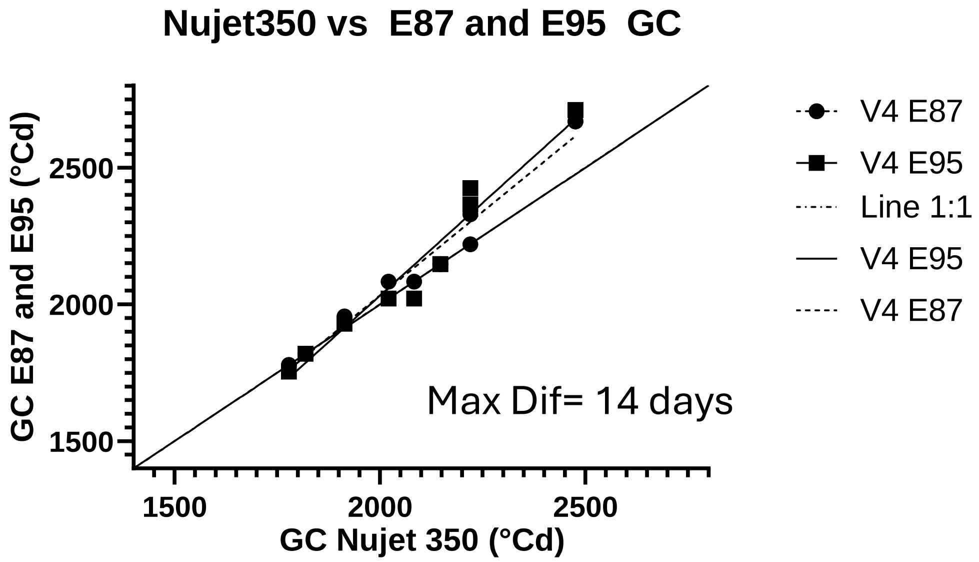


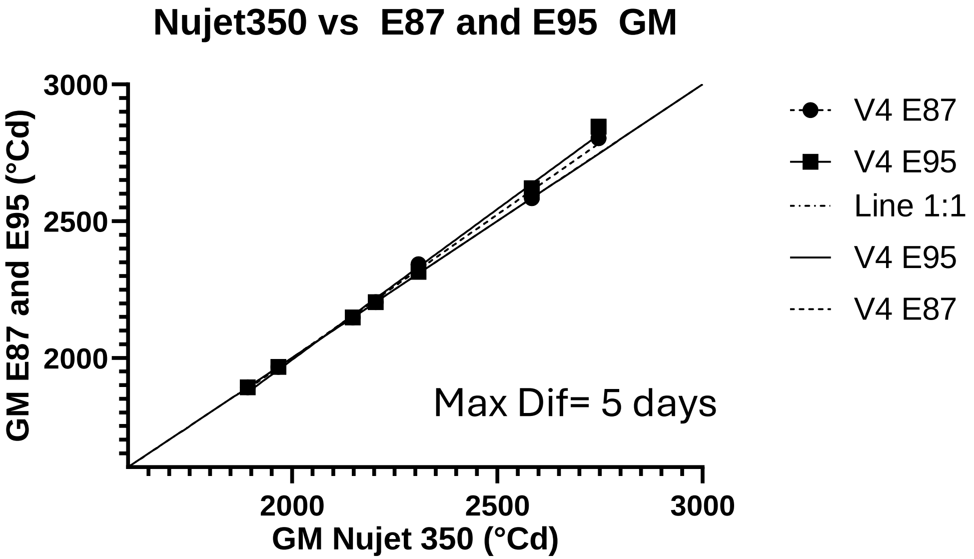
Nujet350 vs E87 and E95 IFr



Phenology: Comparison Nujet350 vs E87 and E95

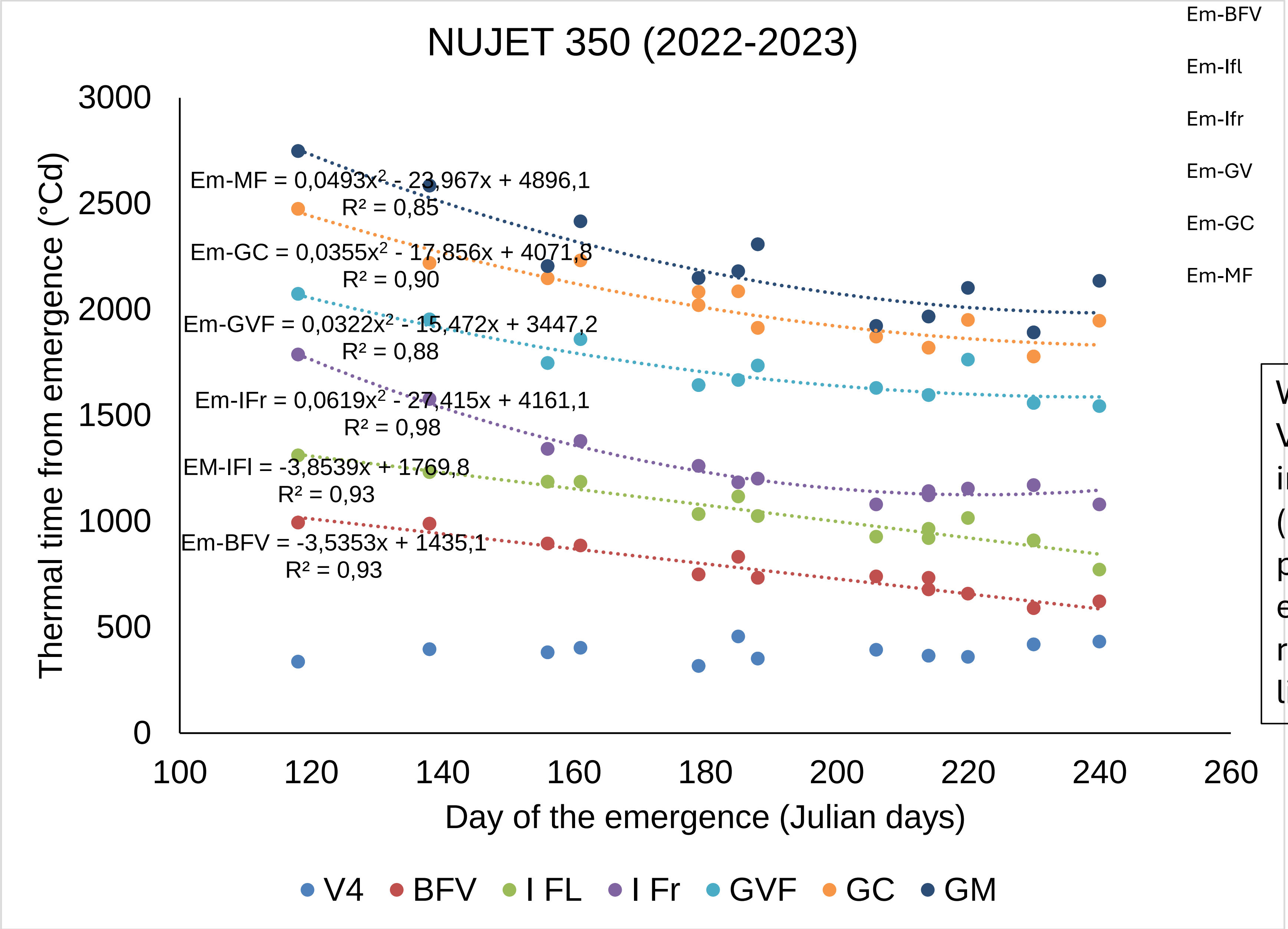






Differences between Nujet 350 and E87 and E95 were observed for all stages of development. Nujet 350 was shorter than E87 and E95 (in thermal time and in days) but differences were not relevant. With the exception of GC (colored grain) at which E87 and E95 were 14 days longer than Nujet 350 from emergence to that stage for the rest of the phases the differences were from 0 (later sowing dates) to 5 days in the earlier sowings-

Phenology: Nujet350 2022-2023 Data



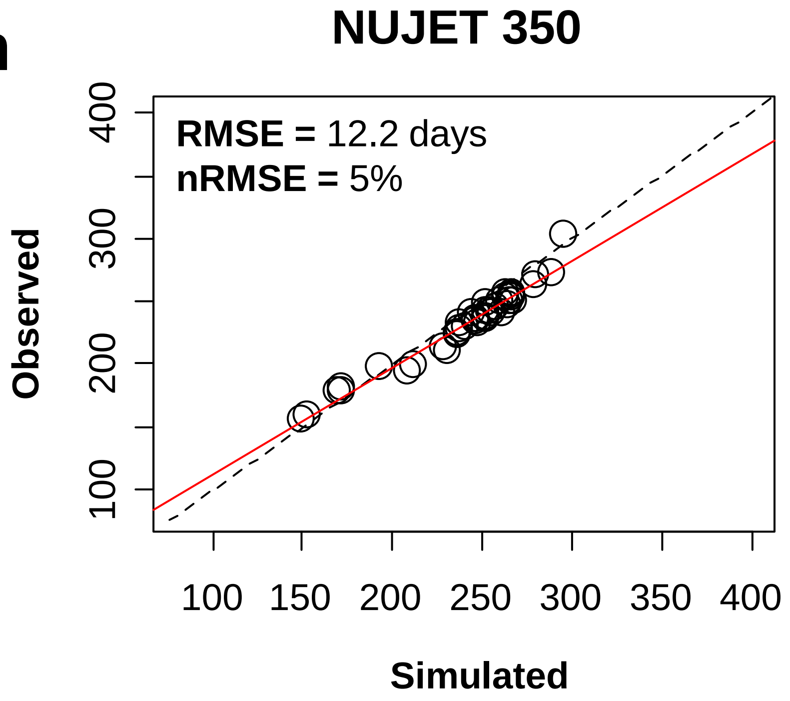
Thermal times

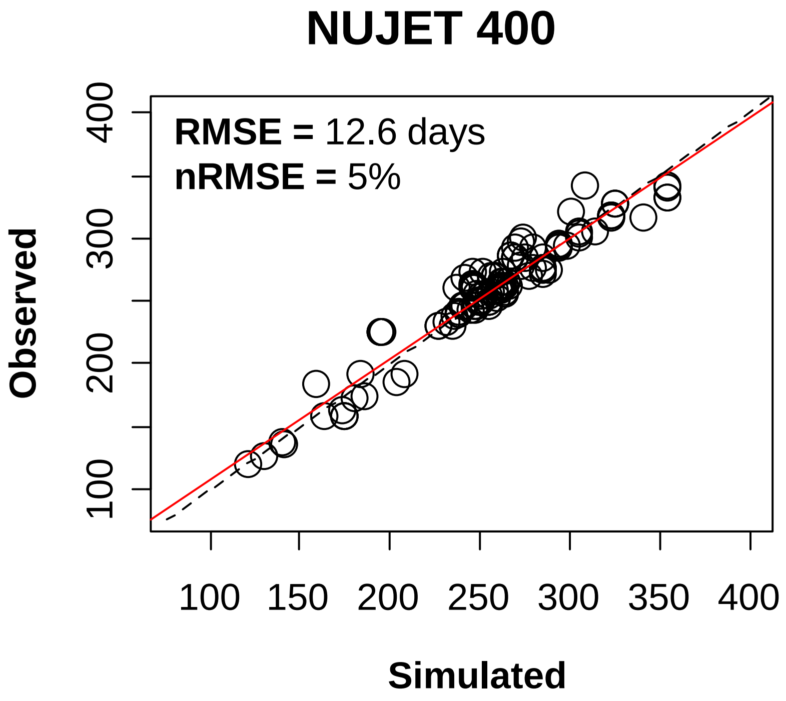
	Base Temperture 0 °C
Siembra Emergencia	109
Emergencia-V4	378
Em-BFV	Em-BFV = -3,5353x + 1435,1 R^2 = 0,93
Em-Ifl	EM-IFl = -3,8539x + 1769,8 R^2 = 0,93
Em-Ifr	Em-IFr = 0,0619x2 - 27,415x + 4161,1 R^2 = 0,98
Em-GV	Em-GVF = 0,0322x2 - 15,472x + 3447,2 R^2 = 0,88
Em-GC	Em-GC = 0,0355x2 - 17,856x + 4071,8 R^2 = 0,90
Em-MF	Em-MF = 0,0493x2 - 23,967x + 4896,1 R^2 = 0,85

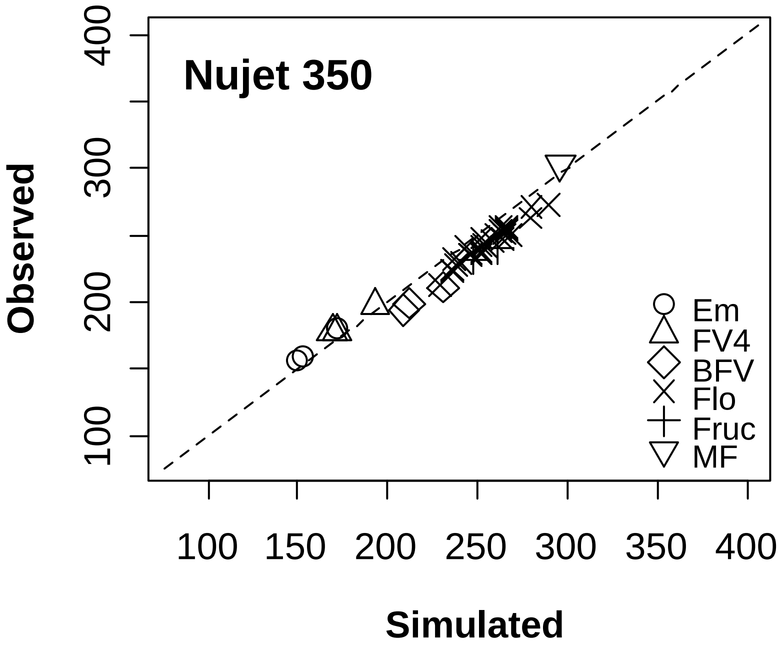
With the exception of the period Em-V4 (Rossete) that showed to be insensitive to the day of emergence (i.e. Photoperiod) the rest of the phases were reduced as the date of emergence was delayed. Those reductions were characterized by lineal or polynomial models.

Phenology: Validation

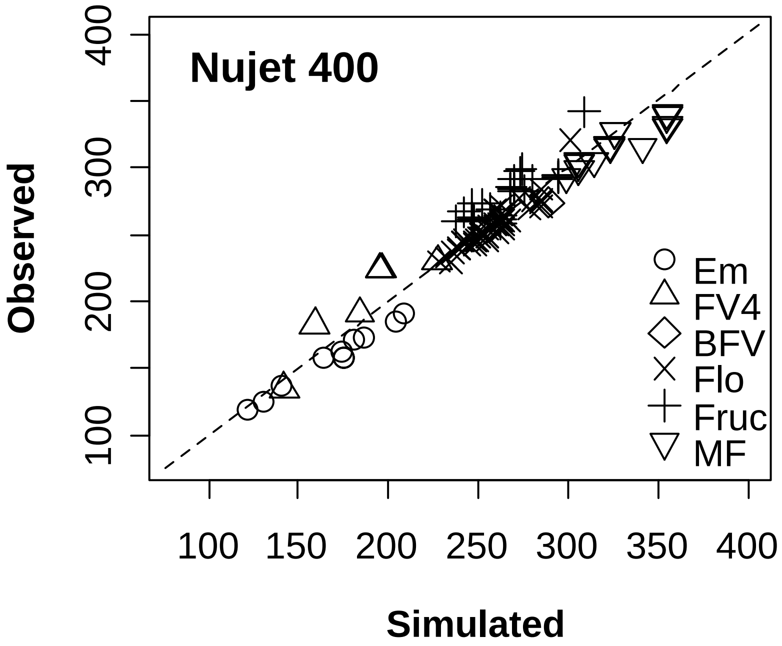
The phenology of the genotypes Nujet 350 and Nujet 400 was validated using independent data provided for the company. The level of the errors depends on the stage that was considered ranging from 6 to 22 days.





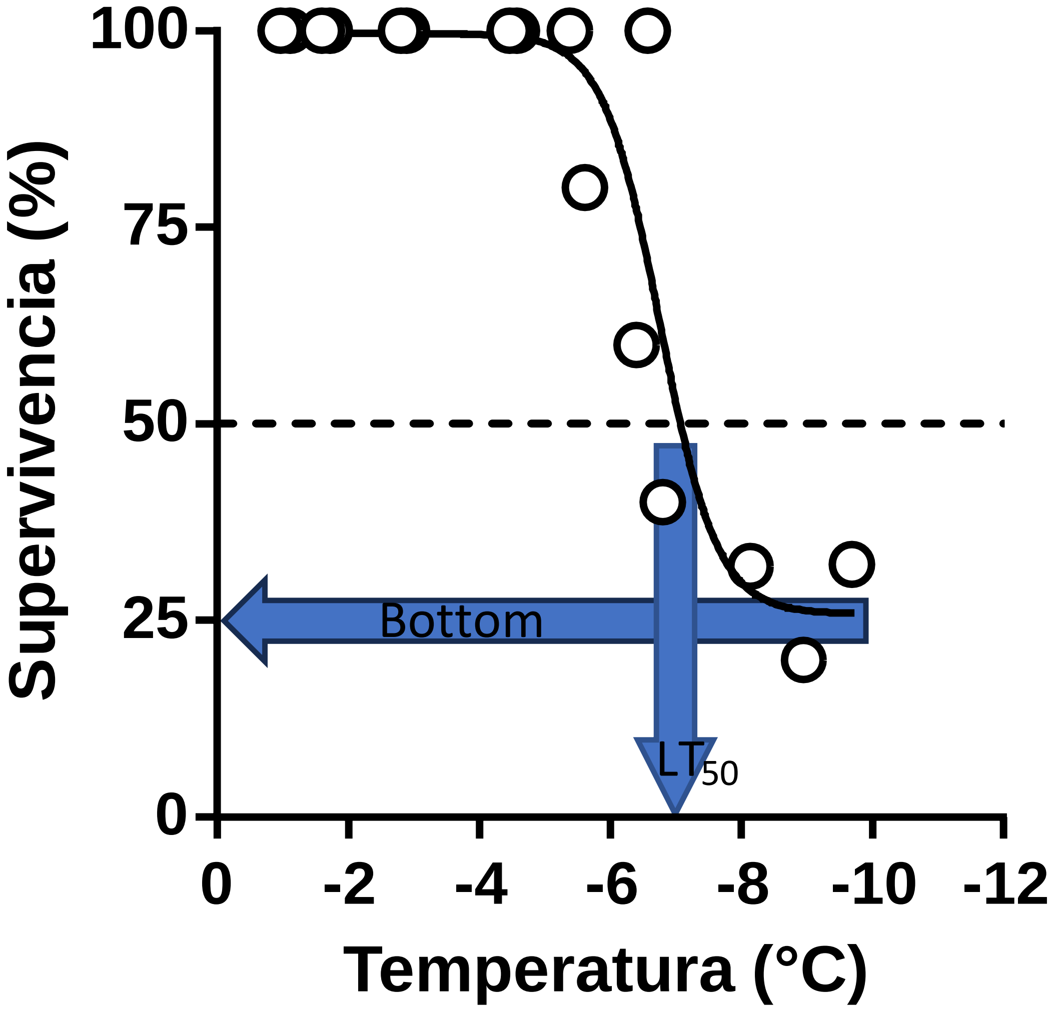


Stage	RMSE
Em	7.4
FV4	6.9
BFV	16.3
Flo	12.1
Fruc	18.7
MF	7



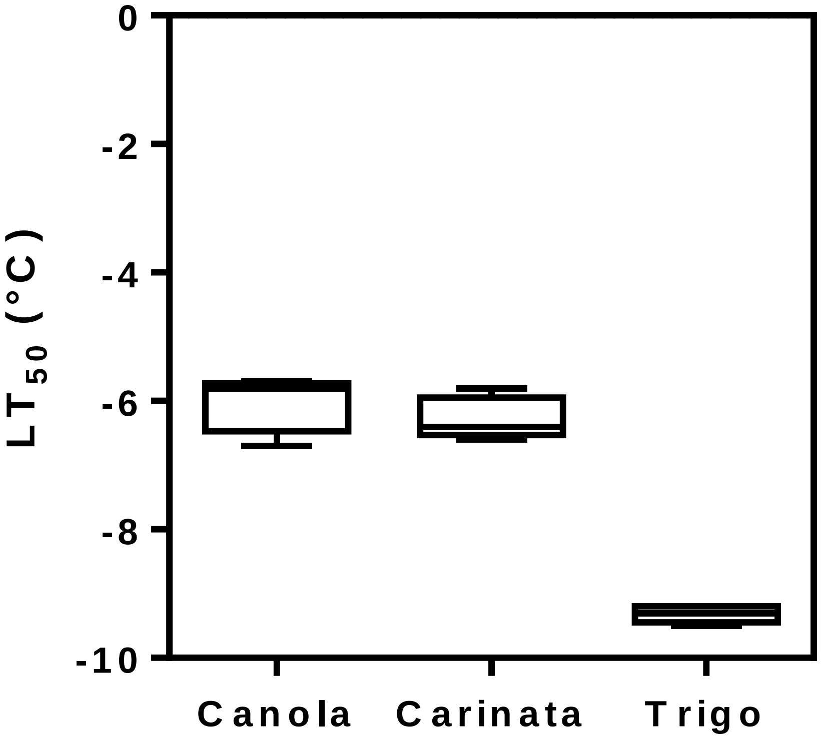
Stage	RMSE
Em	13
FV4	22.3
BFV	15
Flo	6.3
Fruc	16.1
MF	12.2

Frost risk characterization: Comparison Carinata-Canola-Wheat



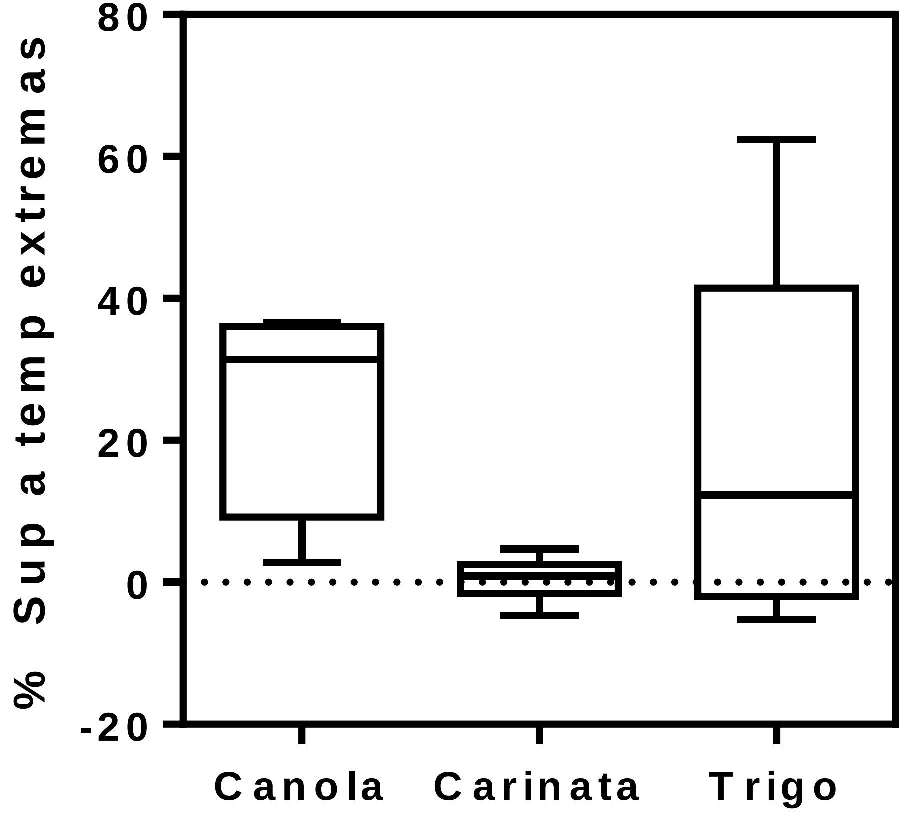
Frost risk characterization: Comparison Carinata-Canola-Wheat

Especie	Variedad	Bottom_%	LT50_°C
Canola	Nuola 300	2,8 ± 2	-6,7 ± 0
	DSV PHOENIX	28,5 ± 7	-5,7 ± 0,4
	DSV DUKE	36,6 ± 15	-5,8 ± 2,5
	Nuseed Diamond	34,2 ± 15	-5,8 ± 2,2
Carinata	Nujet 350	2,3 ± 5	-6,4 ± 0,2
	Nujet 400	-4,6 ± 5	-6,4 ± 0,2
	HYB076	-2,2 ± 4	-5,8 ± 0,1
	HYB089	-2,1 ± 1	-6,2 ± 0,1
	HYB095	1,9 ± 4	-6,5 ± 0,2
	H2-125	4,7 ± 5	-6,4 ± 0,2
	H2-167	1,2 ± 2	-5,8 ± 0,1
	H2-170	-1,4 ± 1	-6,6 ± 0,1
	H2-207	-1 ± 1	-6,4 ± 0,1
	H2-208	0,7 ± 4	-6,5 ± 0,2
	H1-254	-0,6 ± 3	-6,6 ± 0,1
	H2-124	1,1 ± 2	-6,6 ± 0,1
	H1-264	3,5 ± 5	-6 ± 0,3
	H1-269	3,2 ± 3	-5,8 ± 0,1
Trigo	Tr1	No se registro mortandad	
	Tr2	62,4 ± 6	-9,2 ± 0,2
	Tr3	20,5 ± 11	-9,3 ± 0,6
	Tr4	12,3 ± 14	-9,2 ± 0,5
	Tr5	-5,2 ± 16	-9,4 ± 0,4
	Tr6	1,3 ± 14	-9,5 ± 0,4



The table on the left shows the values of % plant survival in the lower plateau (Bottom), which is an estimator of plant survival in the most freezing temperatures and the LT50 (temperature that kills 50% of plants) for the Canola, Carinata and Wheat cultivars. In the graph on the right, a box plot is shown with the variability of the LT50 parameter for Canola, Carinata and Wheat. The boxplot box represents 50% of the values and the vertical lines (Whiskers) indicate the maximum and minimum extreme values of each set of materials evaluated. The horizontal line inside the boxes represents the median value.

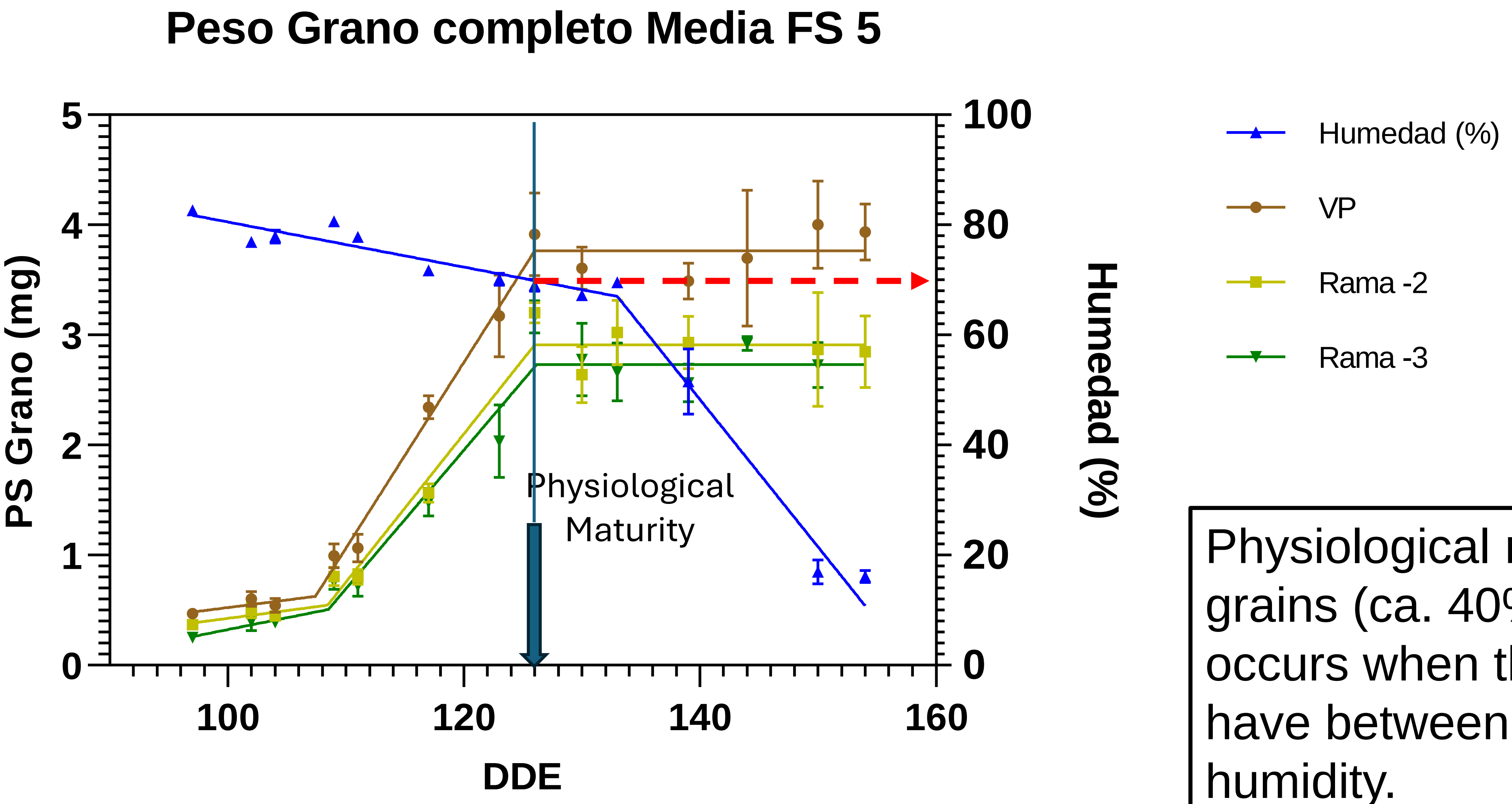
Frost risk characterization: Comparison Carinata-Canola-Wheat



Box Plots indicating the % survival of plants at extreme temperatures (value of the lower plateau for the model fitted with equation 1, see figure 3). The same is indicated for the Canola, Carinata and Wheat cultivars. The boxplot box represents 50% of the values and the vertical lines (Whiskers) indicate the maximum and minimum extreme values of each set of materials evaluated. The horizontal line inside the boxes represents the median value.

Especie	Variedad	Rango 0°C a -2°C	Rango -2°C a -4°C	Rango -4°C a -6°C
Canola	Nuola 300	Ningún daño visible	Punta hojas amarillas	50% hojas amarillas
	DSV PHOENIX	Ningún daño visible	Punta hojas amarillas	Punta hojas amarillas
	DSV DUKE	Ningún daño visible	Ningún daño visible	50% hojas amarillas
	Nuseed Diamond	Ningún daño visible	Punta hojas amarillas	nd
Carinata	Nujet 350	Ningún daño visible	Punta hojas amarillas	50% hojas amarillas
	Nujet 400	Punta hojas amarillas	50% hojas amarillas	50% hojas amarillas
	HYB076	Punta hojas amarillas	Punta hojas amarillas	nd
	HYB089	Ningún daño visible	Ningún daño visible	50% hojas amarillas
	HYB095	Ningún daño visible	50% hojas amarillas	50% hojas amarillas
	H2-125	Ningún daño visible	50% hojas amarillas	nd
	H2-167	Punta hojas amarillas	Punta hojas amarillas	hojas completamente amarillas
	H2-170	Ningún daño visible	Punta hojas amarillas	50% hojas amarillas
	H2-207	Ningún daño visible	Punta hojas amarillas	50% hojas amarillas
	H2-208	Punta hojas amarillas	Punta hojas amarillas	hojas completamente amarillas
	H1-254	Ningún daño visible	50% hojas amarillas	50% hojas amarillas
	H2-124	Punta hojas amarillas	Punta hojas amarillas	hojas completamente amarillas
	H1-264	Ningún daño visible	Punta hojas amarillas	Punta hojas amarillas
	H1-269	Punta hojas amarillas	Punta hojas amarillas	hojas completamente amarillas
Trigo	Tr1	Ningún daño visible	Ningún daño visible	Ningún daño visible
	Tr2	Ningún daño visible	Ningún daño visible	Ningún daño visible
	Tr3	Ningún daño visible	Ningún daño visible	Ningún daño visible
	Tr4	Ningún daño visible	Ningún daño visible	Ningún daño visible
	Tr5	Ningún daño visible	Ningún daño visible	Ningún daño visible
	Tr6	Ningún daño visible	Ningún daño visible	Punta hojas amarillas

Determination of the optimal harvest time based on the moisture content of the siliques



Physiological maturity in grains (ca. 40% humidity) occurs when the siliques have between 65-70% humidity.

Determination of the optimal harvest time based on the moisture content of the siliques

Fecha (DDS)	FS	Humedad silicuas (%)	VP	Rama -2	Rama -3
24/10 (109)	5	81%			
24/10 (109)	5	81%			
1/11 (117)	5	72%			
1/11 (117)	5	72%			
7/11 (123)	5	70%			
7/11 (123)	5	70%			
14/11 (130)	5	67%			
14/11 (130)	5	67%			
23/11 (139)	5	54%			
23/11 (139)	5	54%			

The objective of these experiments was to establish the optimal harvest time based on the humidity of siliques and generate a simple model for determining grain humidity based on the moisture content of the siliques so that the user can know the moment of physiological maturity. allowing you to use a desiccant if necessary. The results show that between 65-70% humidity in siliques, physiological maturity is reached. The work group will prepare a visual guide for determining the harvest time throughout the filling of the grains.

Conclusions

Biomass and seed yield

- Nujet 350 sowed in early May reached **3.5 t/ha seed yield** (with high variability among plots)
- **Oil yield was high (1.4 t oil/ha)** despite the relatively low seed oil content (40%)
- High seed yield was related to high aerial biomass (10-20 t DM/ha) and harvest index (0.21)
- It had high seed number (50-150 thousands/m^2) with regular thousand seed weight (3.7 g)
- At harvest, aerial+root biomass was **at least 17 t/ha.**
- More than **13 t DM/ha of residual biomass remained on the plot** (1 t/ha root + 12 t/ha straw)
- Shoot/root ratio=15 (probably overestimated because fine roots were not retained)

Phenology

- Nujet 350 was from 2 to 5 days earlier than E87 and E95 depending on the phase that was considered when duration was measured in calendar days. However, that difference was not evident when data were measured in Thermal time.
- The algorithms for NUJET350 to be included in the CRONOCANOLA/CARINATA model were calculated using 2022 and 2023 date. With the exception of the phase Emergence-V4 (Rossete) that was insensitive to photoperiod, the rest of the phases were shortened as emergence was delayed.

Frost Damage

- There was not important differences in frost tolerance in the 14 genotypes of carinata evaluated. The LT50 (when 50% of the plants died) was from -5,8 to -6,6 °C. The genotypes of canola were more tolerant being Nuola300 the genotype with the highest frost tolerant. In all cases wheat genotypes showed the highest from tolerant when were compared with canola and carinata genotypes.