Wheat starch variability in characteristics and Rheological properties : the influence of varieties, harvest years and phytotechny

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GEMBLOUX - BELGIUM

With the financial support of General Direction of agriculture, Walloon Region

Project strategy

Known sample production
(Unité de Phytotechnie FUSAGx)

3 variability sources:
- varieties
- phytotechny
- harvest dates

Enzymatic aspects
(Dpt Qualité CRA-W)

Starch (Unité de Technologie des IAA FUSAGx)

- Caracterisation of ground wheat
- Evaluation of α-amylase activities
- Starch sensitivity to enzymatic hydrolysis

- flour characterisation
- Starch extraction
- Starch Characterisation

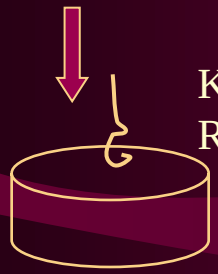
Common interpretation of the results

Possible specific end-uses according to the starch

Starch isolation :

Batter procedure

Flour + water
(60% flour weight)

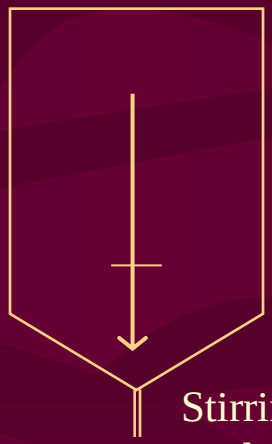


Kneading: 2 min
Rest: 8 min

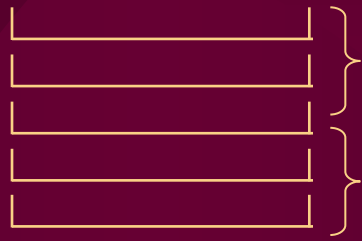
+ water (100% flour weight)

Mix: 20 min

+ water (400% flour weight)



Stirring to agglomerate the gluten: 35 min

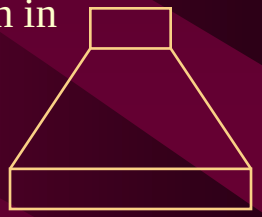


Gluten

Fibers

Filtration

3 cycles of starch centrifugation and re-suspension in water



Freeze-drying and storage

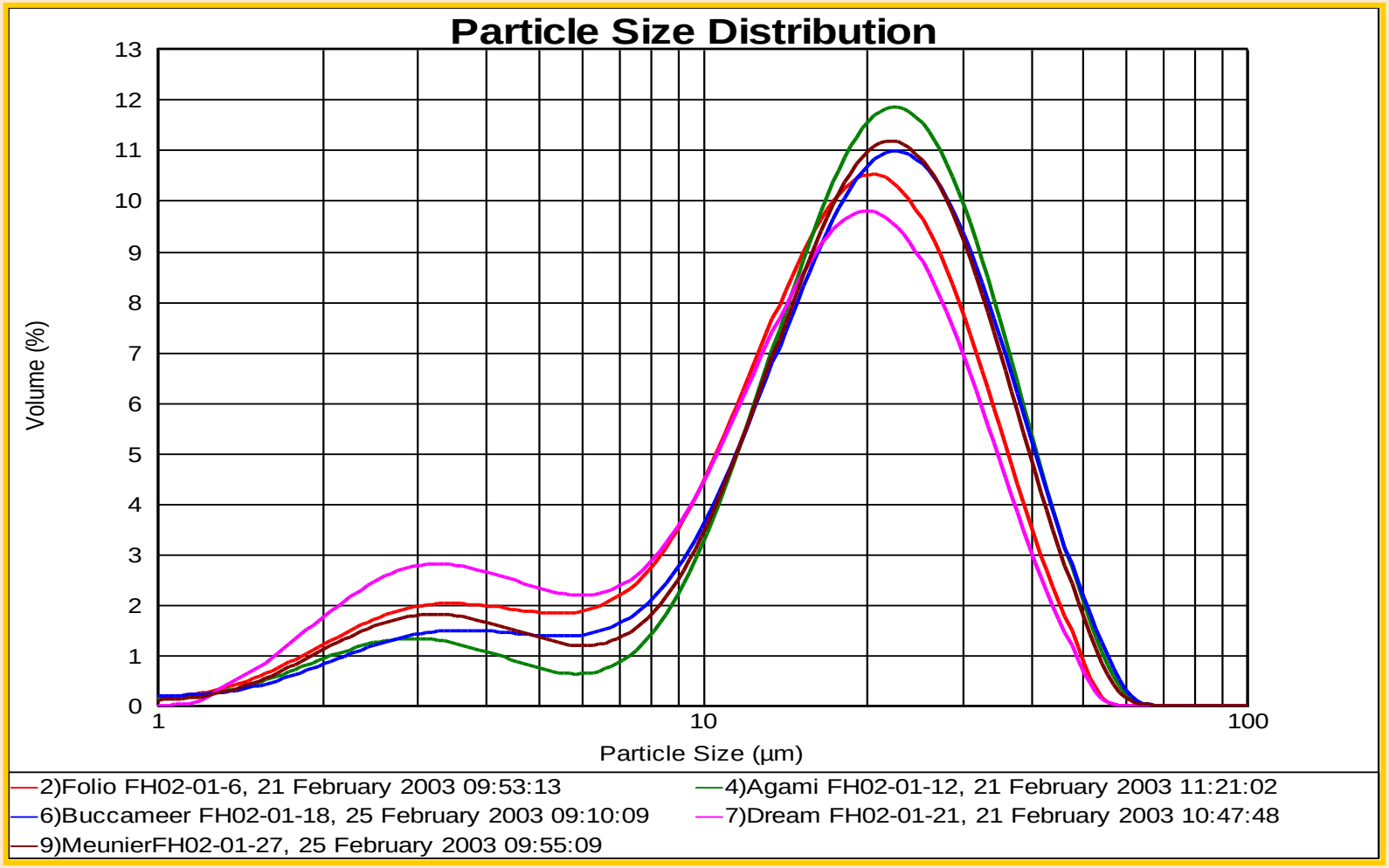
Starch suspension

(stored 24h at 4°C)

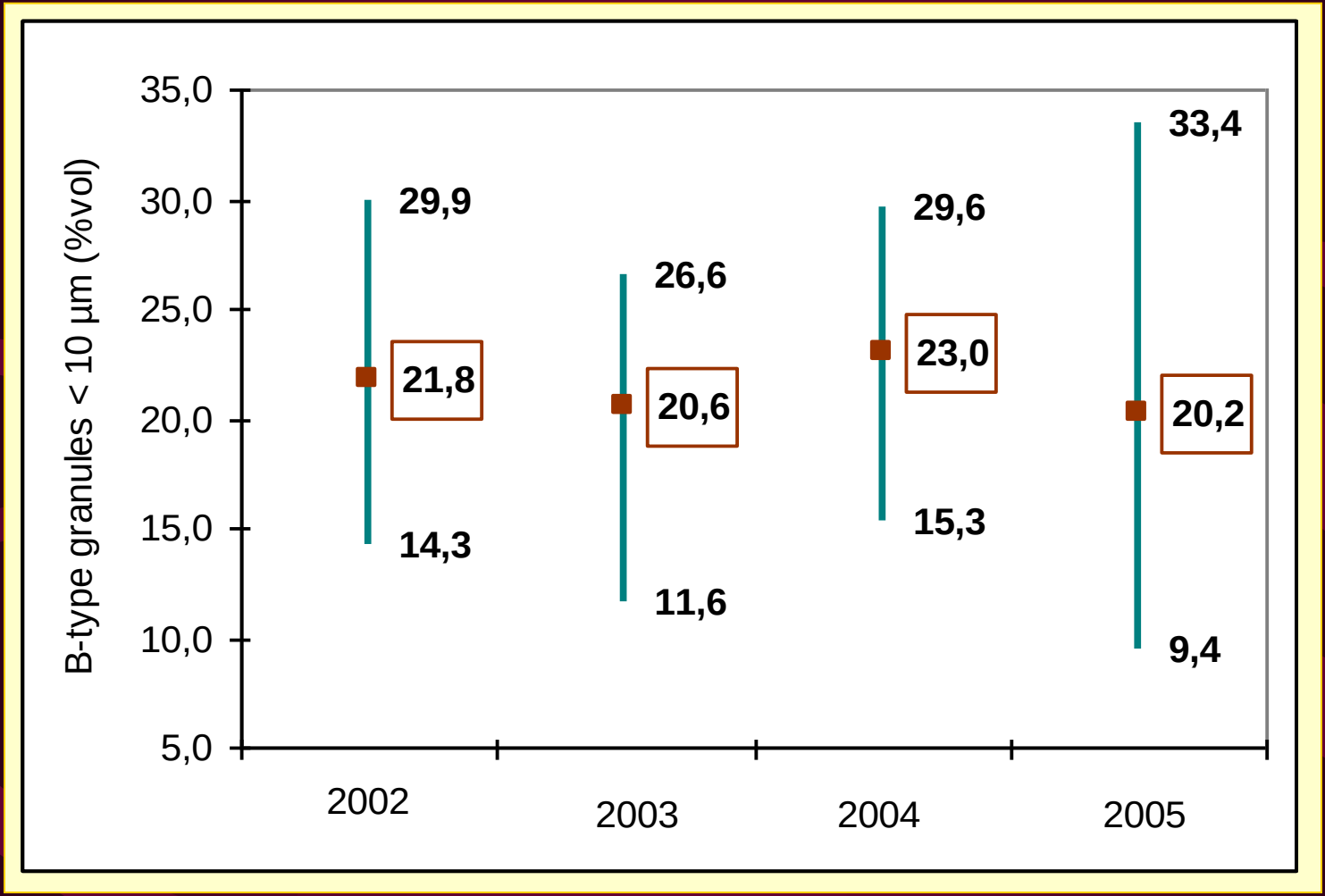
Starch characterisation

- Dry matter (ISO n°712)
- Starch Damaged (amperometry determination by the Chopin-Dubois SD4 method, NF ISO 5530-1)
- Starch contents (polarimetry method of Ewers, ISO 10520)
- Starch viscosity (micro visco-amylograph Brabender)
  - in water suspensions
  - in a 2 mM $AgNO_3$ water solution (alpha-amylase inhibitor)
- Granule size distribution
  (laser light scattering using a Malvern granulometer)
- Amylose / amylopectin content
  (modified iodometric method of Morrisson et Laignelet, 1983)

Starch granules : size distribution

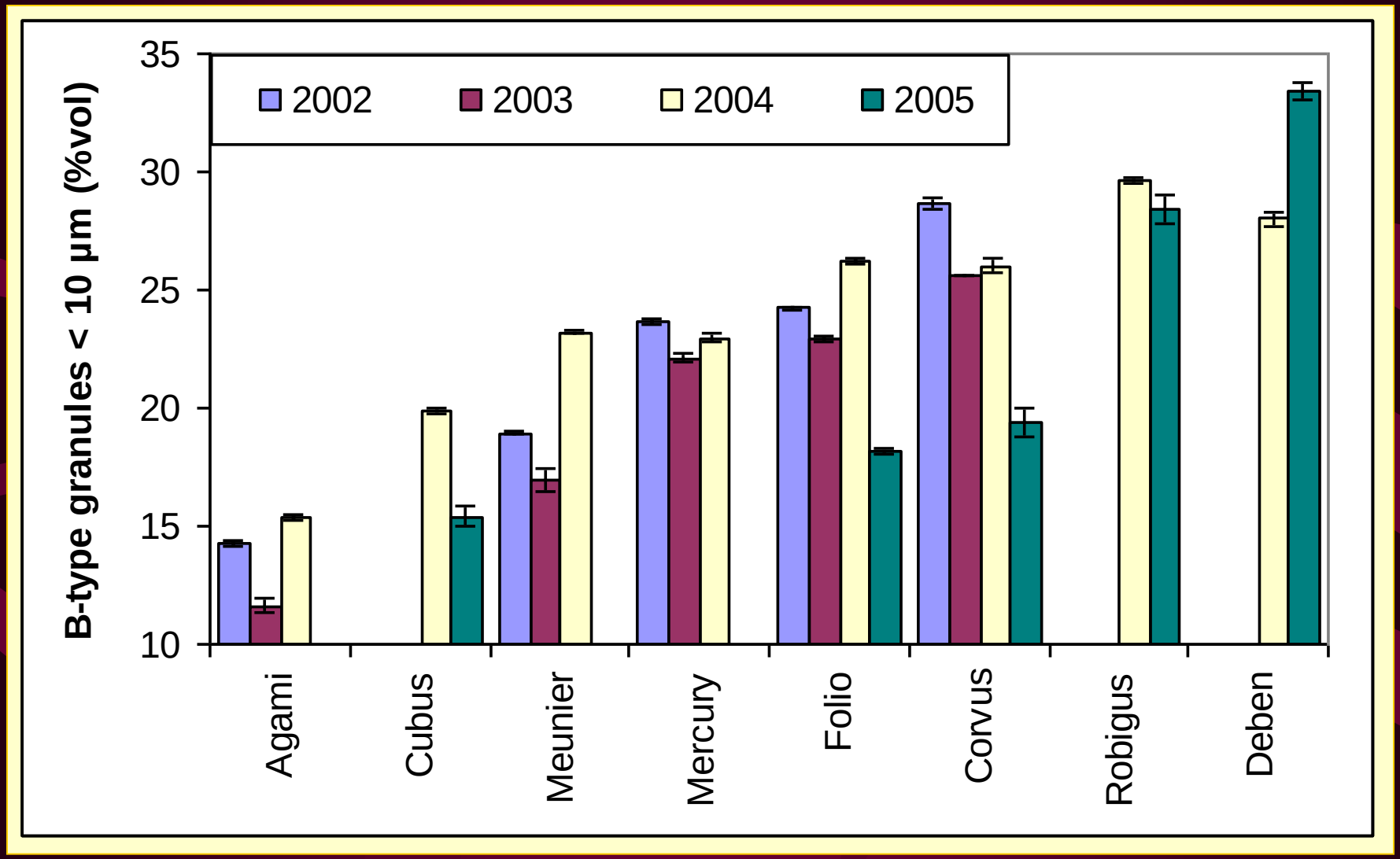


Starch granules : size distribution (minimal, mean and maximal values, harvests 2002-2005)

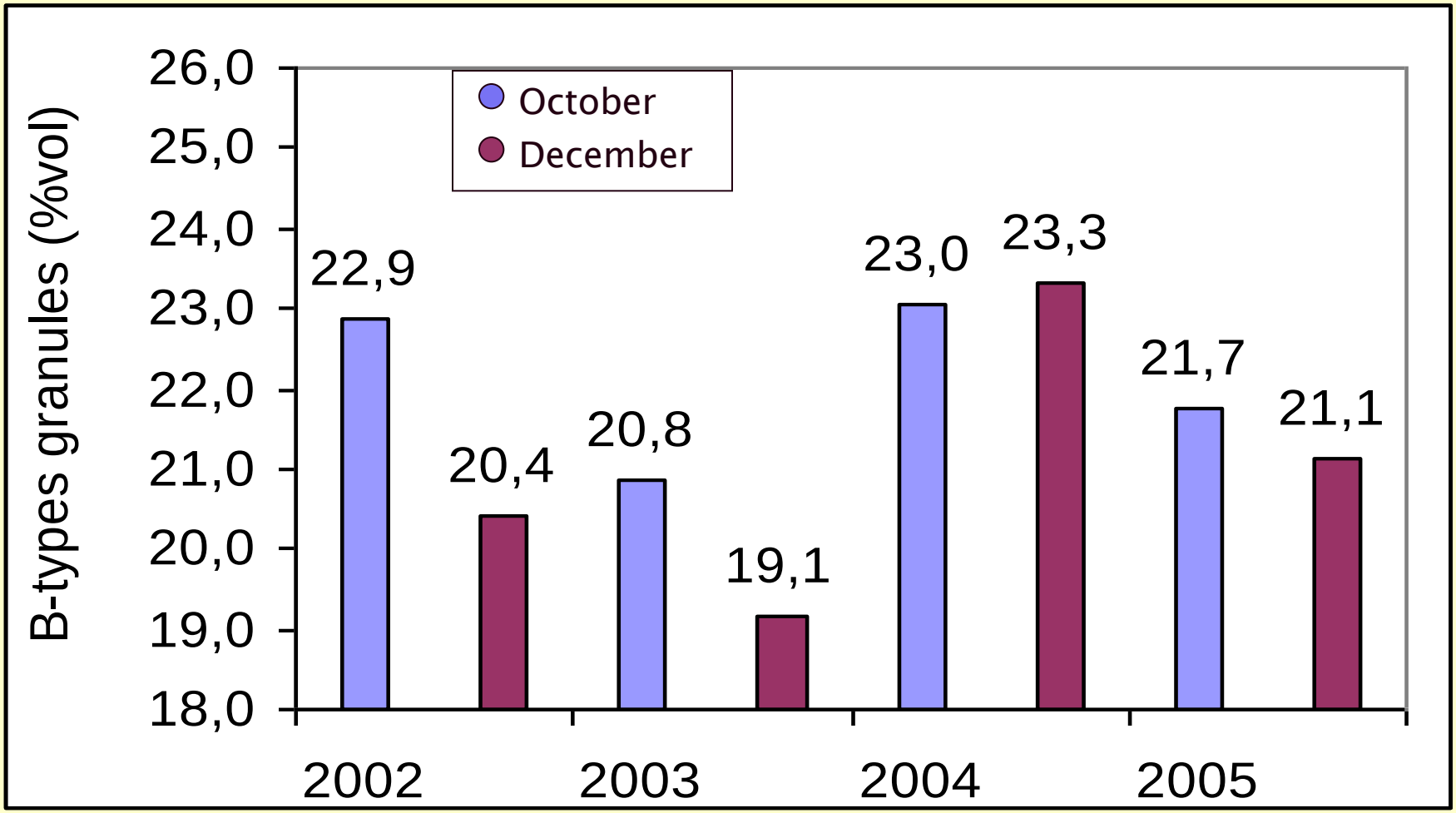


Maximum variations (B-type granules < 10 µm) : 15 to 20 % vol

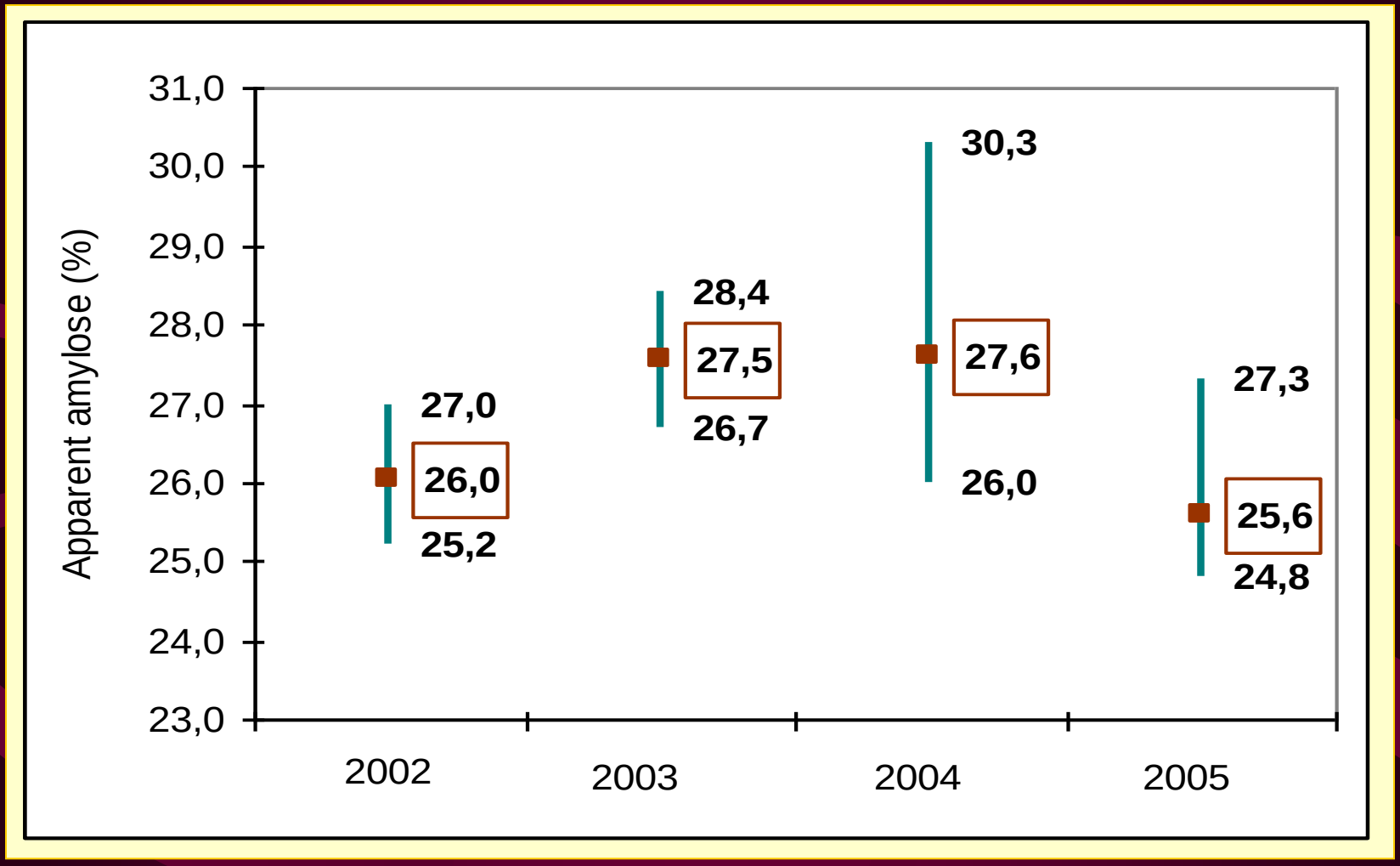
Starch granules size distribution (harvests 2002–2005)



Starch Granules size distribution (harvests 2002–2005) : means of the varieties under study

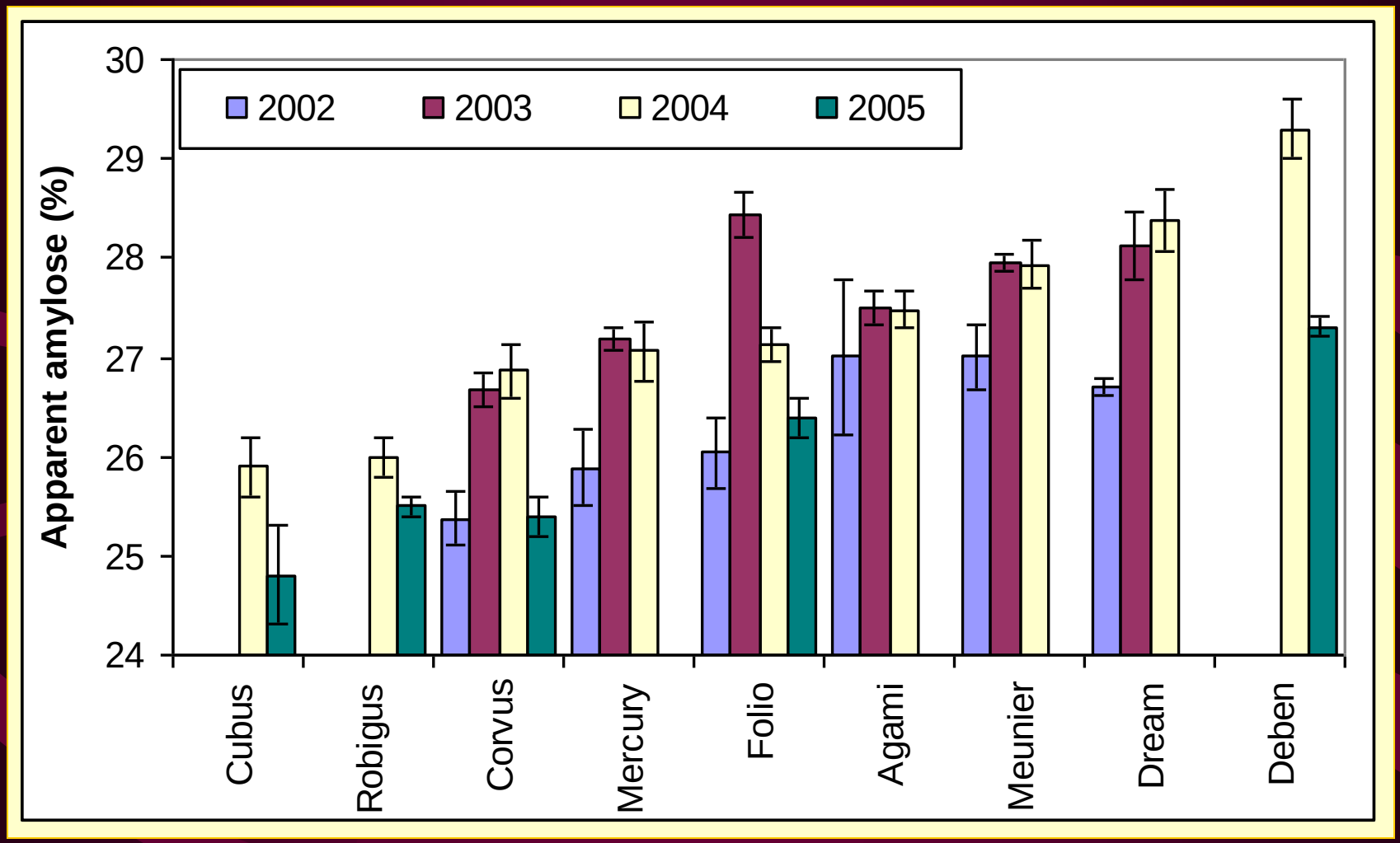


Amylose content : minimal, mean and maximal values, harvests 2002–2005



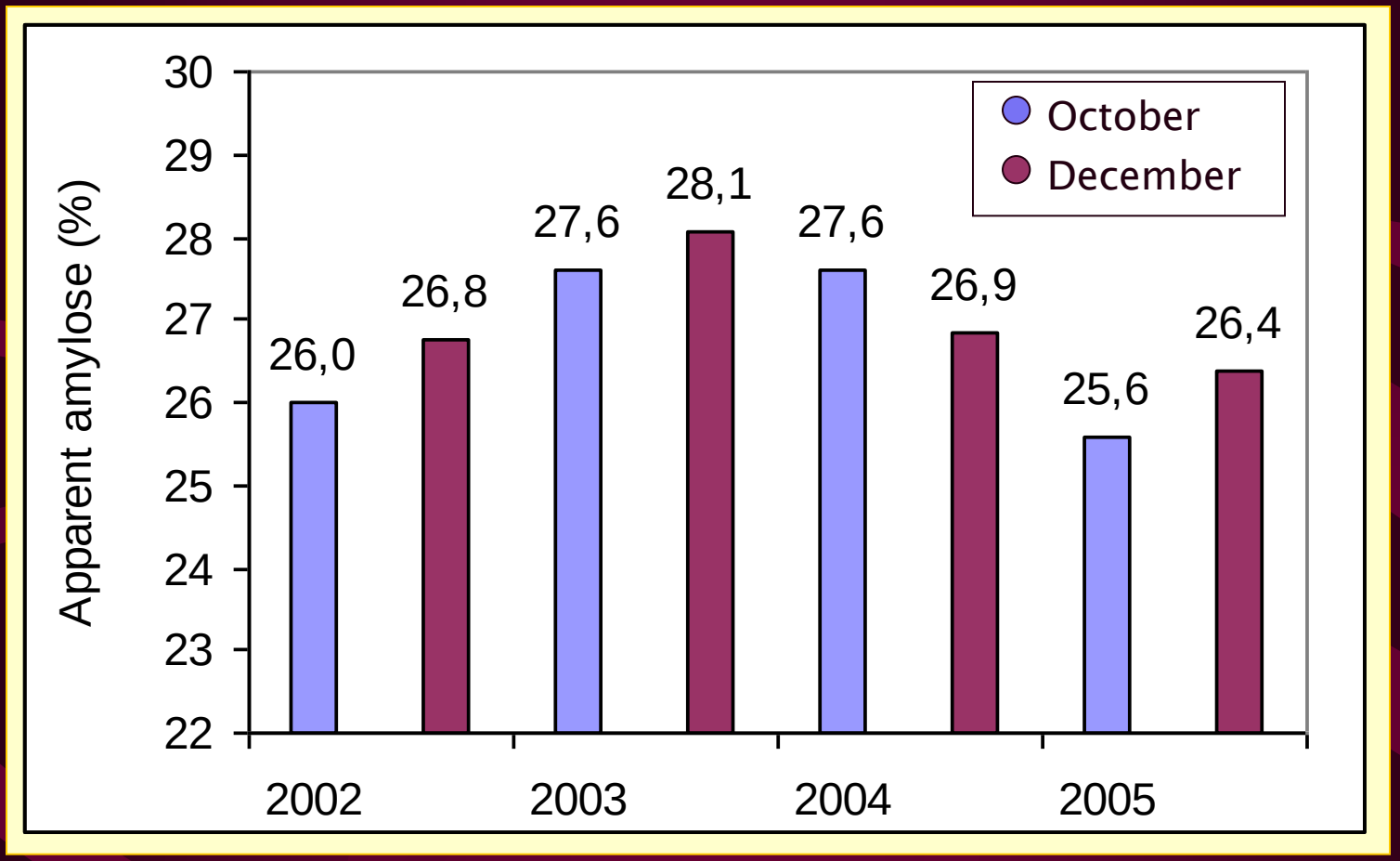
Maximum variations : 2–4% of the apparent amylose

Amylose / amylopectin (harvests 2002-2005)



2002 et 2005 : lower apparent amylose content

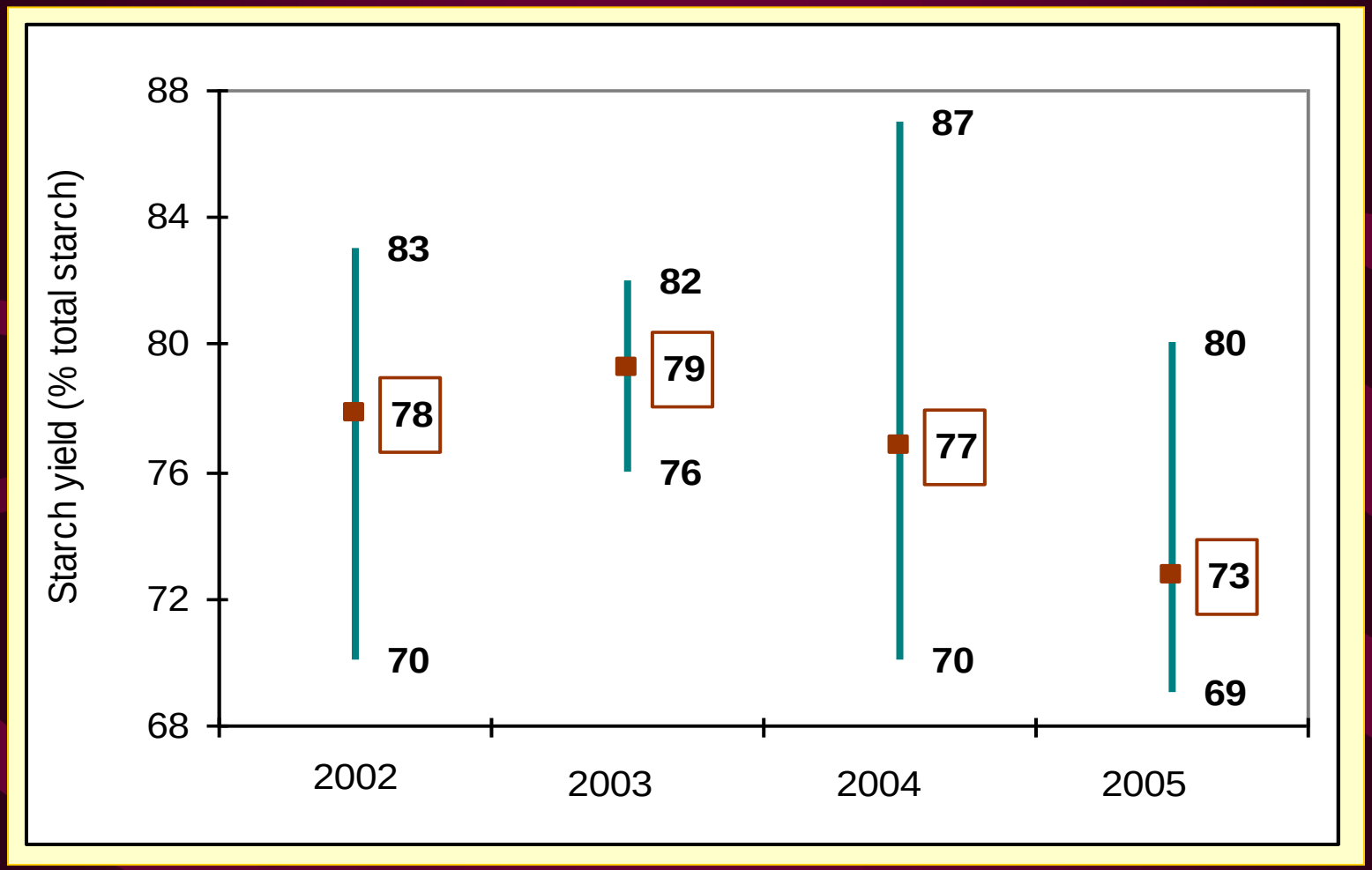
Amylose / amylopectin (harvests 2002–2005) : means of the varieties under study



Amylose content : October < December (2002, 2003, 2005)

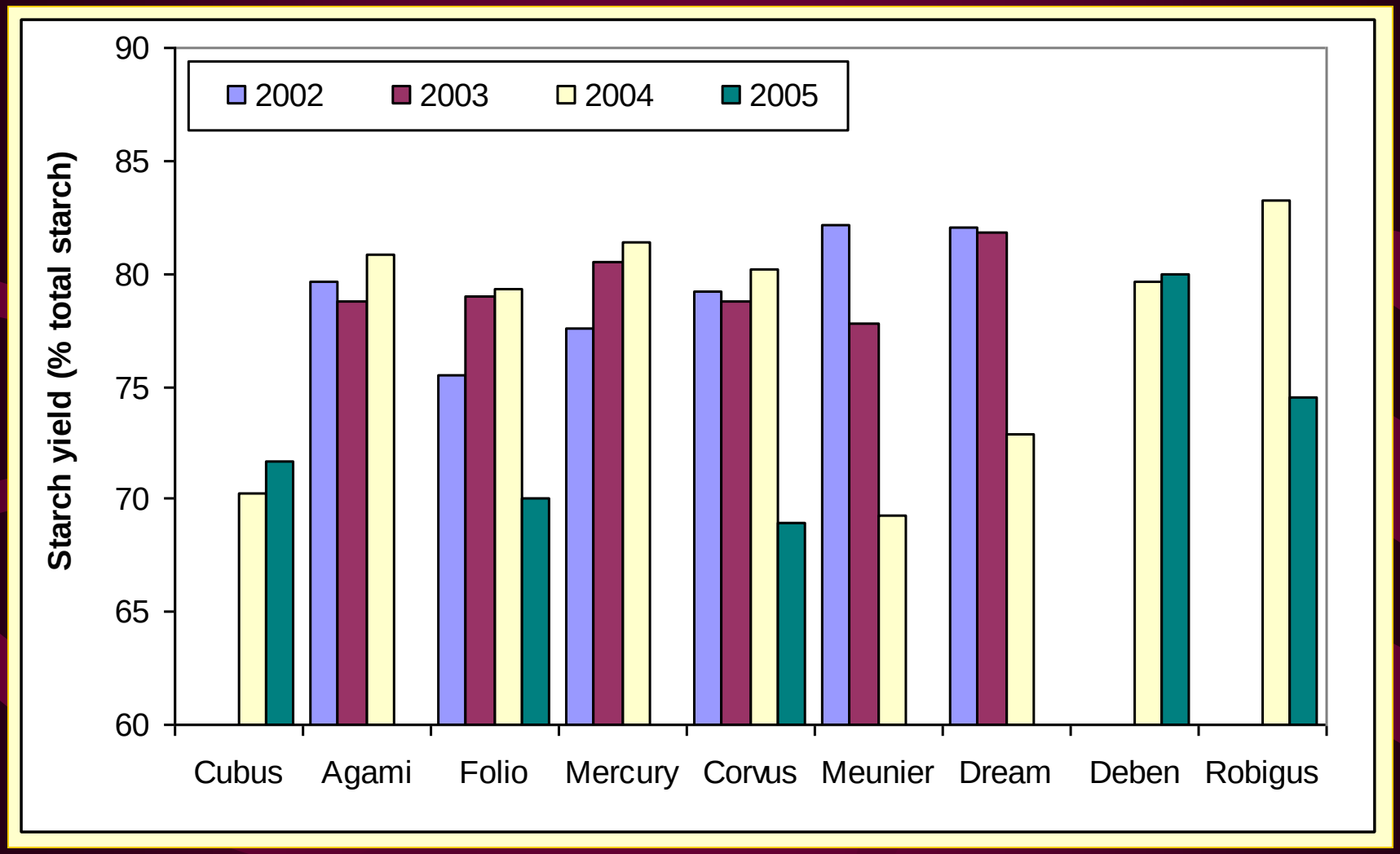
(⇔ associated with higher A-granules content in December starches)

Starch yield (% starch) : minimal, mean and maximal values, harvests 2002-2005

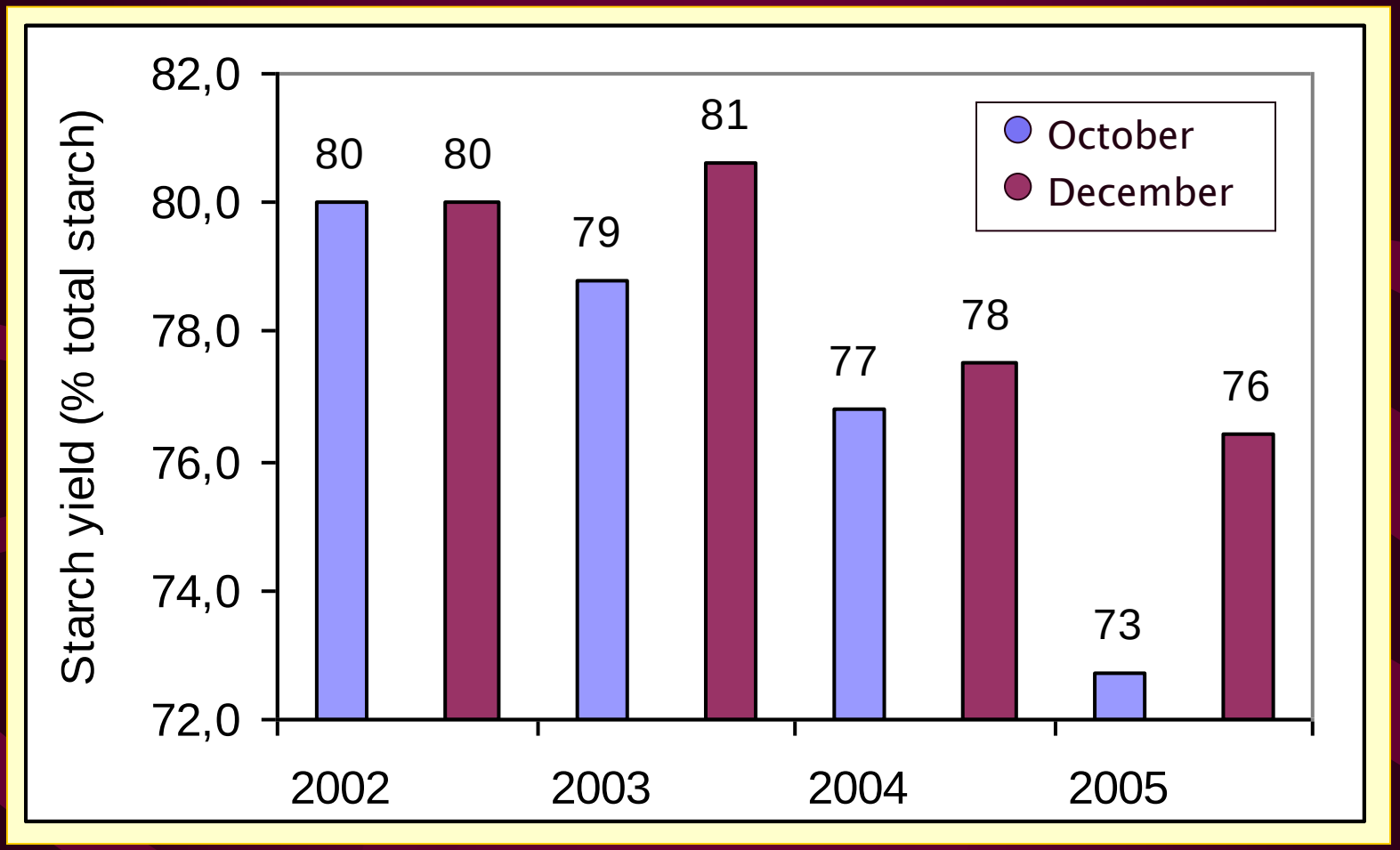


Maximum variations : 6 to 17 % of the total starch

Starch yield (harvests 2002–2005)



Starch yield (harvests 2002–2005) : means of studied varieties

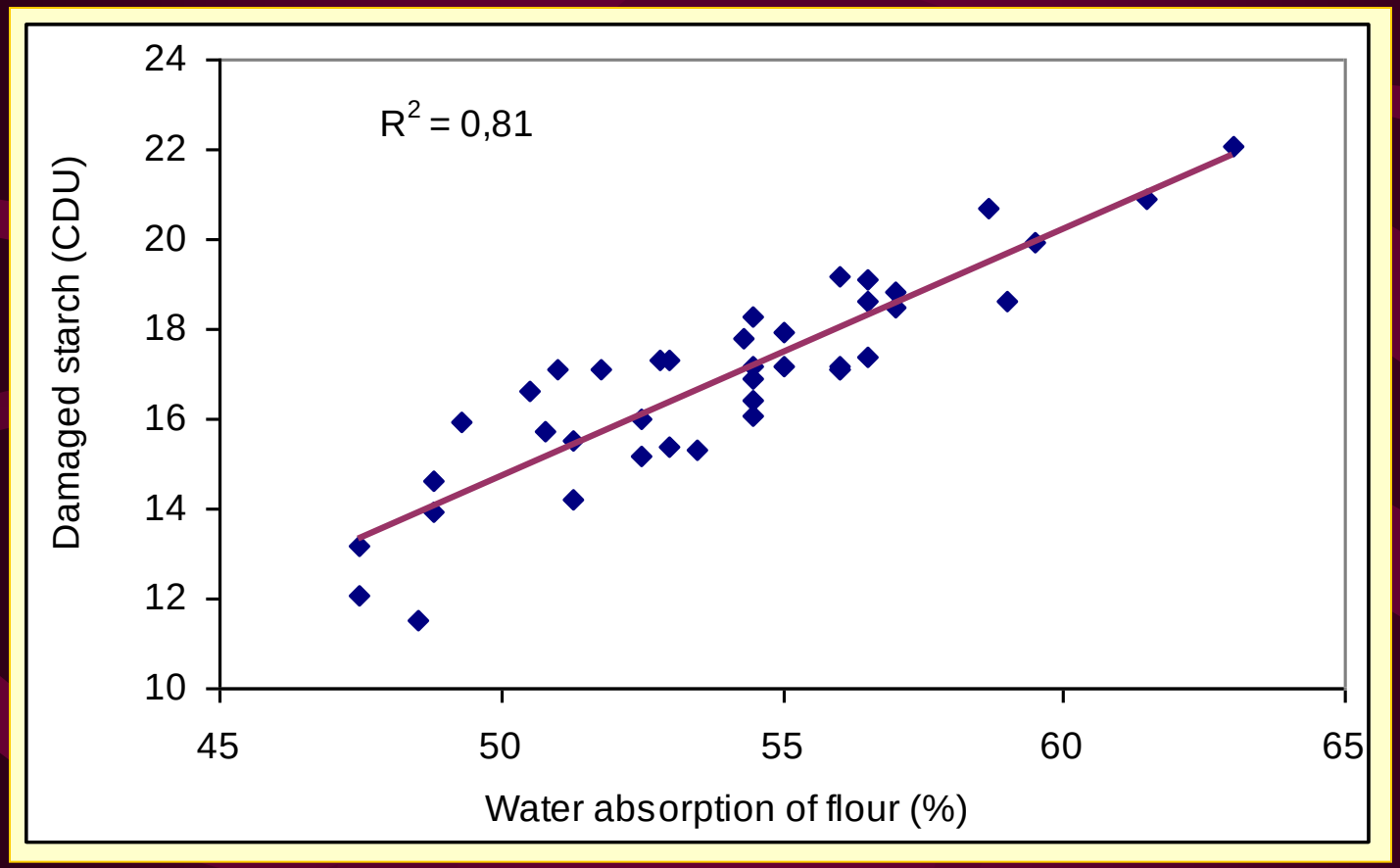


Yield values similar in October and December (except in 2005)

Starch damaged

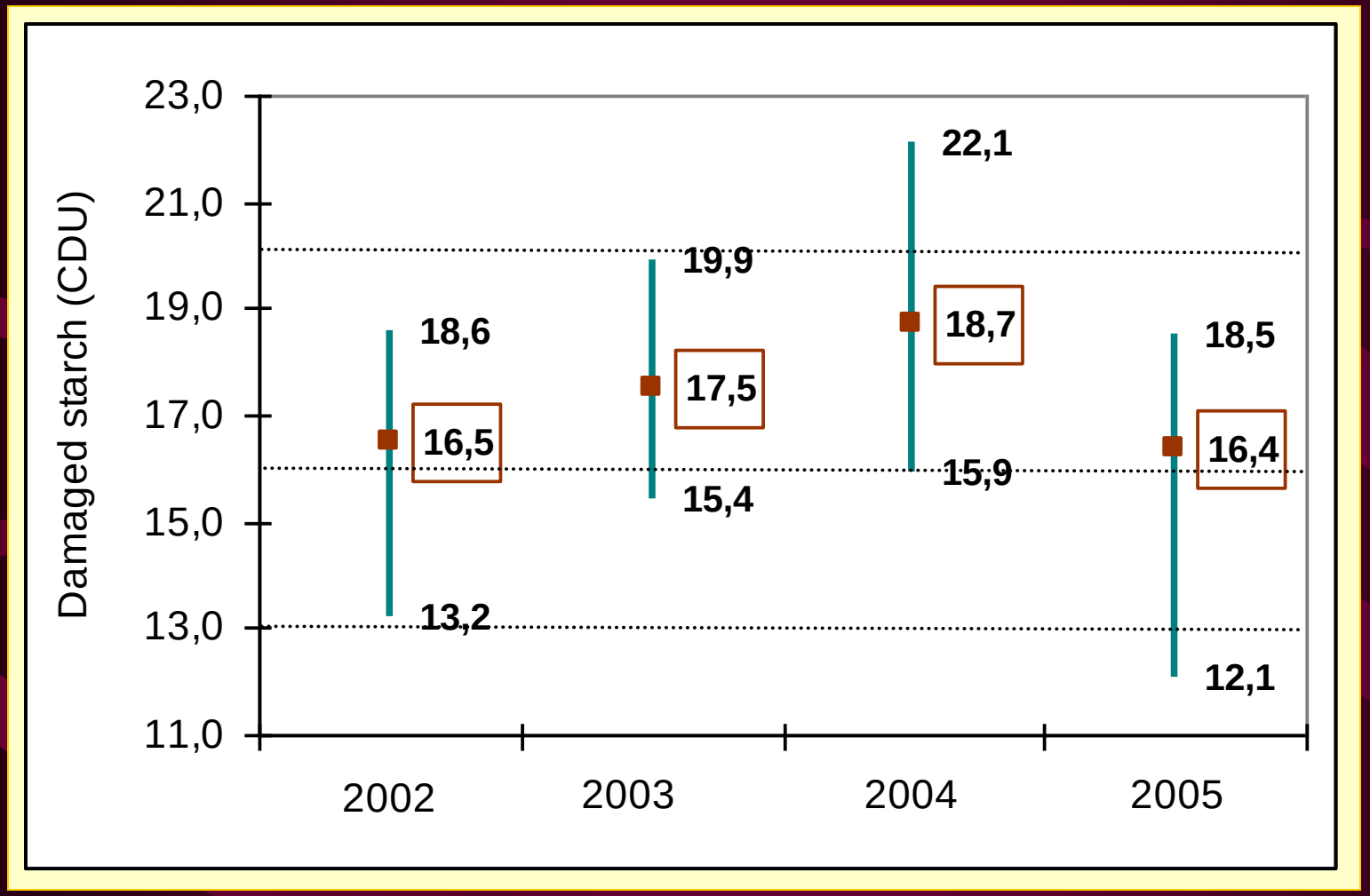
A higher damaged starch is

- correlated with a higher water absorption of flours
- more sensitive to enzymatic hydrolysis



Varieties from harvests 2002-2005

Starch Damaged : minimal, mean and maximal values, harvests 2002-2005

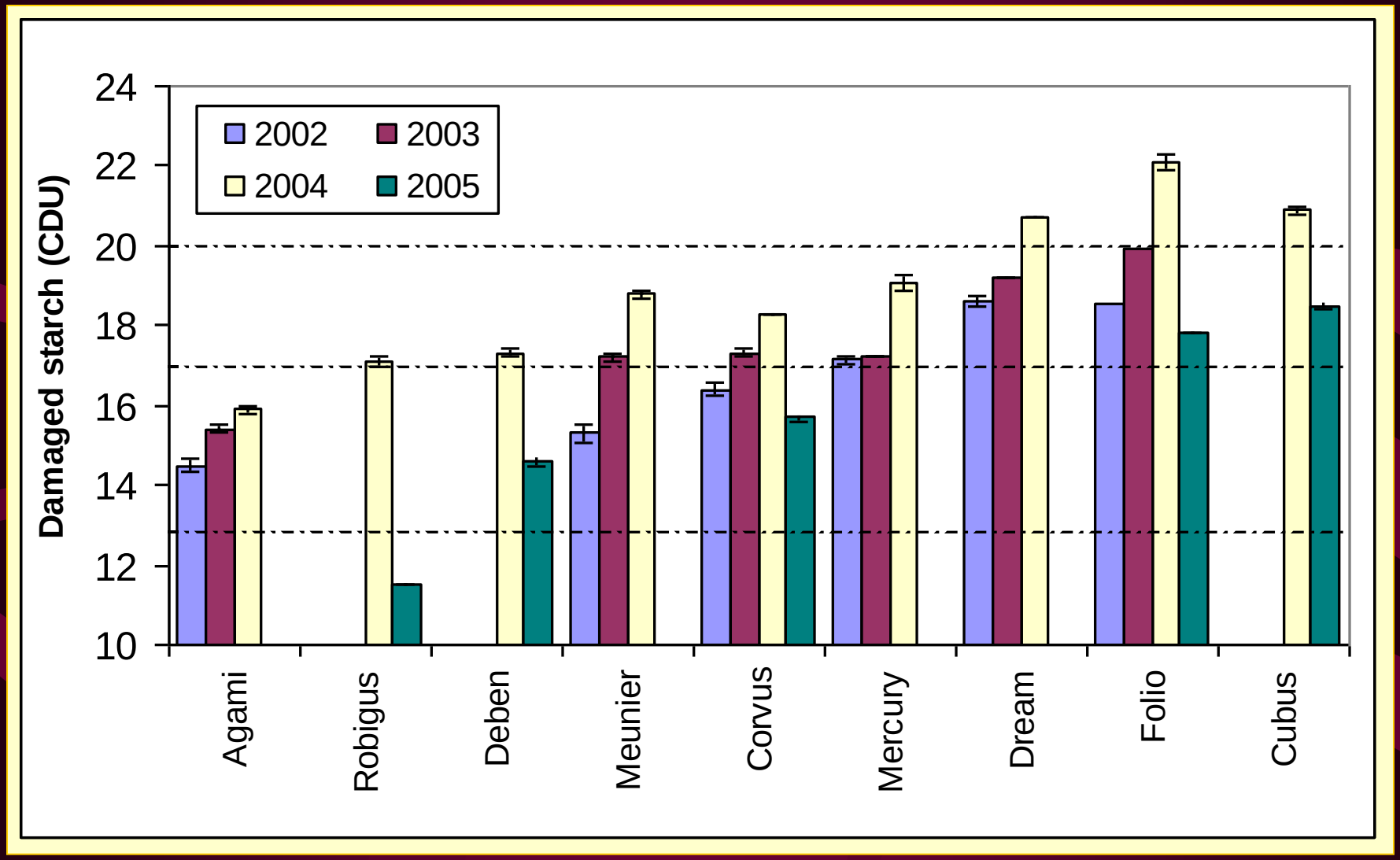


Very high

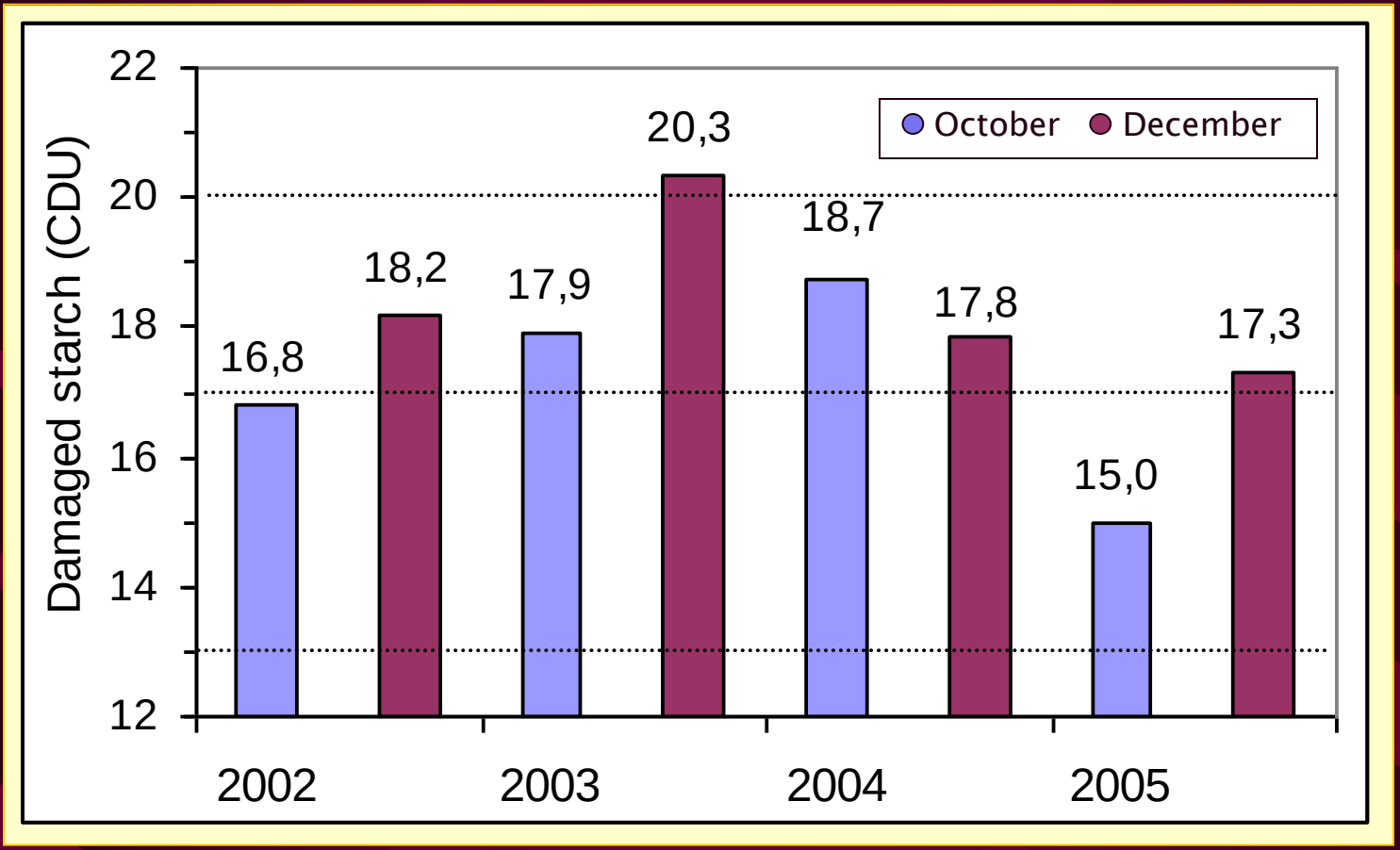
Weak

Maximum variations : 5 to 6 CDU

Starch damaged (harvests 2002–2005)



Starch Damage (harvests 2002-2005) : means of studied varieties



Starch damaged : october< december (2002, 2003, 2005)

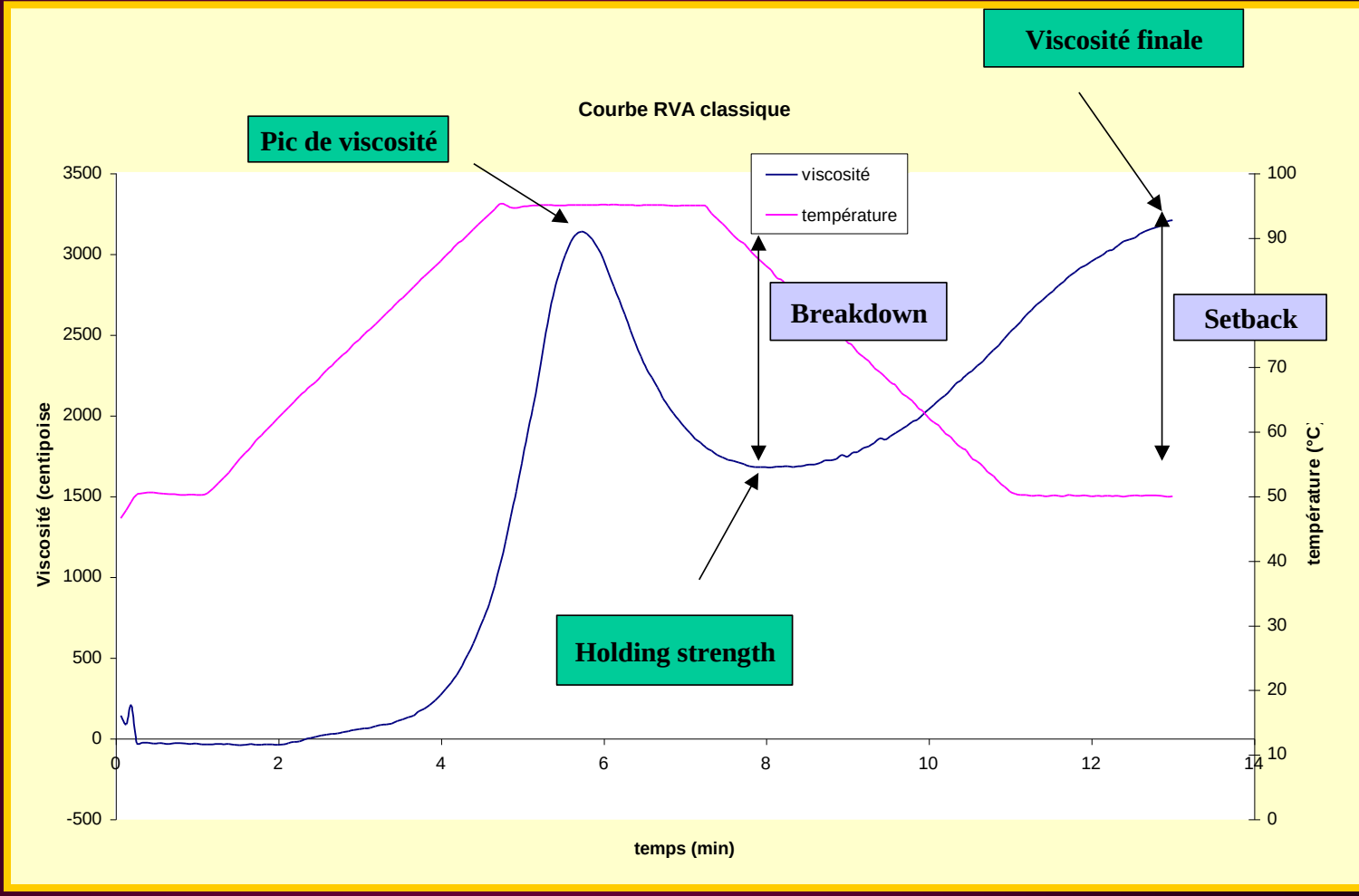
(associated with higher A-granules and amylose contents in starches from December seedlings)

Viscosity of starch and ground wheats

RVA (Newport), ICC method N°162

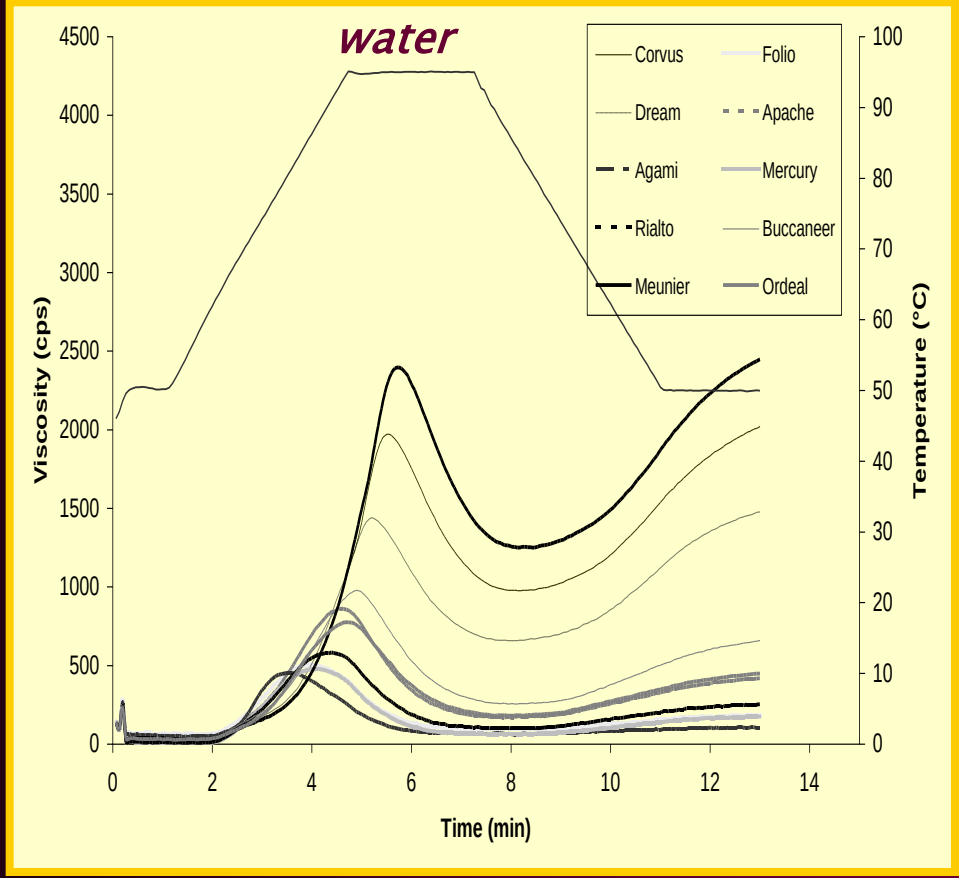
Time of analysis :

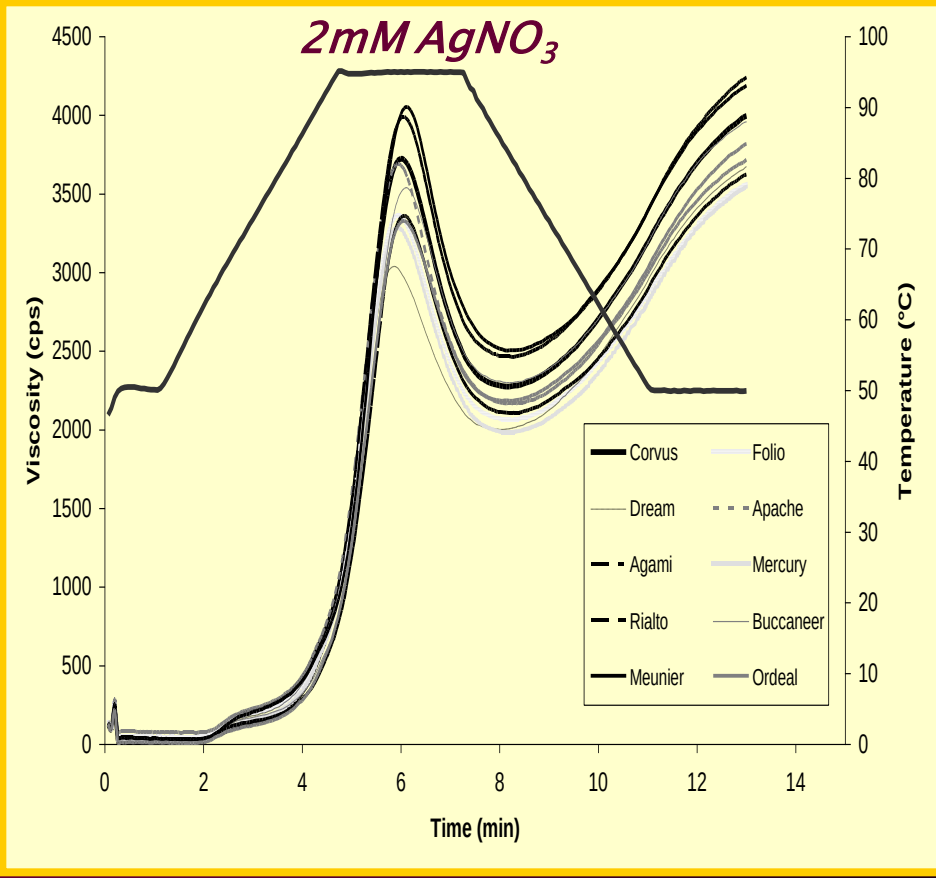
13 minutes



Viscosity properties

Dissociating the enzymatic and the starch contribution to viscosity
(starch, ground wheat)

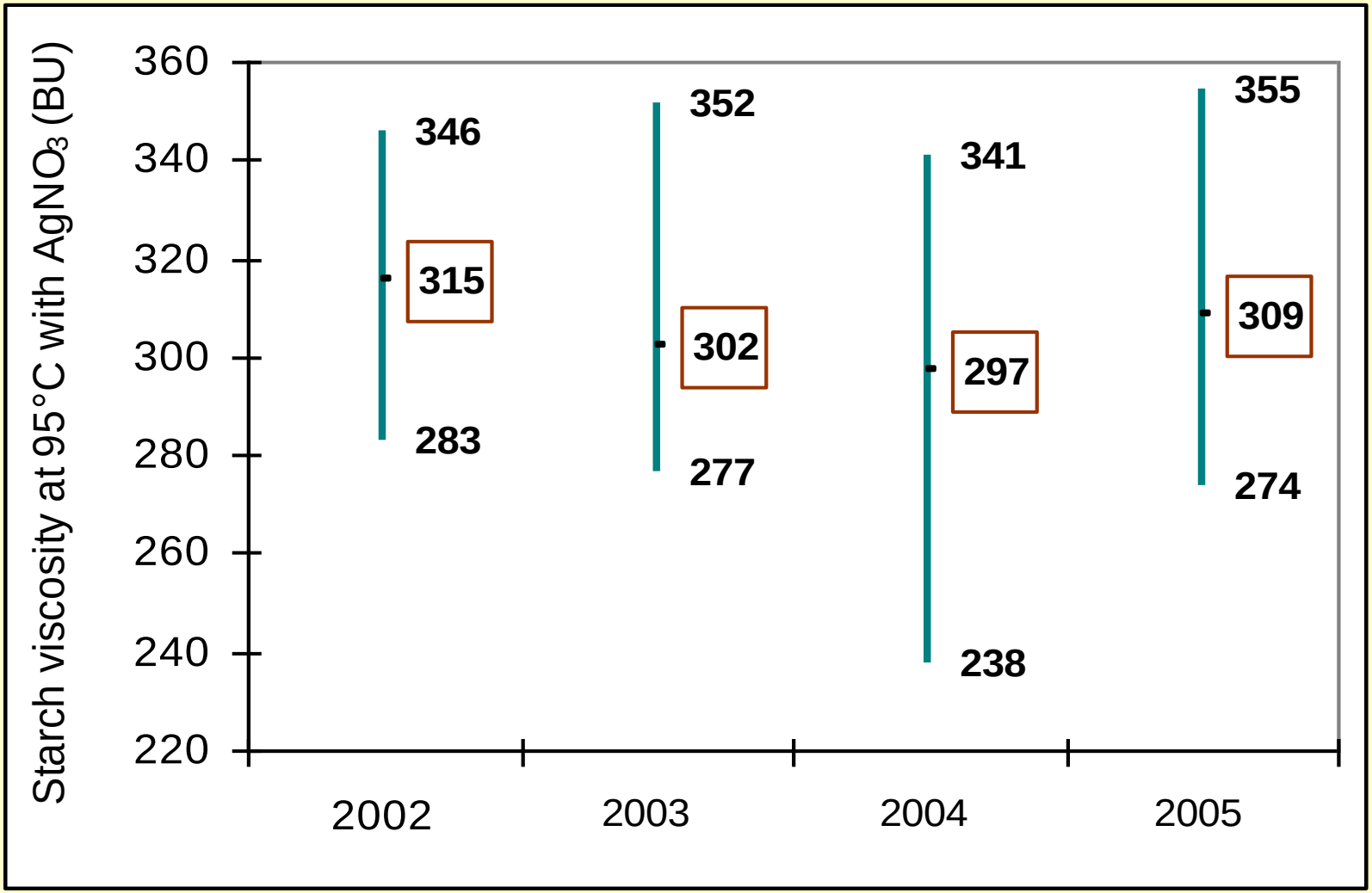




Brabender Micro-visco amylograph

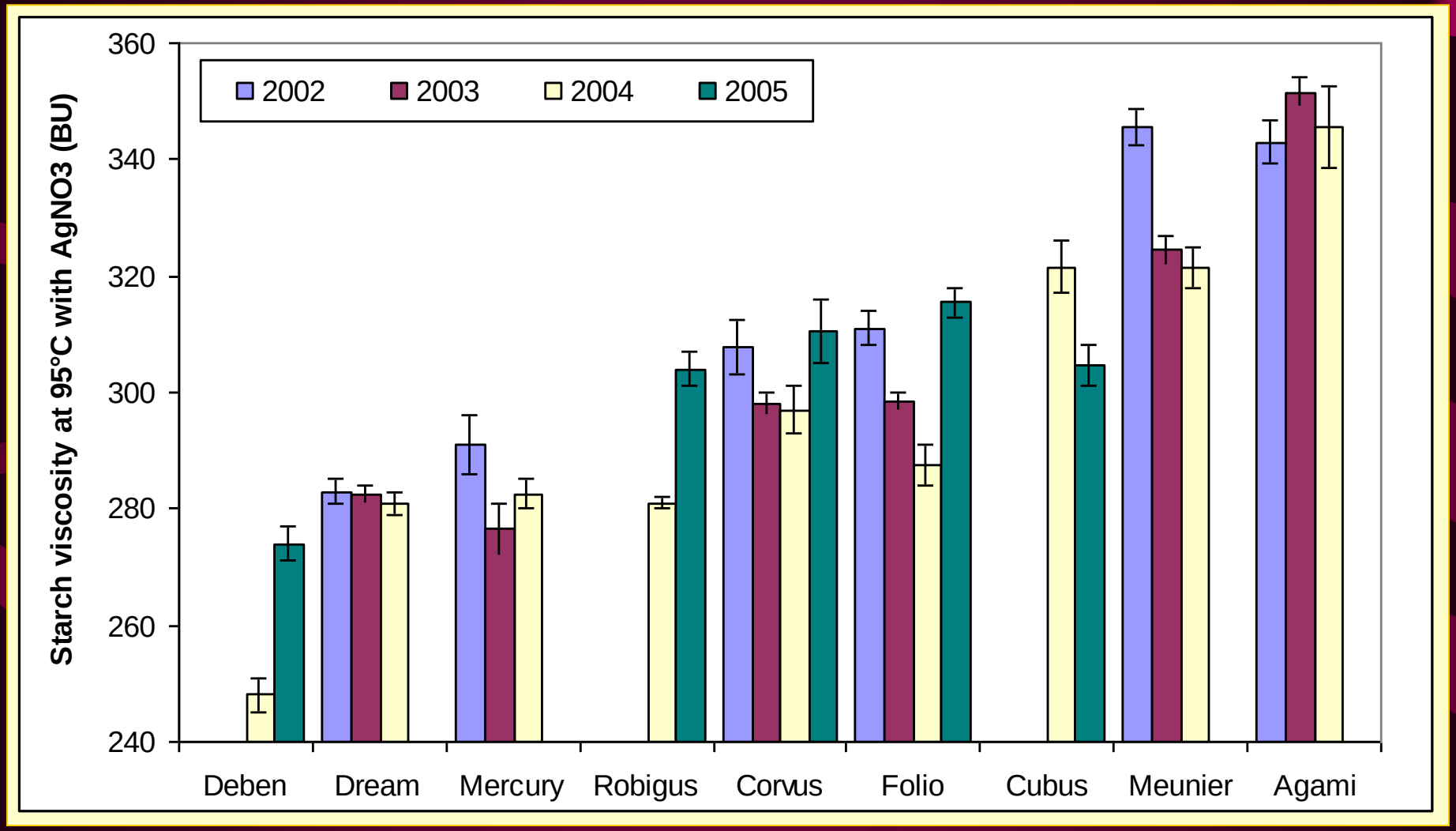
Newport Rapid Visco Analyser

Starch: Pic of viscosity at 95°C (with $AgNO_3$) : minimal, mean and maximal values, harvests 2002-2005

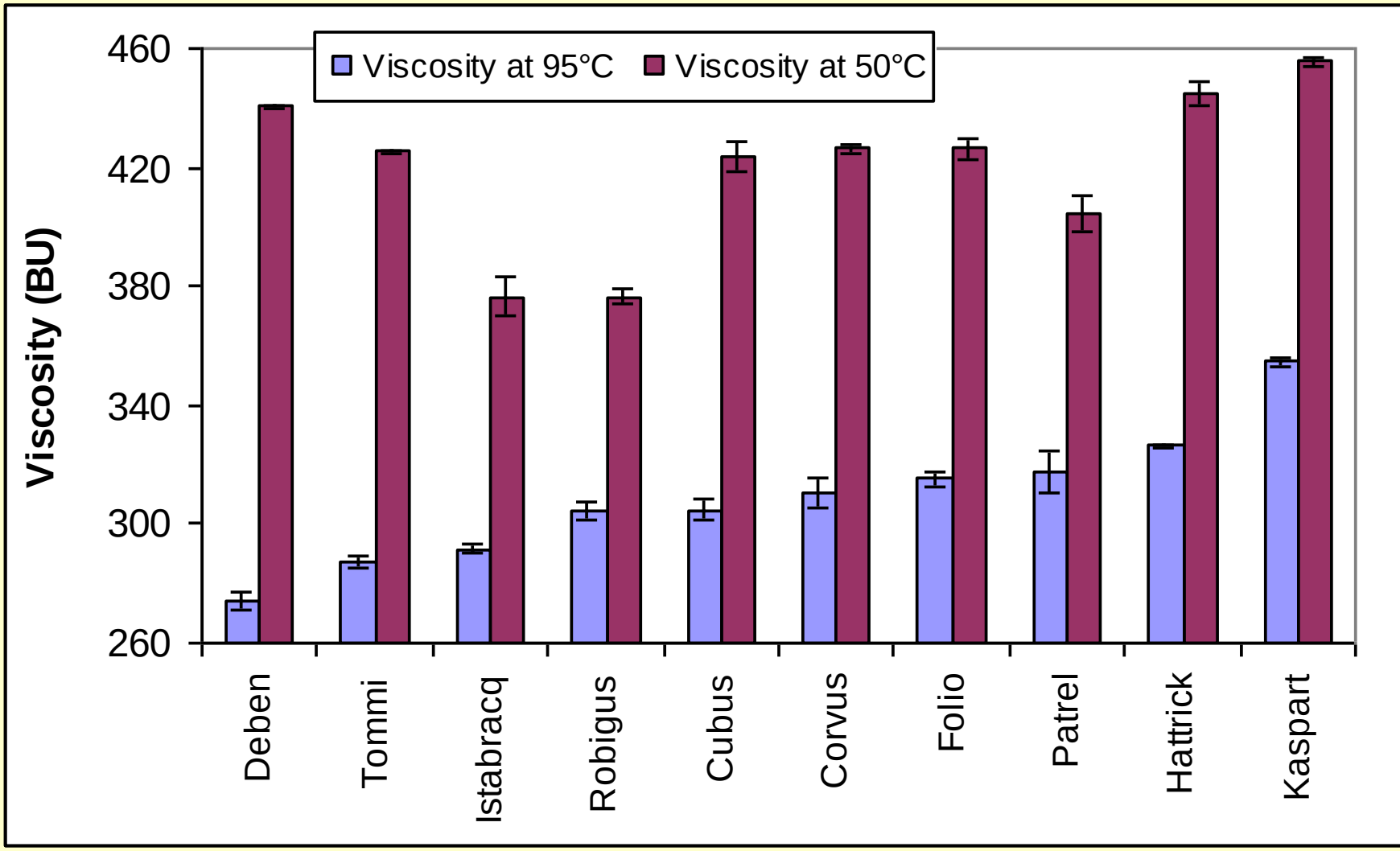


Maximum variations at 95°C : 60 to 100 BU

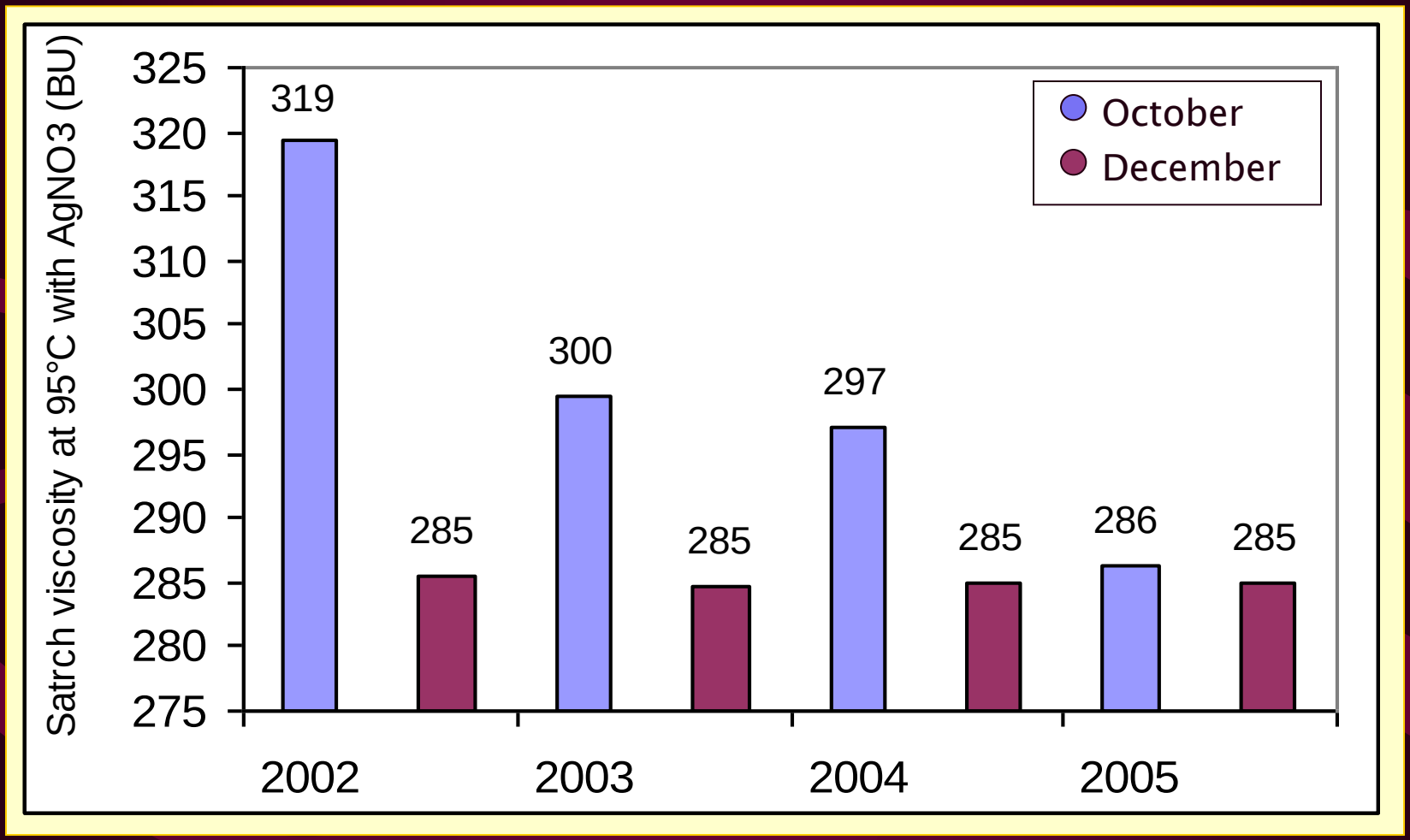
Starch pic of viscosity at 95°C (with $AgNO_3$) harvests 2002 to 2005



Starch pic of viscosities at 95°C and final viscosity at 50°C (with $AgNO_3$) harvest 2005

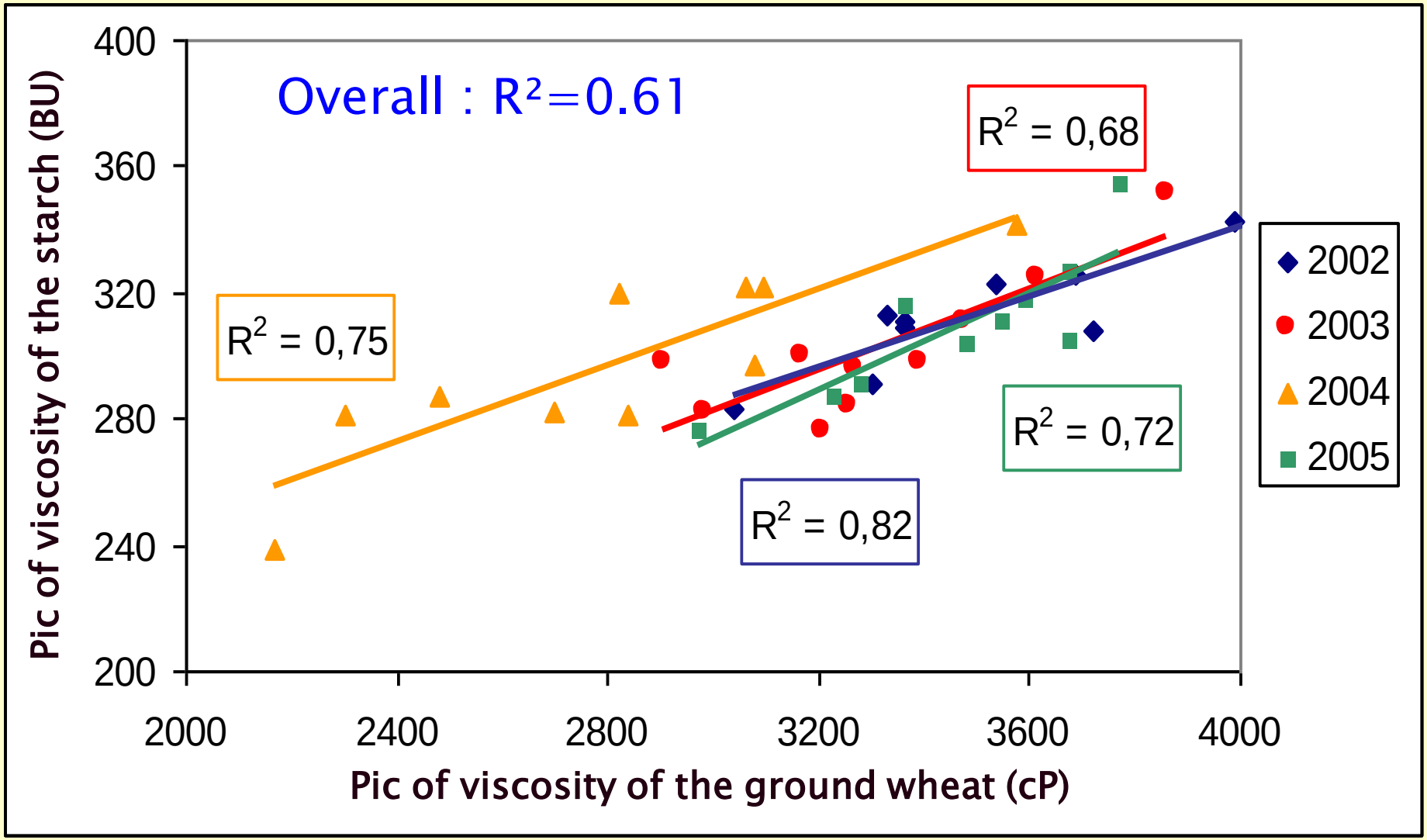


Starch : pic of viscosity at 95°C (with $AgNO_3$) : mean values for the varieties under study (harvest 2002 to 2005)



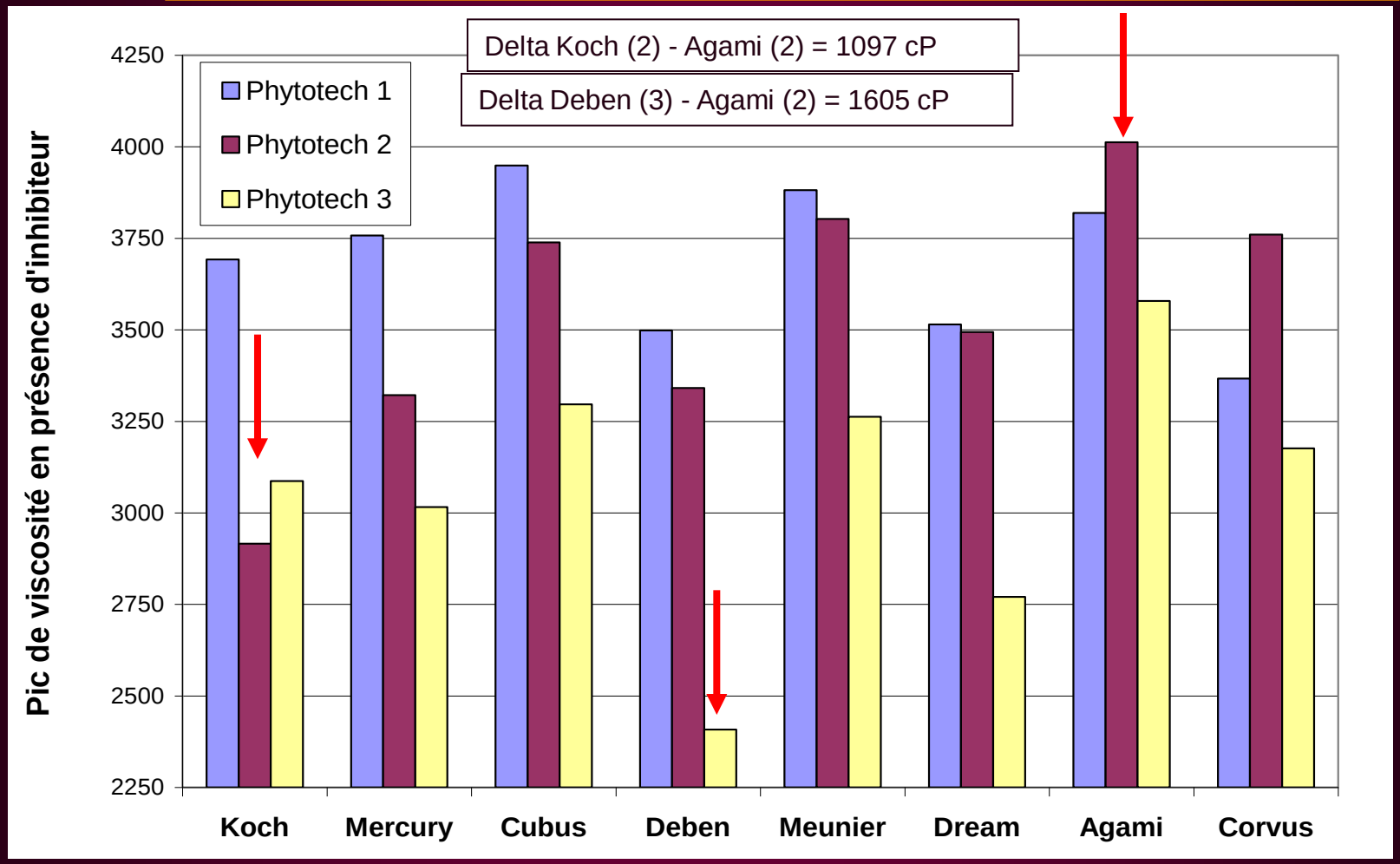
October > December

Correlations between the pic of viscosity at 95°C (with $AgNO_3$) measured on ground wheat and on the corresponding starch (harvest 2002 to 2005)



Combined effects of the phytotechny on the pic of viscosity (95°C) ground wheats

Phyto 1 : October seedlings, No fungicide, N fertilisation : 50-60-0
Phyto 2: October seedlings, fungicide, N fertilisation: 50-60-75
Phyto 3: December seedlings, fungicide, N fertilisation: 0-60-155



Enzymatic effects (alpha-amylase activities)

- Indirect methods

  Hagberg Falling Number

  Rapid Visco Analyser (ICC method N°162)

- Direct methods for AAA

  Ceralpha Method (Megazyme, ICC N°303)

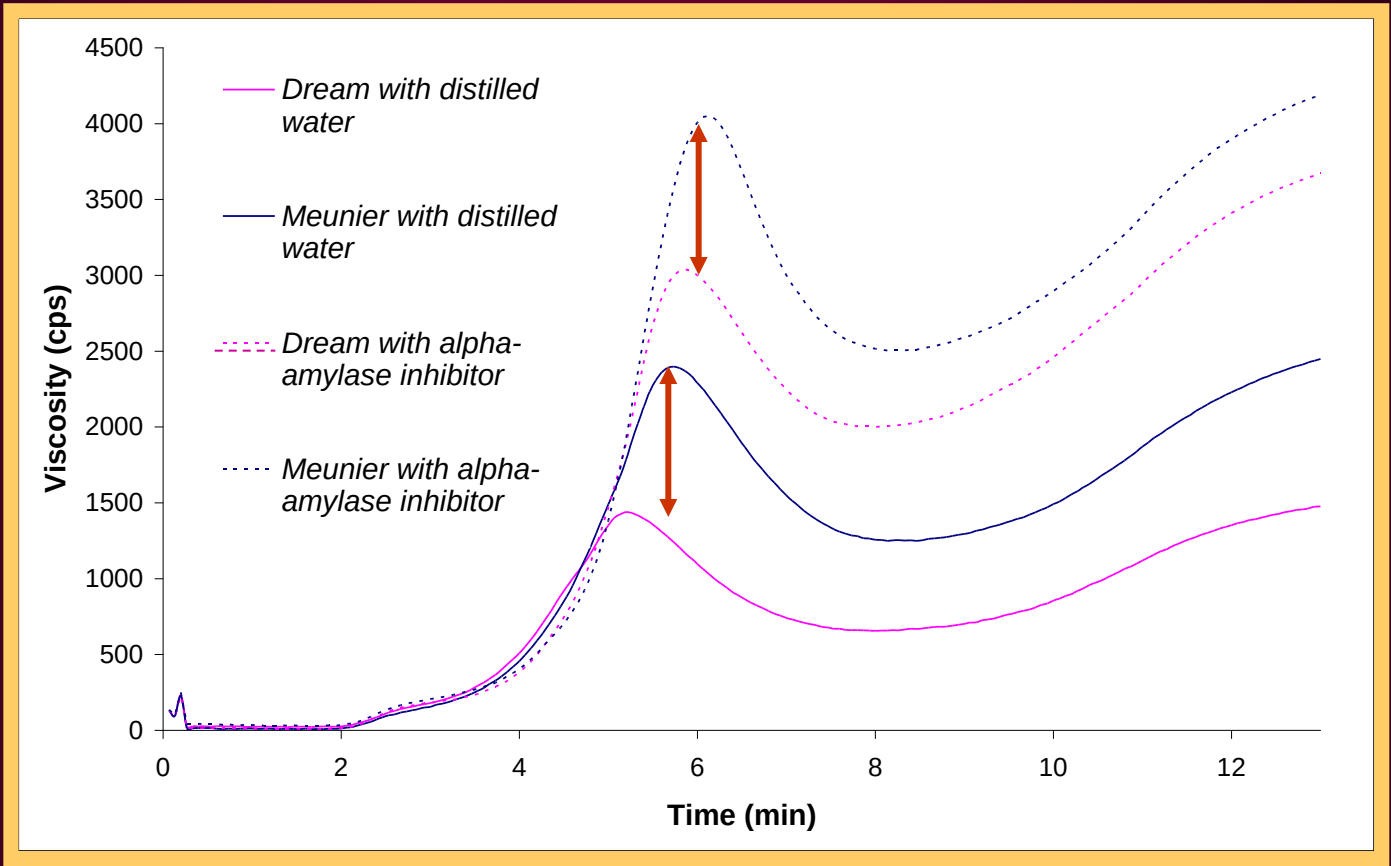
  Amylazyme Method (Megazyme, AACC 22.05)

Endogenous enzymes

2 contribution : the starch, the enzymes

RVA (water- 2 mM $AgNO_3$)

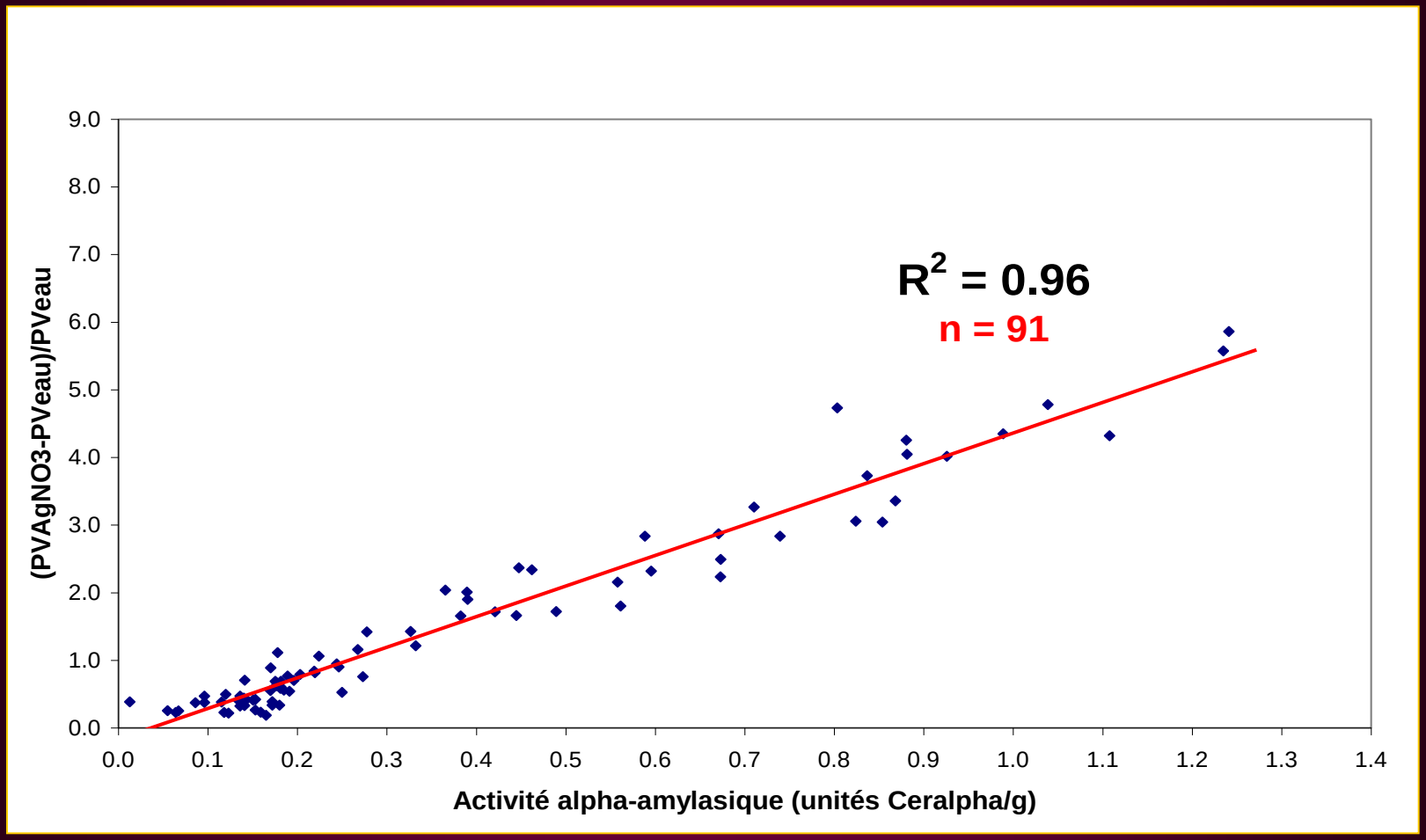
2 varieties with similar AAA



Endogenous enzymes

Ground wheats from 2002 to 2005

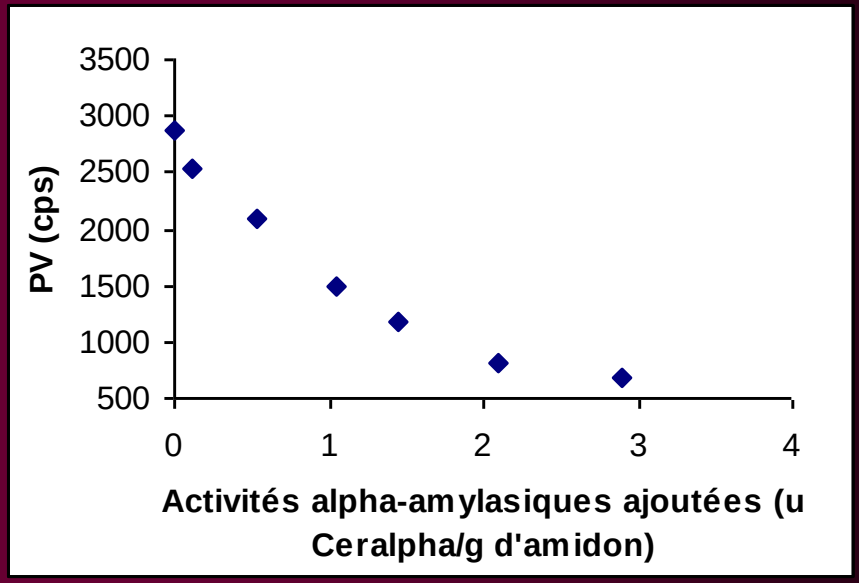
(PV AgNO3- PV water)/PV water VS AAA ceralpha



Starch sensitivity to enzymatic hydrolysis

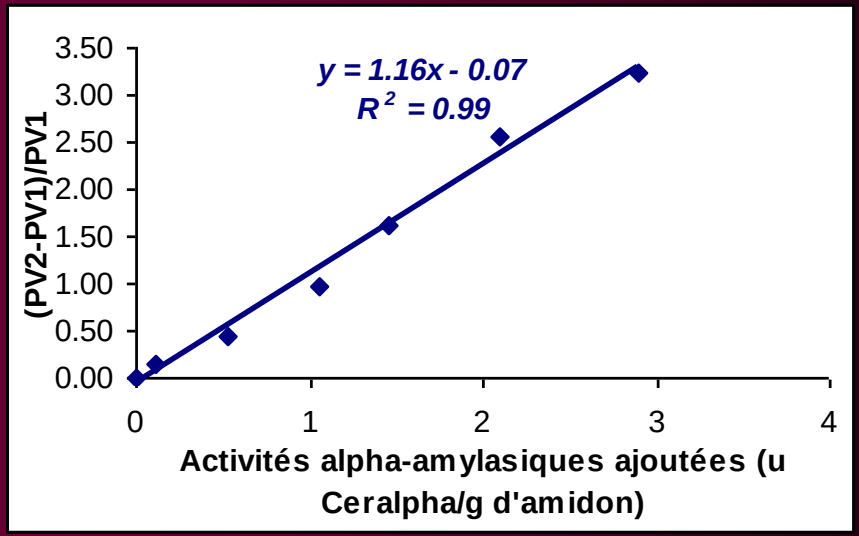
Addition of growing activities of an amylase from *Bacillus sp.*

- Pic of viscosity vs added activities



- Linearisation by using pic ratios

$(PV_{intial} - PV_{after\ adding\ AA}) / PV_{after\ adding\ AA}$



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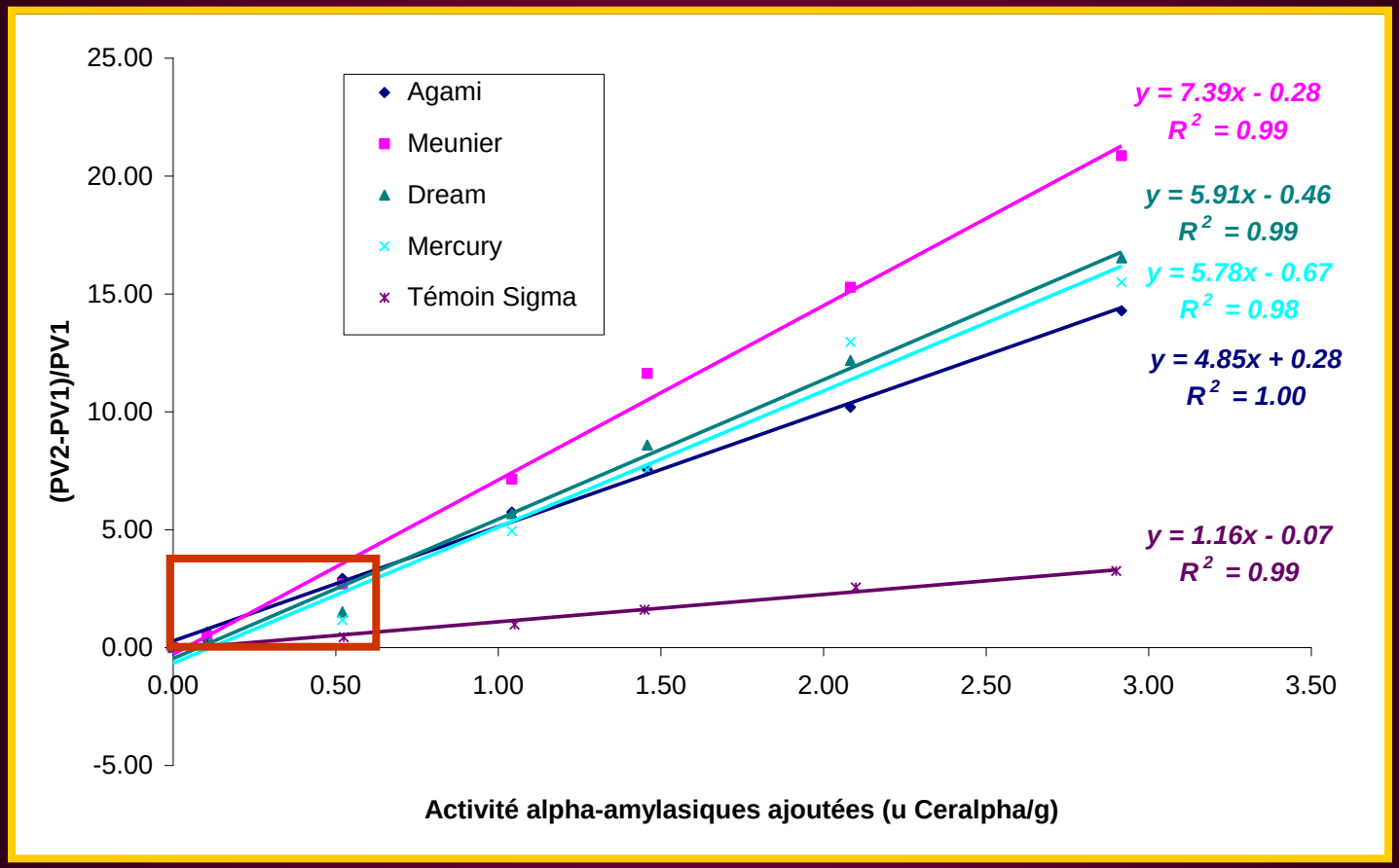


Slope of the regression = sensitivity to enzymes

Conclusions and futher prospects

There is a variability in the intrinsic properties of starch
We may not neglect it négligeable !!!

- Genetic and phytotechny have an influence on the caracteristics of the ground wheat and the corresponding starches
- Major influence of the harvest years
- Variety is of a major concern
- It can be reinforced by the phytotechny

Goal : Orientation of wheat lots according to the applications

Many thanks for your attention

Composante amidon: résultats obtenus

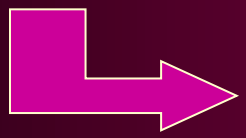
- Influence importante de la variété et de la date de semis sur les propriétés intrinsèques et techno-fonctionnelles de l'amidon
- Relations entre les caractéristiques intrinsèques de l'amidon et ses propriétés de viscosité
- Relations entre les propriétés de viscosité des moutures intégrales et celles des amidons
- Méthode d'extraction de l'amidon à l'échelle du laboratoire et à l'échelle semi-pilote

Composante enzymatique

Alternative à l'indice de chute de Hagberg : conclusions

- Double protocole : estimation précise et rapide de l'AAA endogène des moutures intégrales
- Multiples informations : AAA et propriétés intrinsèques de gélification
- Valider le principe sur les farines blanches (augmenter la base de données) et les amidons extraits (adapter la méthode de dosage spectrophotométrique)

- N'intègre pas les aspects « cinétique d'hydrolyse/liquéfaction » càd que la méthode considère que les amidons ont la même sensibilité à la hydrolyse enzymatique



Investigation de cette sensibilité

Composante enzymatique

Investigation de la sensibilité des amidons à l'hydrolyse enzymatique

2 aspects

Etude de la liquéfaction des amidons (Ajouts croissants d'AAA)

- Mesures viscosimétriques
- Applications : filière meunerie-boulangerie, IAA utilisatrices des amidons pour propriétés de texture
- En relation avec composition et structure de l'amidon

Etude de la cinétique d'hydrolyse partielle et complète des amidons

- Applications : Production de sirop de glucose (Amidonnerie) et bioéthanol
- En relation avec composition et structure de l'amidon