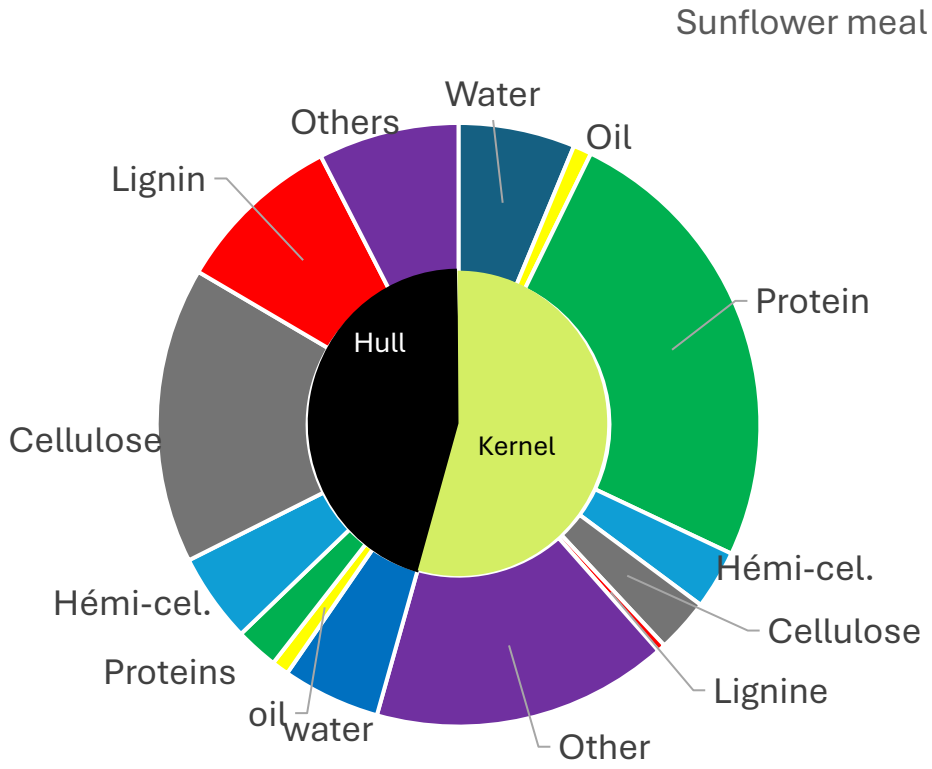
Key parameters related to sunflower dehulling

PROTOUR project

A French collaborative project for improving the sunflower seeds processability

Dehulling, a mean to increase the proteins concentration in the meal



Dehulling can increase the proteins content from 27% in non-hulled meal to ~50% in totally hulled meal.
Hulls are representing 45% of the non-dehulled meal and have very poor interest in animal nutrition.

Hulling is made by impacts

Before impatcs

1 impact

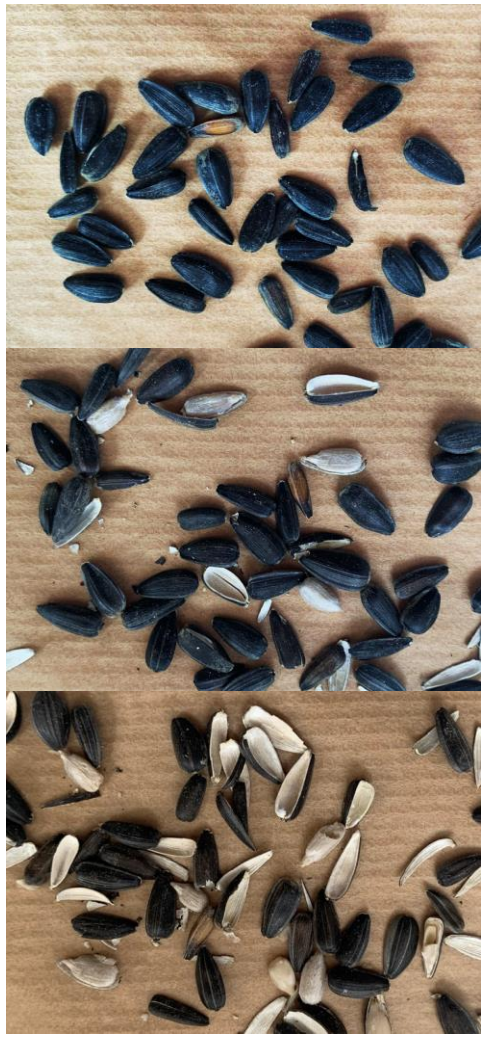
2 impacts

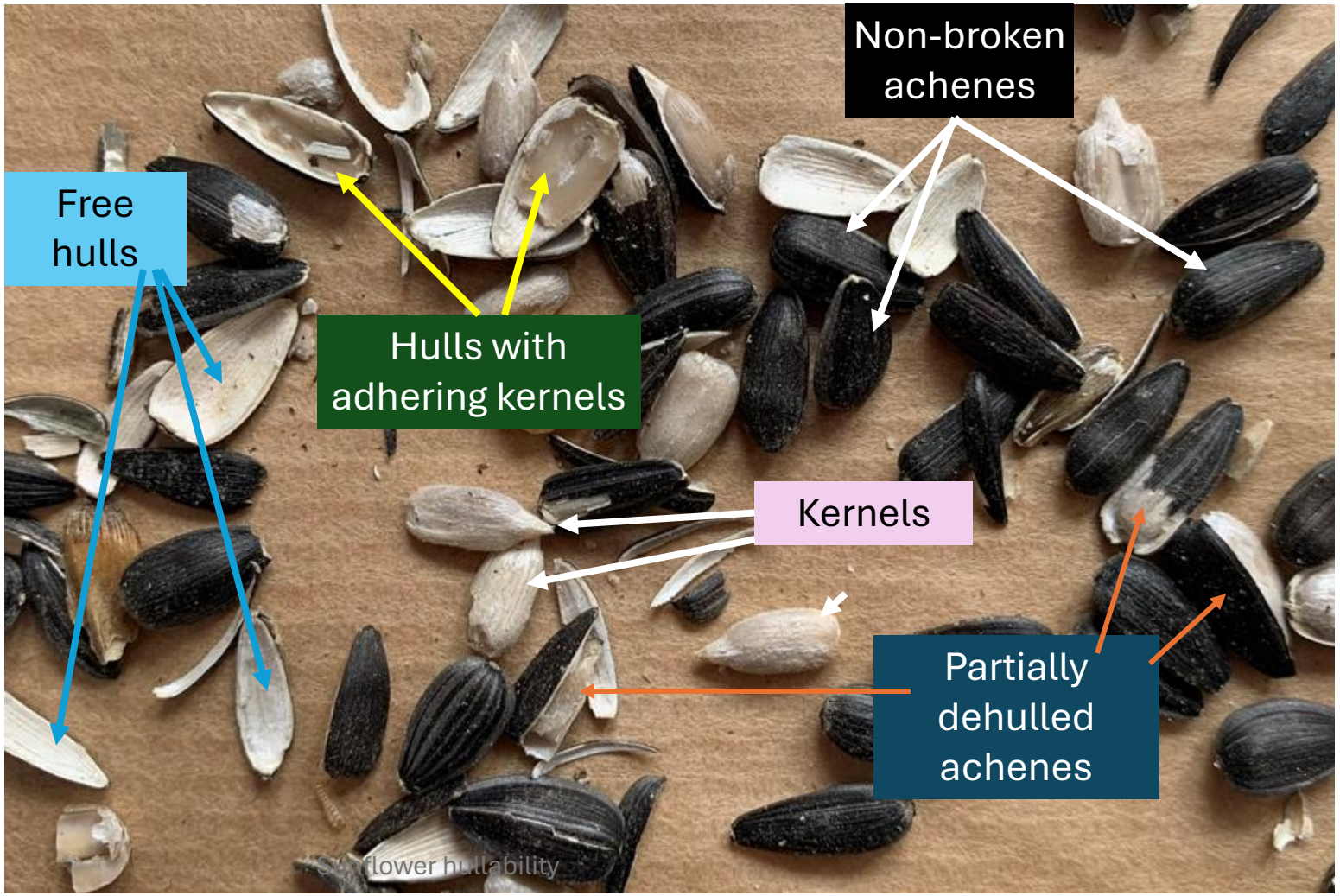
3 impacts

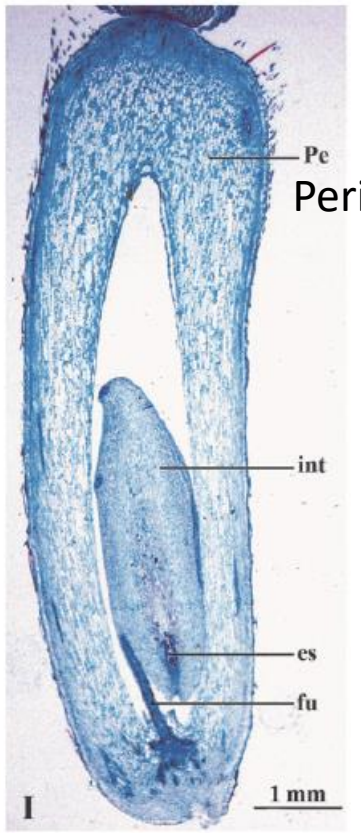
The result of the impactor is heterogeneous

Centrifuge impactor

Result of hulling







Pericarp

Longitudinal section of the ovary at the stage R 5.7 (~4 days later)

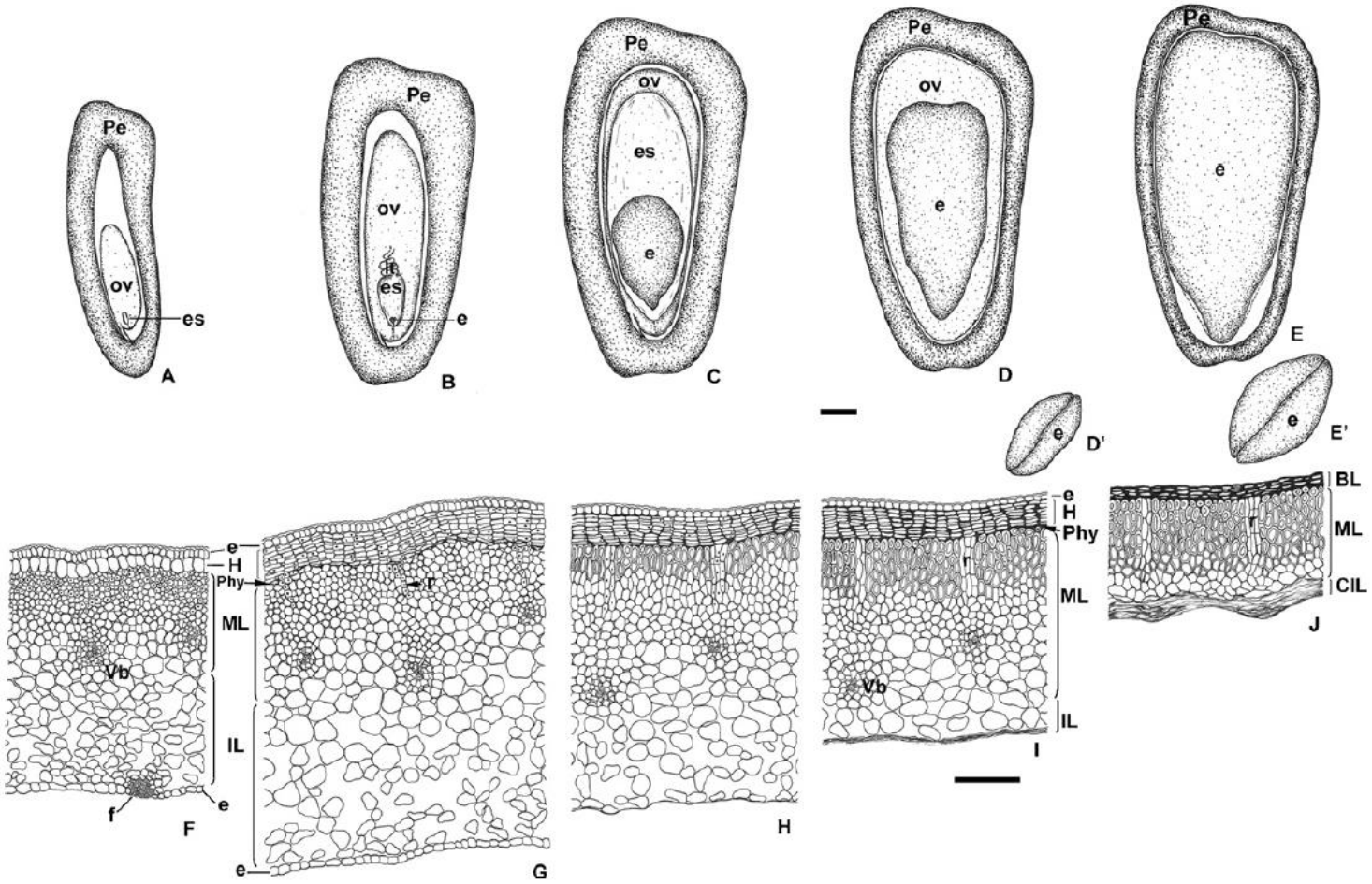


Fig. 1. (A–E′) Relationship between pericarp and embryo development of fruits from the mid position in the capitulum of DK3900 in unshaded plants. (A–E) Open fresh fruits with half the pericarp removed; (D′ and E′) embryo cross-section; (F–J) cross-sections of different stages of the pericarp. (A and F) Anthesis of mid flowers (MA); (B and G) full anthesis (FA); (C and H) 5 days after full anthesis (5 DAFA); (D and I) 10 DAFA; (E and J) physiological maturity (PM). BL, black layer; CIL, compressed internal layers; e, epidermis; em, embryo; es, embryo sac; f, bundle of fibers; H, hypodermis; IL, inner layer; it, integumentary tapetum; ML, middle layer; Ov, ovule; Pe, pericarp; Phy, phytomelanin layer; r, parenchymatic ray; Vb, vascular bundle. Scale bar: A–E = 2 cm; F–J = 100 μm.

Evolution of the pericarp during ripenening

Left : Lindström, LI et al. Botany (2015)
Right : Lindström, L. I., et al. Field Crops Research (2007)

Experimental design:

30 commercial cultivars (CV)
2 harvests year (2021, 2022)
4 locations / year

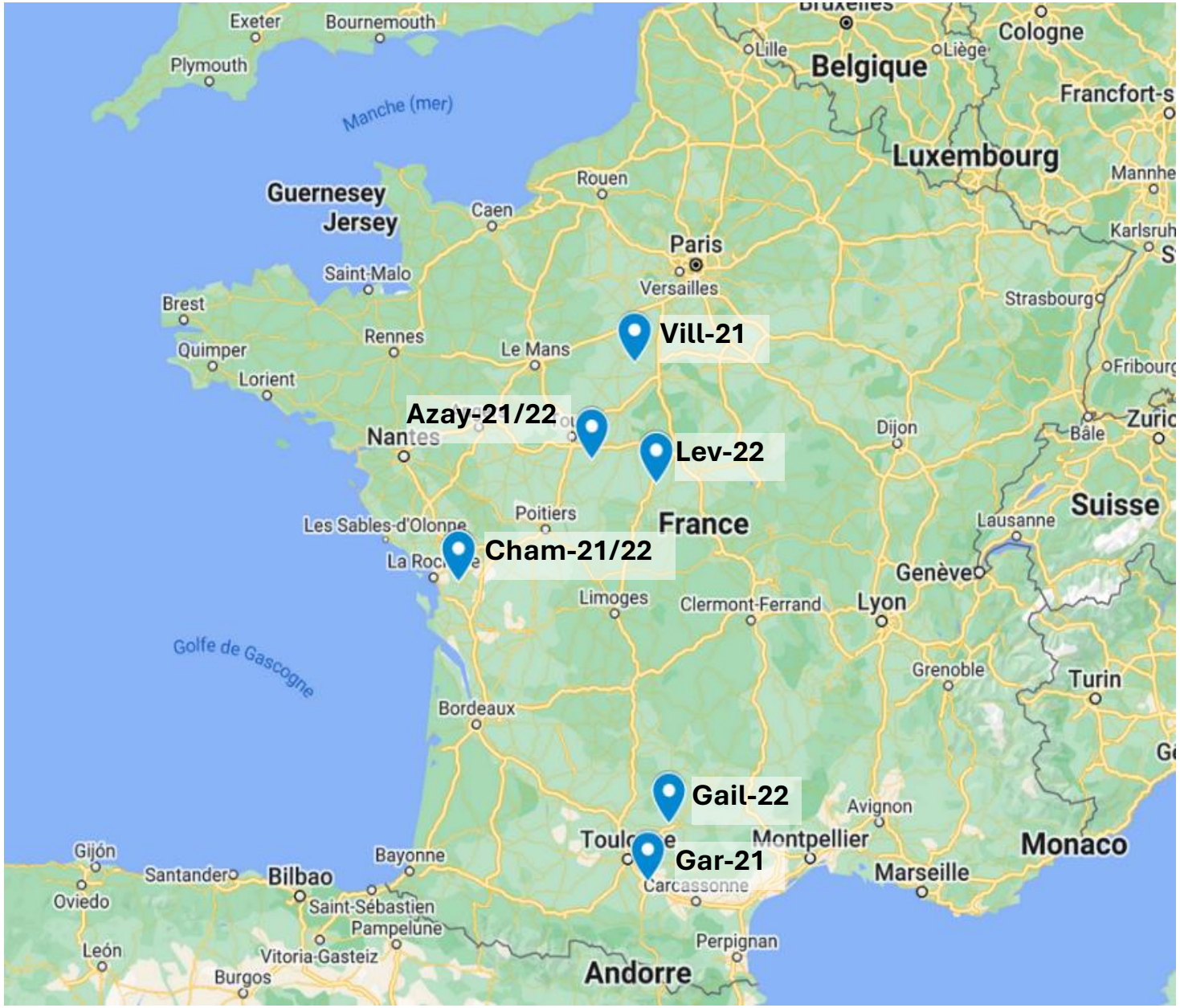
2 plots per CV.

After harvest :

Moisture equilibration

Hullability measured with the lab-scale impactor (3 x 2000 rpm)

Hulls aspirated after rotary sieve (2mm) for fines removal.



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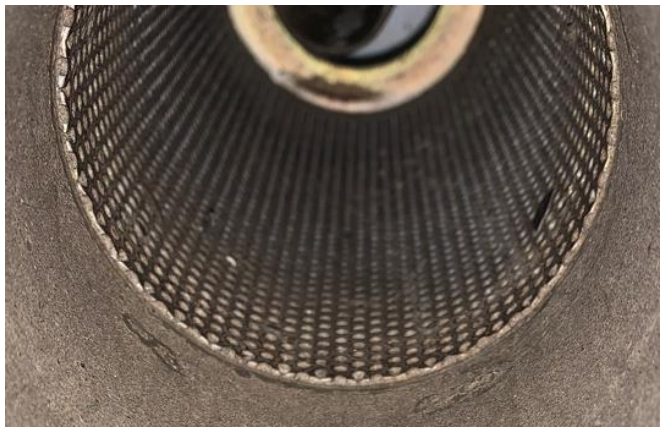
Laboratory impactor



Laboratory sorter

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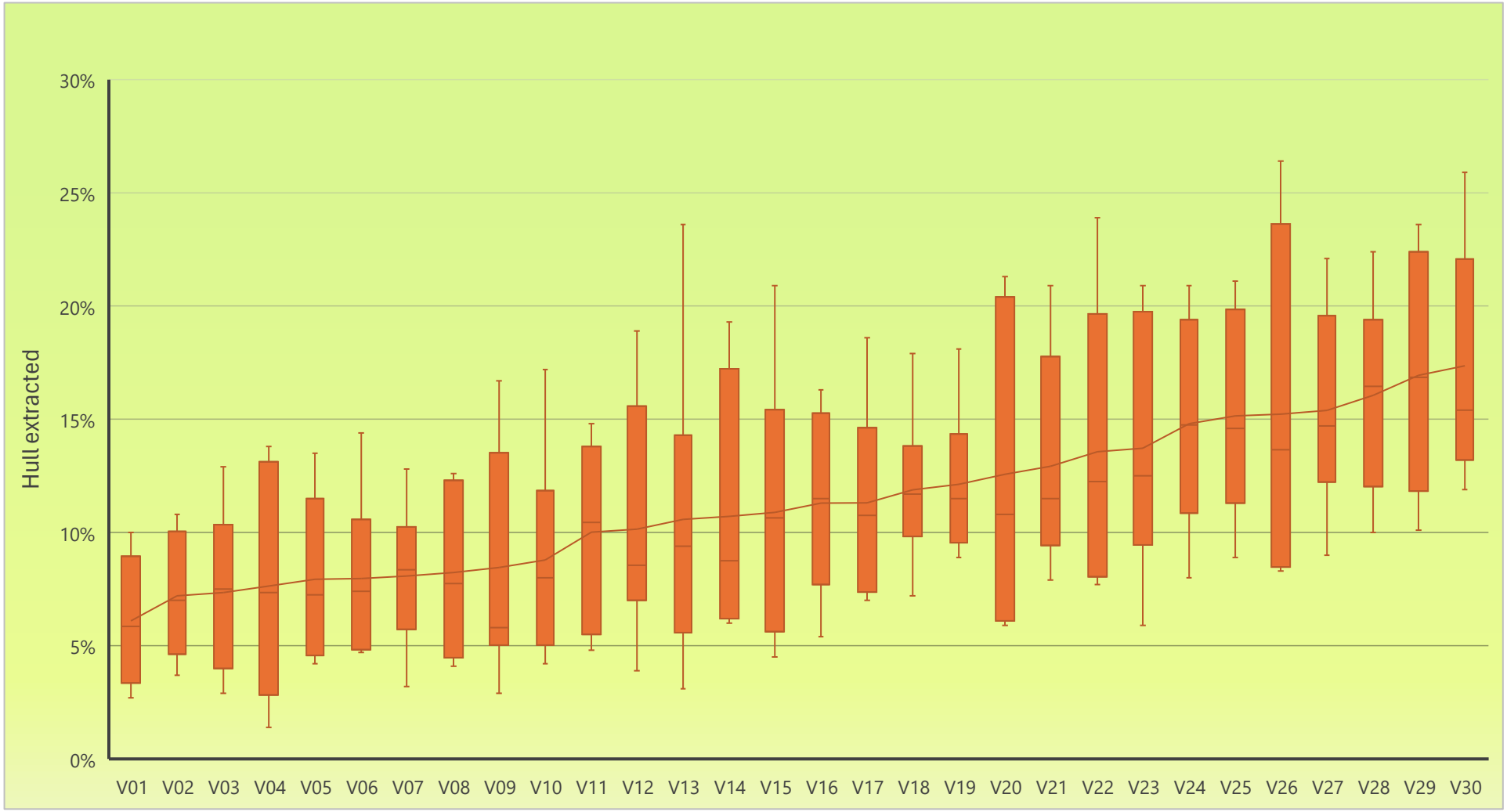
Cultivar effect (8 environments)



Analysis of variance

model Hull = Var + Loc + Year

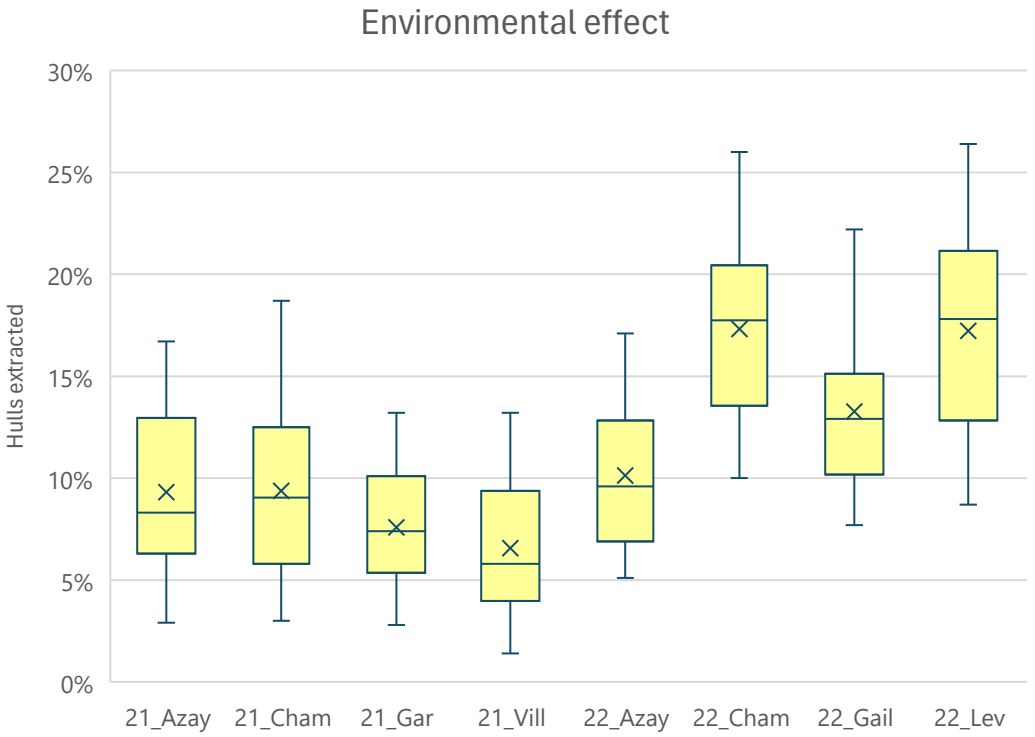
	Df	Sum Sq	Mean Sq	F value	Pr(>F)	
Var	29	0.240046	0.008277	10.996	< 2.2e-16	***
Loc	5	0.265914	0.053183	70.65	< 2.2e-16	***
Year	1	0.057597	0.057597	76.514	8.21E-16	***
Residuals	204	0.153564	0.000753			

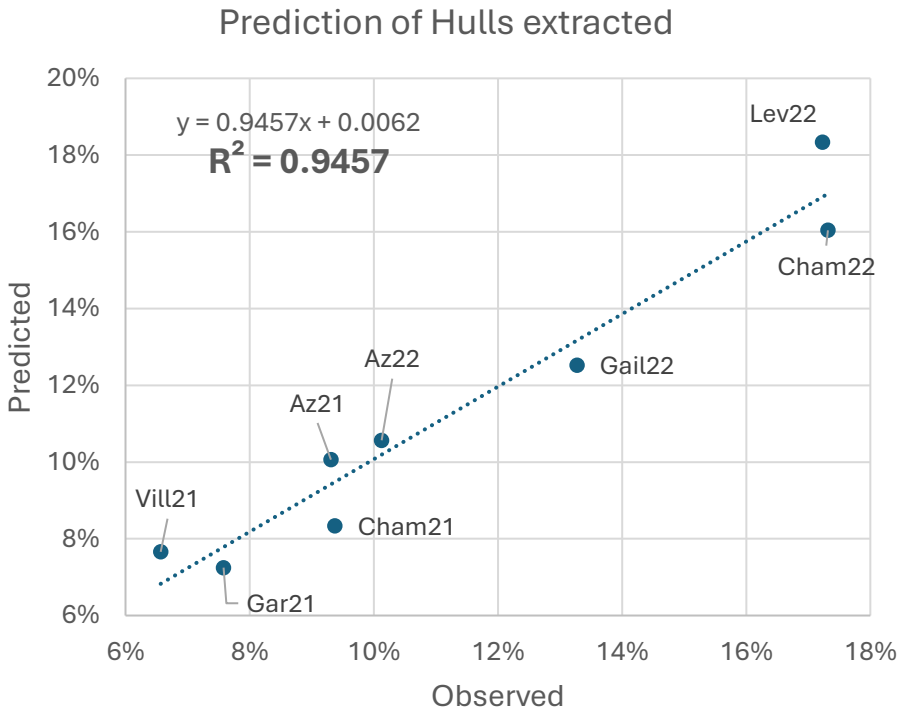
$R^2 = 0.79$, adj. $R^2 = 0.75$

~ 33% of the variability explained by the genetic factor
~ 37% by the location
~ 8% by the year effect

Conclusion: significant genetic effect but environment > genetic

The environmental effect explained



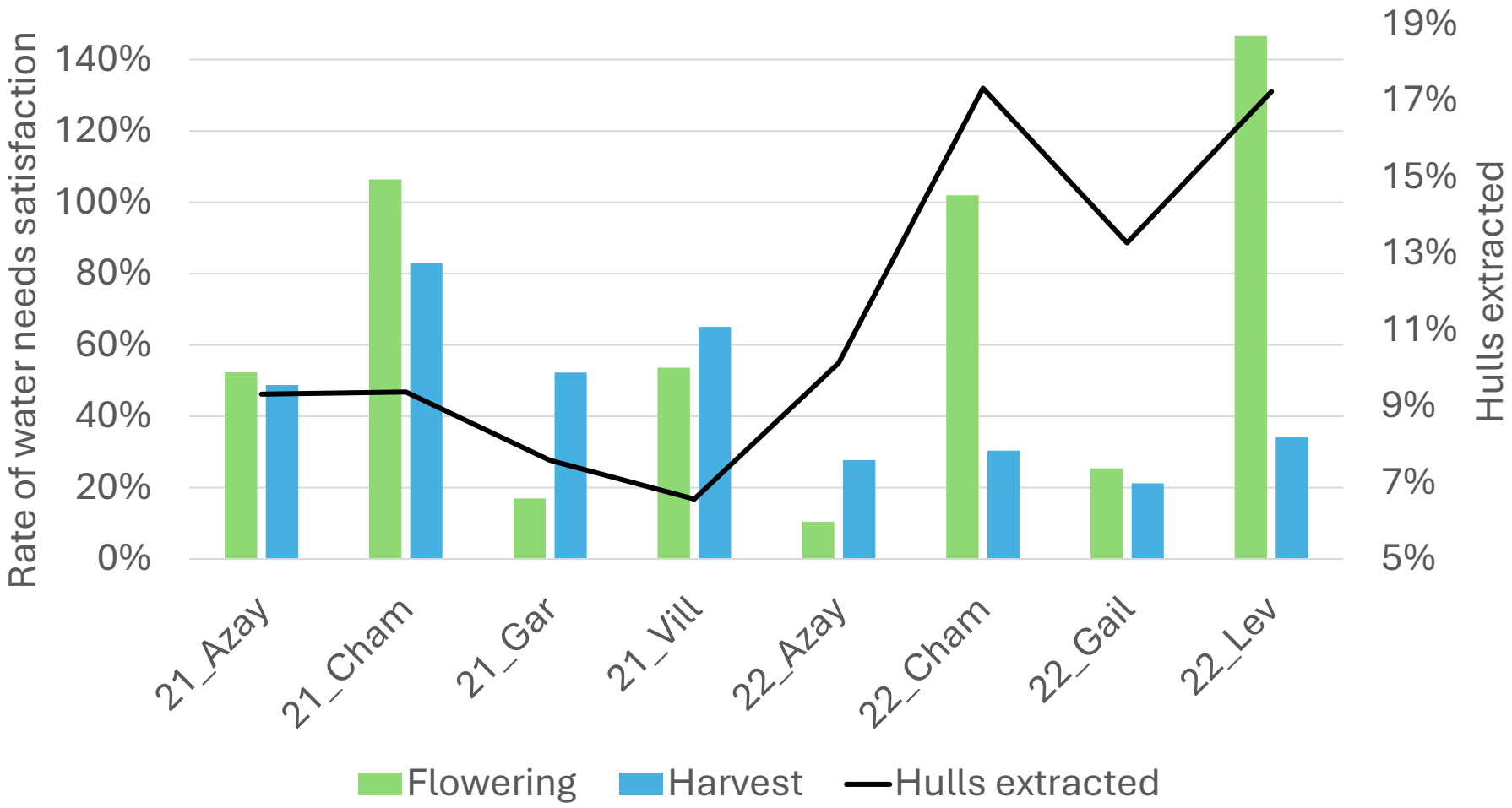


2 variables can explain 94 % of the environment effect:

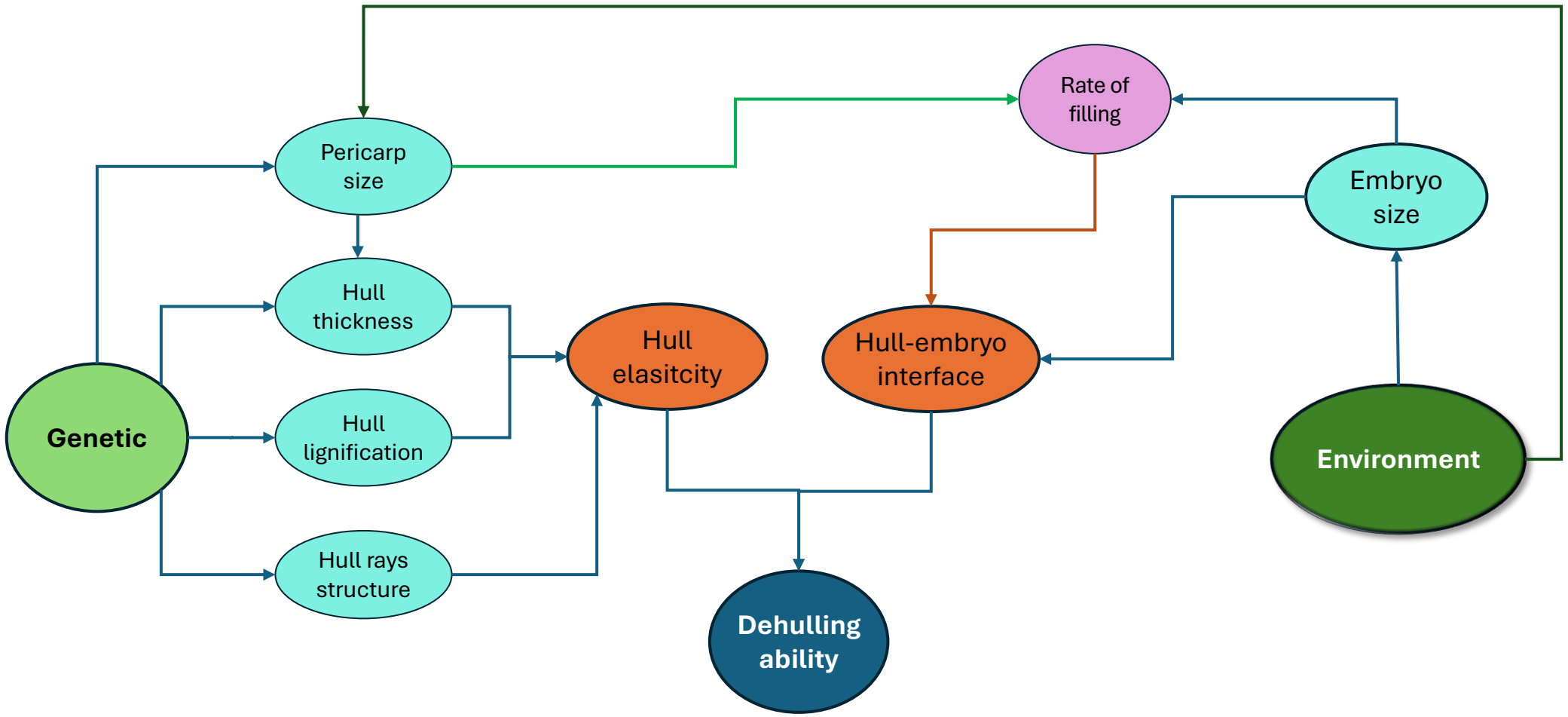
- PET – Precipitations up to flowering = F
- PET – Precipitations up to harvest = H

Pred = 6.24F – 15.23H + 14.12

Meteorologic data



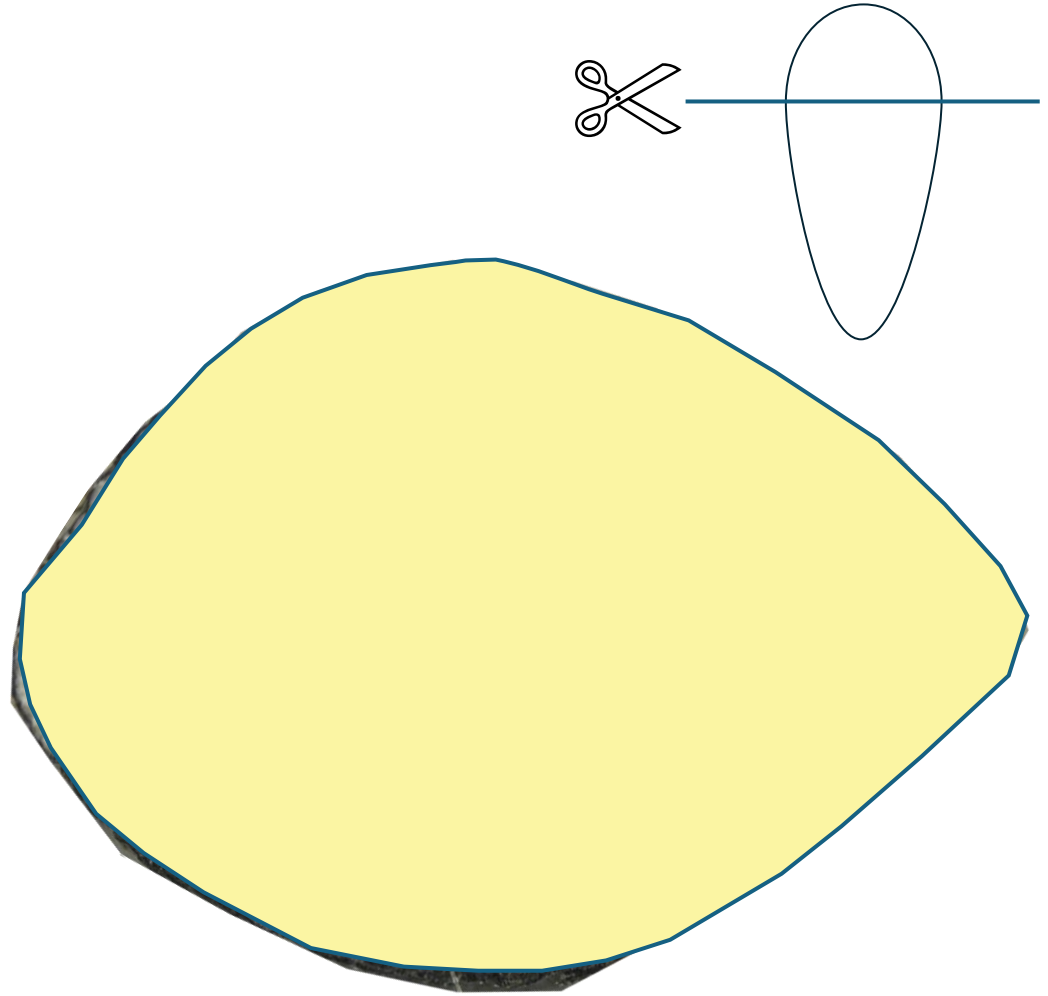
Hullability determinism



Characterization of the achenes

Measures:

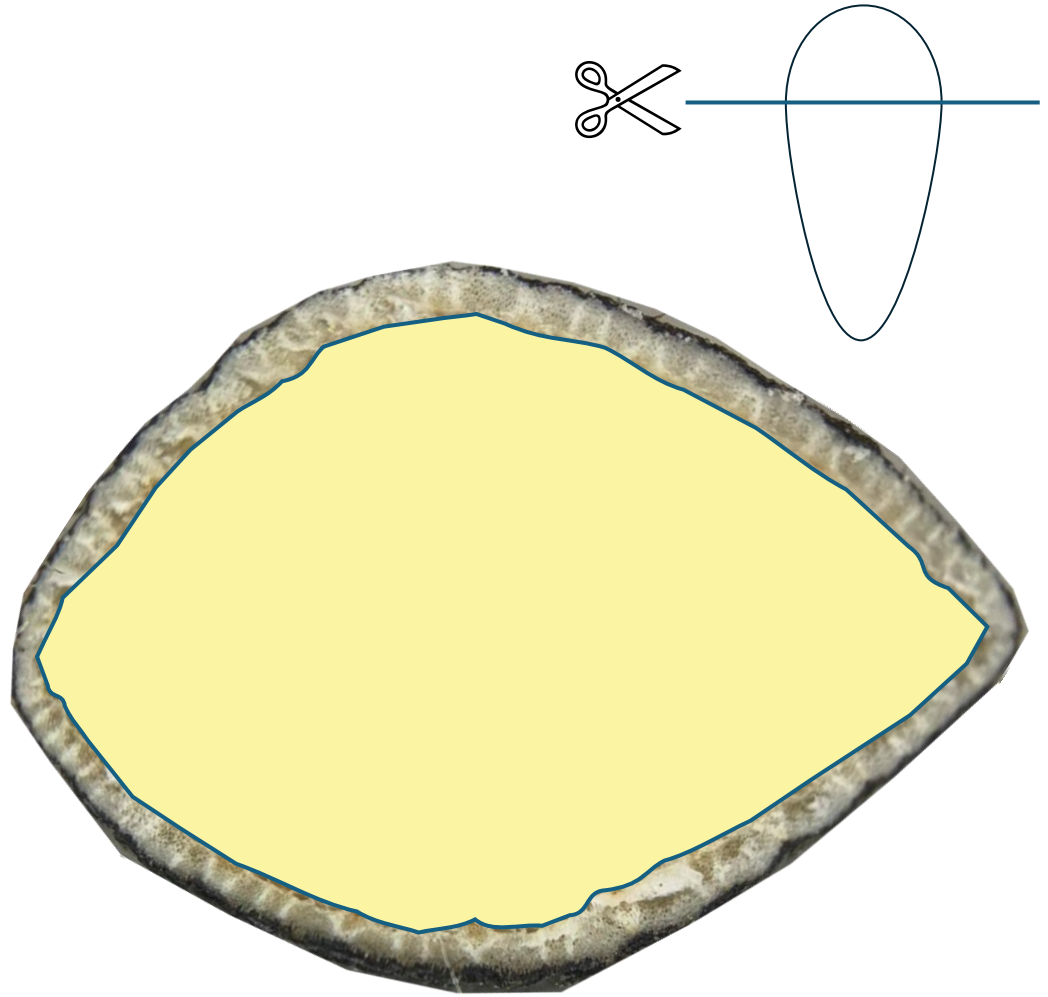
- Achene area (Aa)
- Achene perimeter (Ap)



Characterization of the achenes

Measures:

- Achene area (Aa)
- Achene perimeter (Ap)
- Intra-pericarp area (Ia)
- Intra-pericarp perimeter (Ip)



Characterization of the achenes

Measures:

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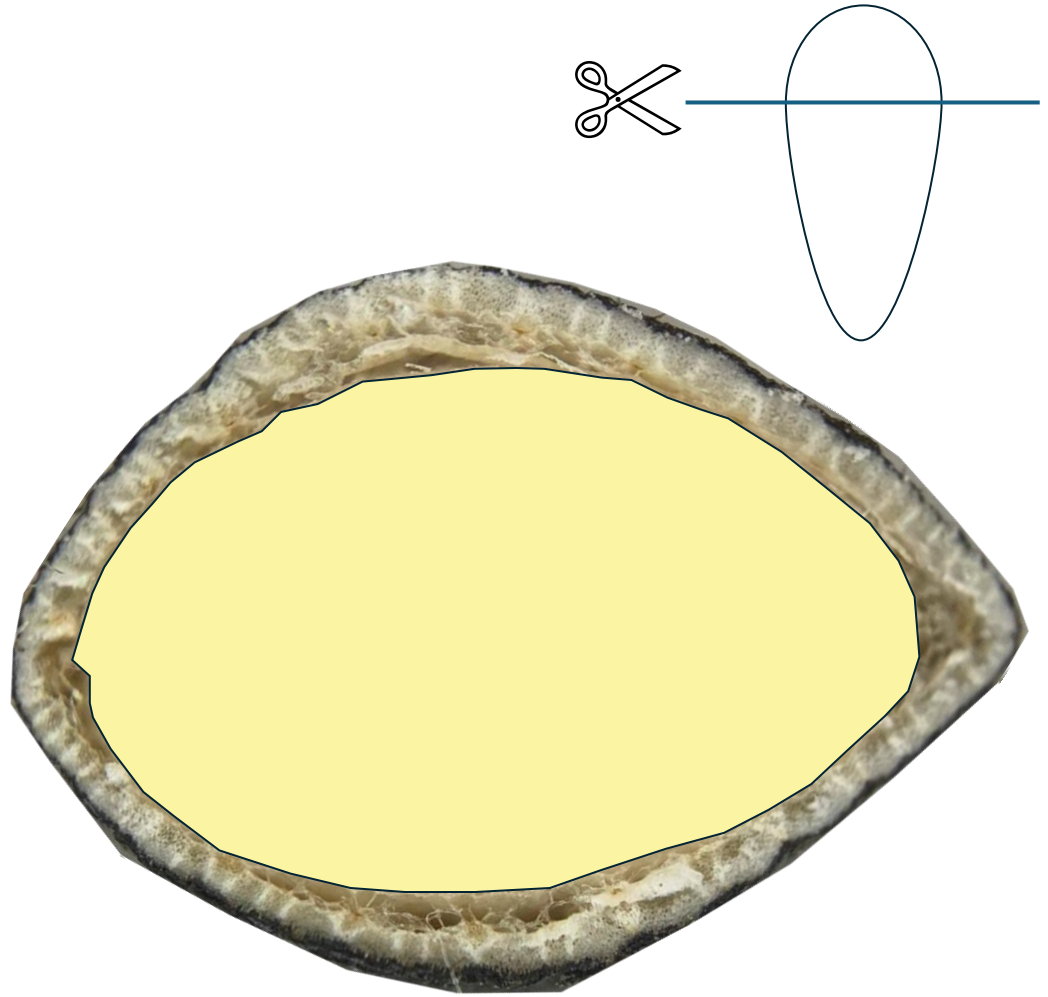
- Intra-pericarp area (Ia)
- Intra-pericarp perimeter (Ip)
- Kernel area (Ka)
- Kernel perimeter (Kp)



Characterization of the achenes

Measures:

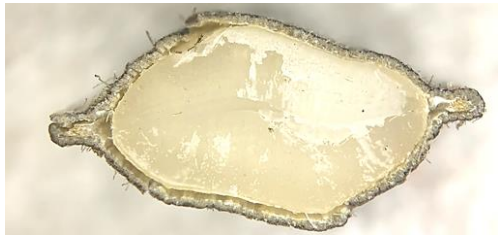
- Achene area (Aa)
- Achene perimeter (Ap)
- Intra-pericarp area (Ia)
- Intra-pericarp perimeter (Ip)
- Kernel area (Ka)
- Kernel perimeter (Kp)
- Pericarp-kernel contact zones lenght (Pc)

Calculations:

- Pericarp area Pa = Aa - Ia
- Pericarp thickness PT = Pa / Ap
- Free space Fs = Ia – Ka
- Rate of free space RFS = Fs / Aa
- Rate of contacts RC= Pc /Kp

Observations

- Nb > 30 achenes per lot
- 4 cultivars
- 2 locations (Cham + Azay)
- 2 harvest years

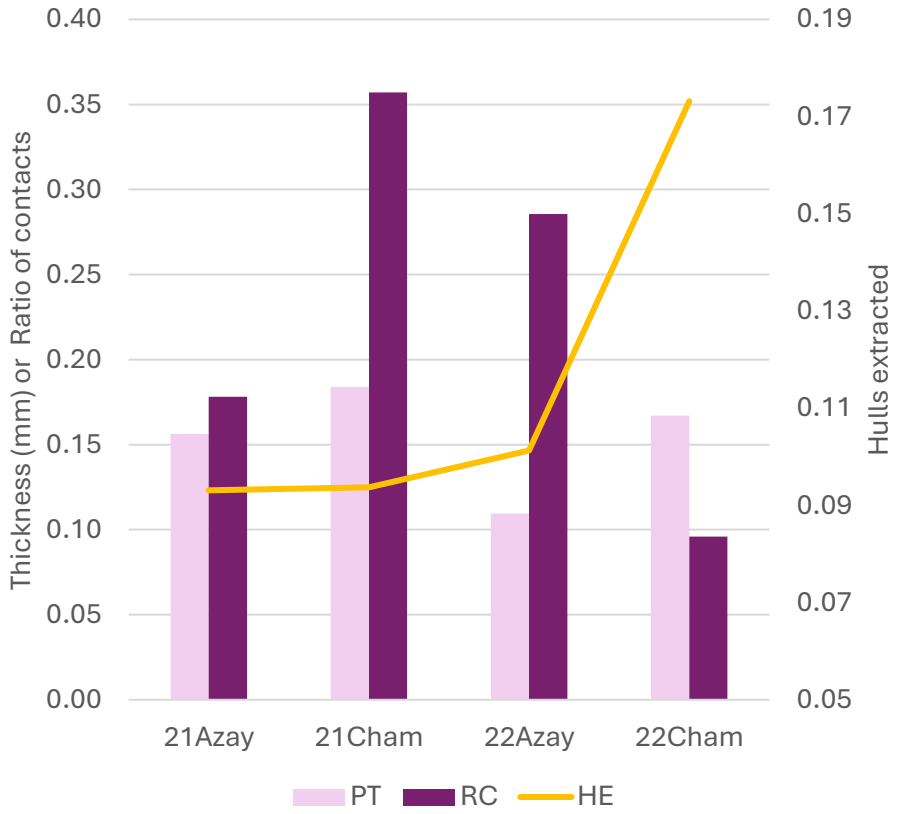


Ratio of contacts & pericarp thickness

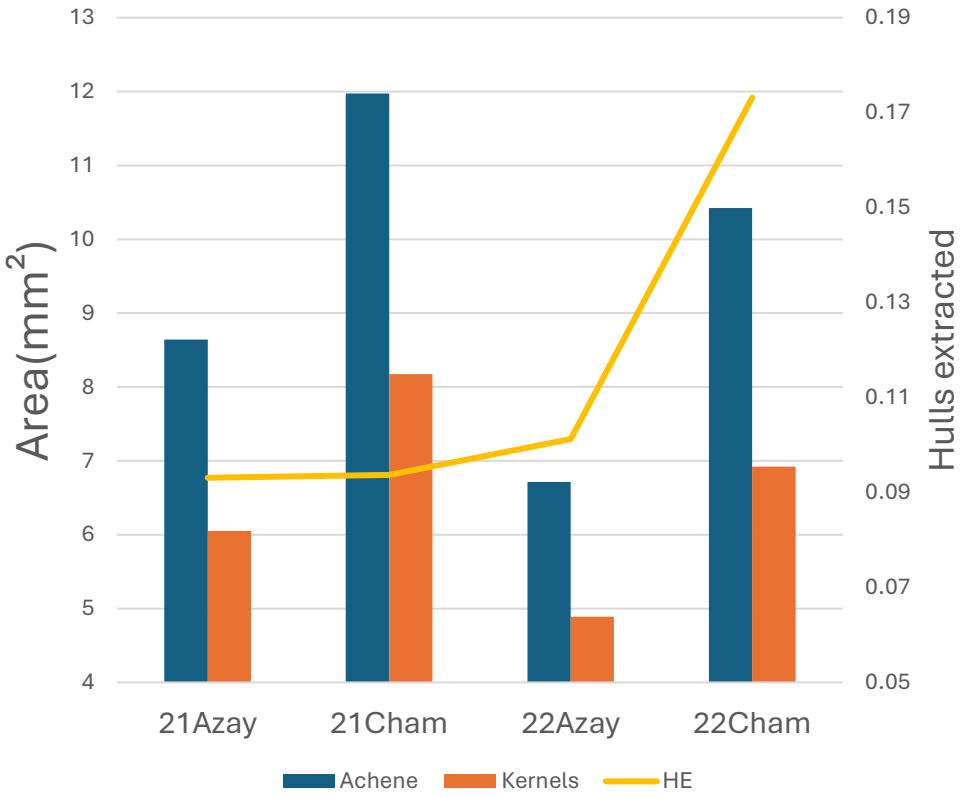
22Cham characterized by a low ratio of contacts between hull and kernel.

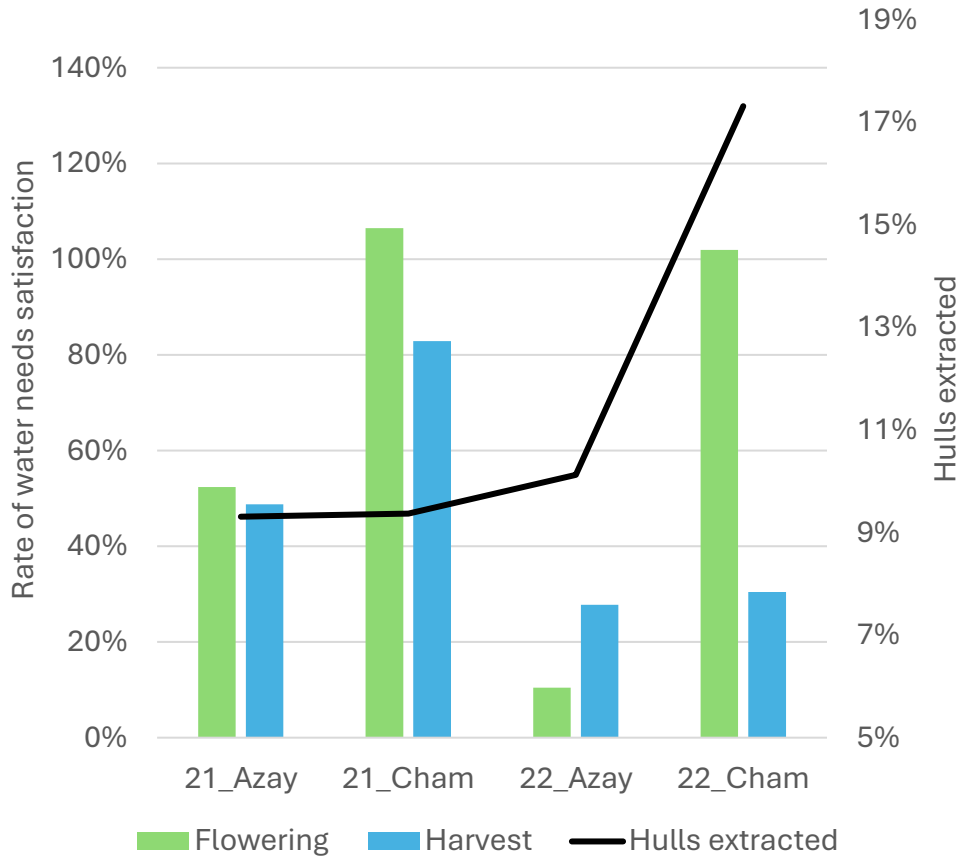
But it is not sufficient to explain the poor hullability of 21Azay which could result of the combination of several factors:

- PT/Aa 18 vs. 16 µ/mm²
- RFS: 11.8 vs. 16.7 %
- Aa: 8.6 vs. 10.4 mm²
- RC: 17.8 vs. 9.6 %



Achene & kernels area / satisfaction of water needs





Conclusions

- Sunflower hulling ability under the influence of environment & genetic.
- Environment effect is explained by the rate of satisfaction of the water need at flowering stage and during the whole cycle of growth.
- Water stress at flowering limits the achene size
- Water stress during filling limits the kernel size.
- Contact between hulls and kernels gives adhesion and limits hullability.