

**IV Workshop Internacional**  
**Bases ecofisiológicas y genéticas para mejorar el rendimiento y la calidad en trigo y cebada**

# Bases fisiológicas de la generación de calidad en trigo. Impacto de las altas temperaturas

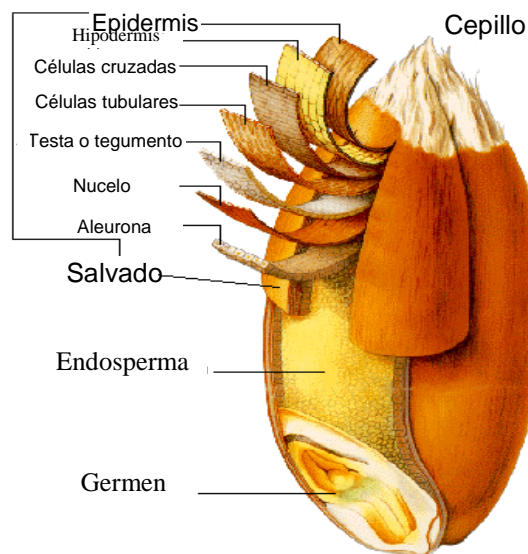
*Roxana Savin*



## Dónde y cómo se acumulan las reservas ?

Fruto: Cariopse  
Fertilización del óvulo

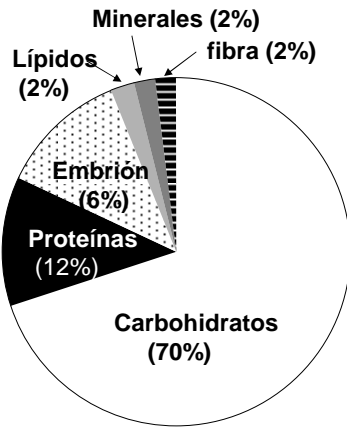
Endosperma      Embrión



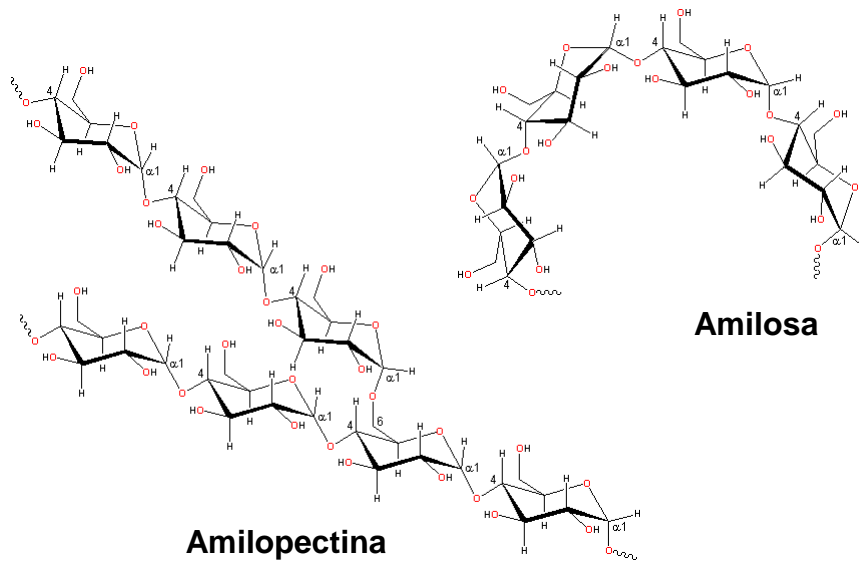
**Peso promedio 30-45 mg**



# Trigo



## Almidón: Amilosa + Amilopectina (20-30%) (70-80%)



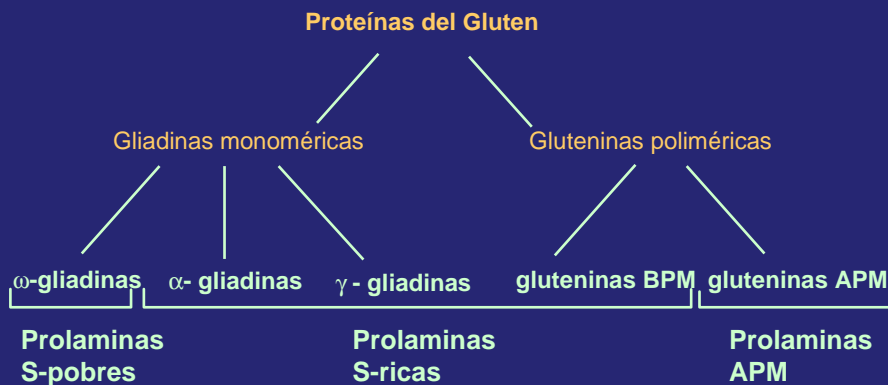
Clasificación de las proteínas } solubilidad  
 } tamaño  
 } secuencia de AA

**Clasificación de Osborne (1907)**

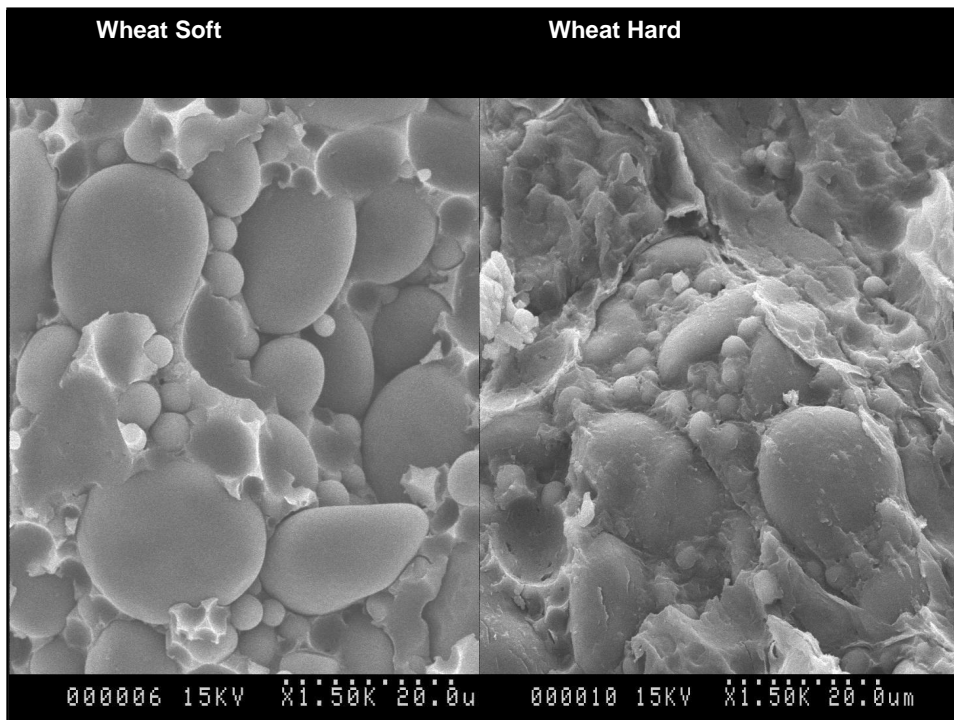
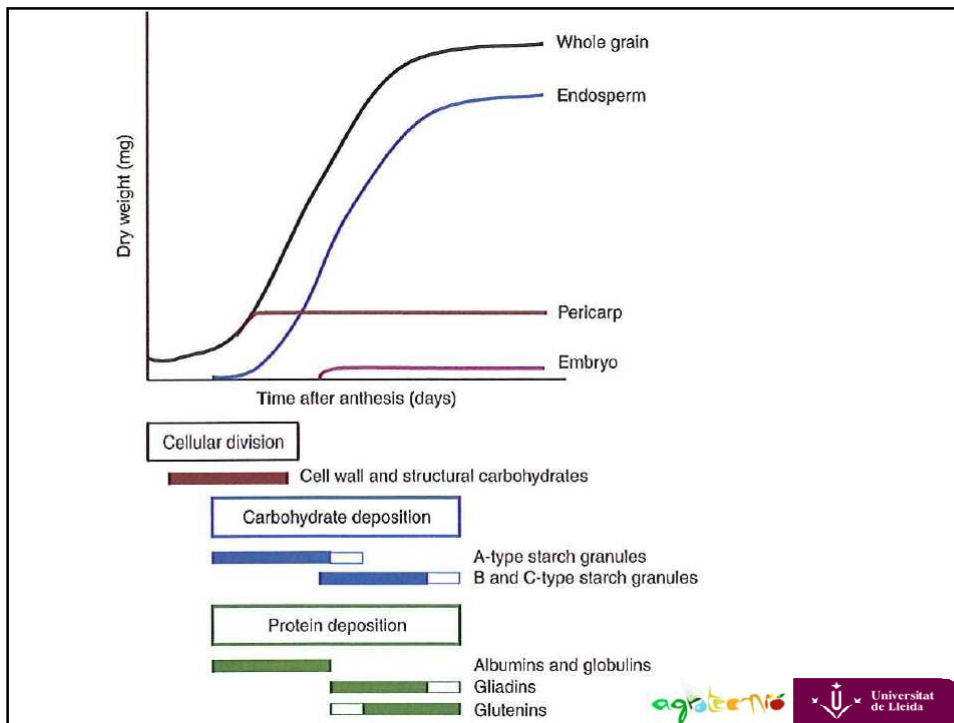
- agua: **ALBUMINAS**
- sc. salina: **GLOBULINAS**
- alcohol-agua: **PROLAMINAS (o GLIADINAS)**
- ac. o alcali: **GLUTELINAS (o GLUTENINAS)**

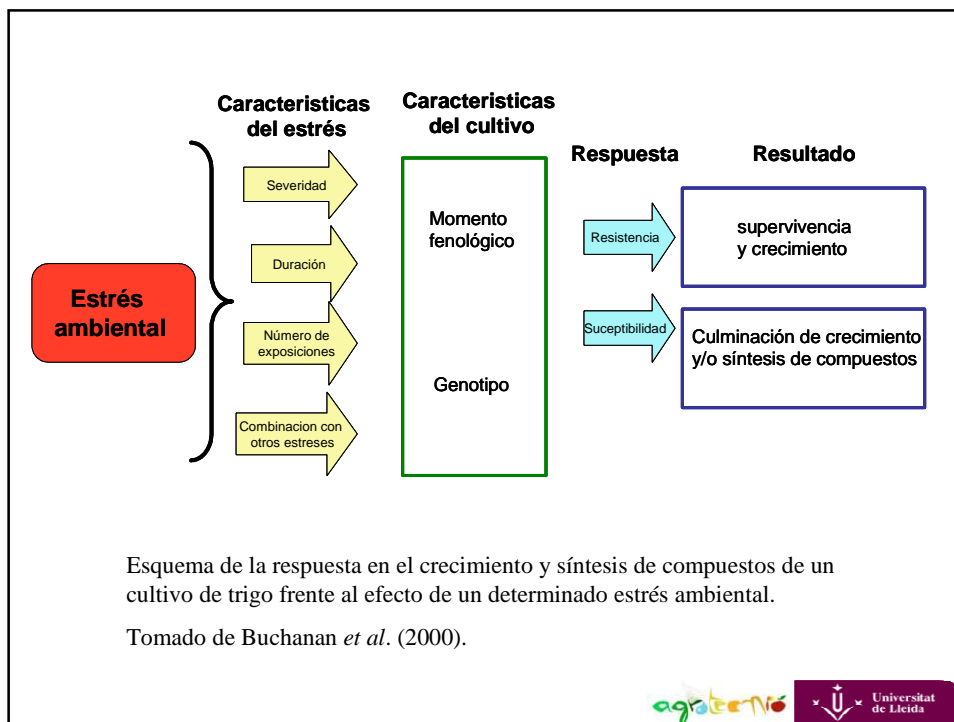
En general, las prolaminas y glutelinas son las proteínas de reserva en cereales y las globulinas son las proteínas de reserva en las dicotiledóneas

**Clasificación convencional y molecular de las proteínas del gluten**



· Hay miles de posibles combinaciones de gliadinas y gluteninas en una variedad de trigo  
 · Estas diferencias son la causa de que la calidad entre variedades pueda diferir ampliamente





**Table 1. Estimates of the effect of high temperature following anthesis on kernel weight in wheat**

Reference (Country)	Temperature range (°C)	Fall in kernel weight per 1°C rise in temperature (mg)	(%)
<b>(A) Field trials (Time of planting)</b>			
Chinoy 1947 (India)	17–28	1.65	4.1
Beech and Norman 1966 (Aust.)	23–31	1.63	4.0
Marcellos and Single 1972 (Aust.)	17–23	–	6.0
Wiegand and Cuellar 1981 (USA)	16–26	3.00	7.5
McDonald <i>et al.</i> 1983 (Aust.)	14–27	1.46	3.6
Saini and Dadhwal 1986 (India)	13–27	1.99	4.3
Shpiler and Blum 1986 (Israel)	16–23	0.71	1.8
Stapper and Fischer 1990 (Aust.)	14–21	–	5.0
Cooper 1992 (Aust.)	16–21	2.23	5.5
<b>(B) Controlled environment studies</b>			
Hsia <i>et al.</i> 1963 (China)	18–23	1.18	3.9
Asana and Williams 1965 (Aust.)	17–24	1.45–1.73	2.7–3.6
Spiertz 1974 (Netherlands)	15–25	1.70–1.90	2.7–3.5
Ford <i>et al.</i> 1976 (UK)	15–25	1.13	2.0
Warrington <i>et al.</i> 1977 (NZ)	13–23	2.0	2.9
Chowdhury and Wardlaw 1978 (Aust.)	12–24	1.17	2.0
Wardlaw <i>et al.</i> 1980 (Aust.)	18–27	2.22	4.0
Al-Khatib and Paulsen 1984 (USA)	22–32	0.85	2.8
Vos 1985 (Netherlands)	16–22	1.67	2.8
Skinnes and Buras 1987 (Norway)	12–21	0.94–1.55	1.4–2.7
Wardlaw <i>et al.</i> 1989 (Aust.)	15–27	1.63–2.78	3.2–5.2
Tashiro and Wardlaw 1989 (Aust.)	18–27	2.78	5.2

Reducción del rendimiento de c. 10%

Wardlaw & Wrigley (1994)  
AJPP 21: 695-703

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## ¿Qué son altas temperaturas?

- Moderadamente altas temperaturas (>15 a 32°C)  
Cambios en la tasa y duración de los procesos
- Breves períodos de altas temperaturas (>32 °C)  
Algunos procesos pueden retardarse y otros nuevos inducirse

AJPP 21 (1994)

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> Tasa y < Duración → < Peso

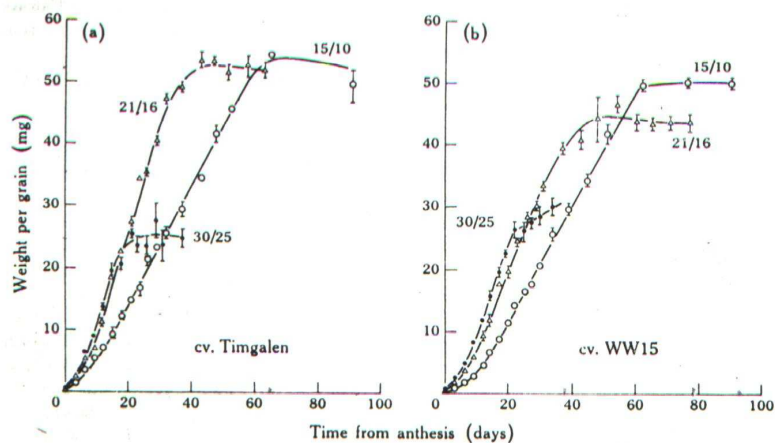
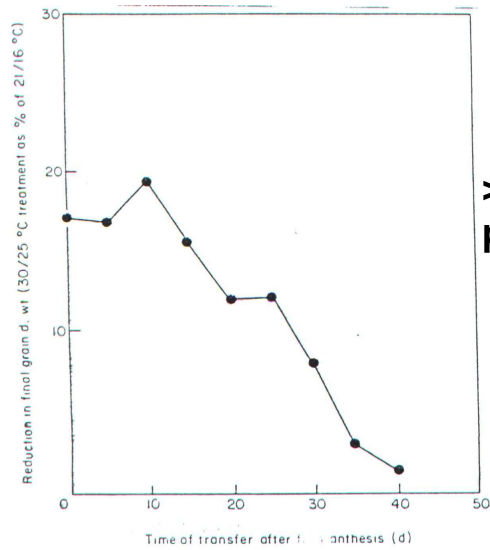


Fig. 1. Increase in dry weight of wheat grains as influenced by temperature after anthesis in experiment II: (a) first floret grains in the middle four spikelets of cv. Timgalen; (b) first floret grains in the middle four spikelets of cv. WW15. Vertical bars indicate the standard errors of the mean.

Sofield *et al.* (1977)  
AJPP 4:785-797

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>Reducción de peso 10-15 dda

Fig. 3. The percentage reduction in grain d. wt with a 10-d increase in temperature from 21/16 °C to 30/25 °C. (Expt 1) applied at various periods following anthesis. The data relate to floret 'a' grains from the four central spikelets in an ear and are expressed as a percentage of the control (21/16 °C) value at maturity.

Wardlaw *et al.*

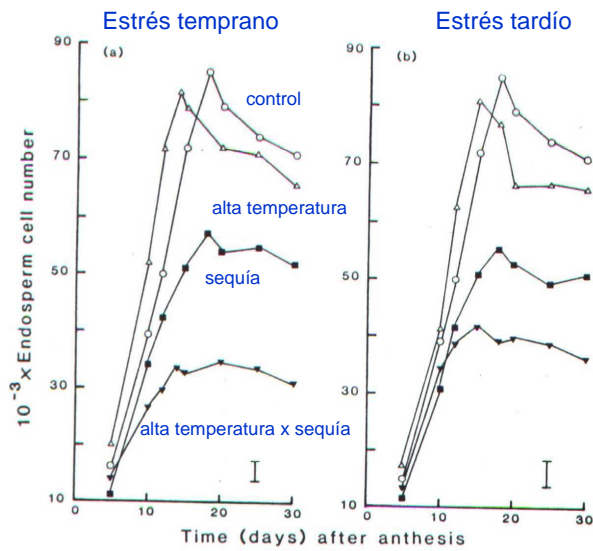


Fig. 3. Number of endosperm cells for plants subjected to treatments during the early period (a) and late period (b) of cell division. Error bars represent the l.s.d. ( $P = 0.05$ ) between means of treatments at any one time. Symbols as for

Nicolas *et al.* (1984)  
AJPP 1:553-566



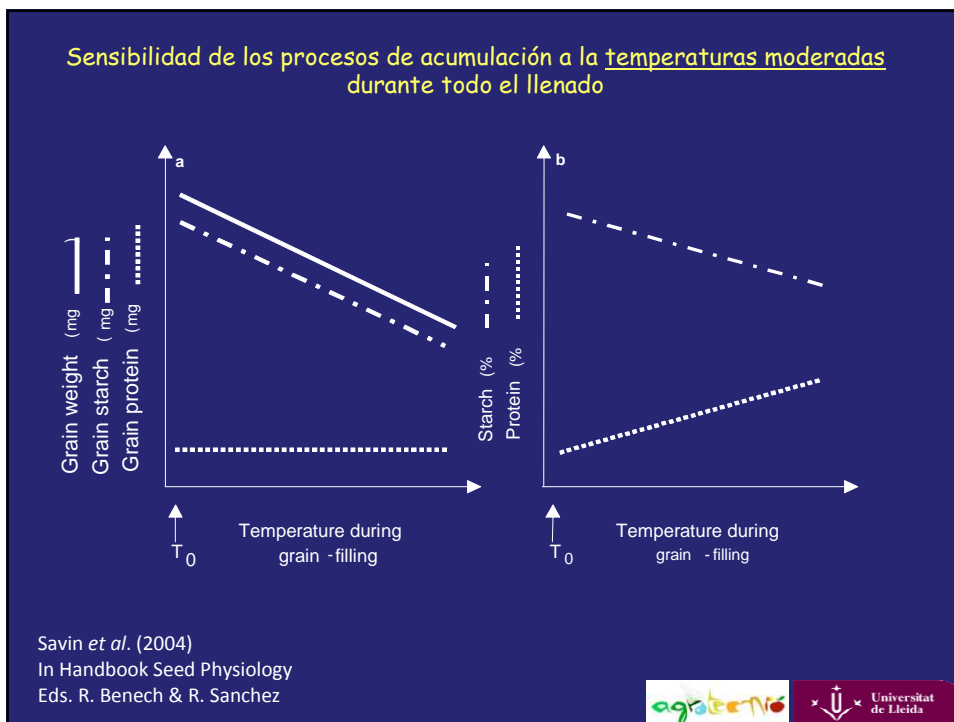
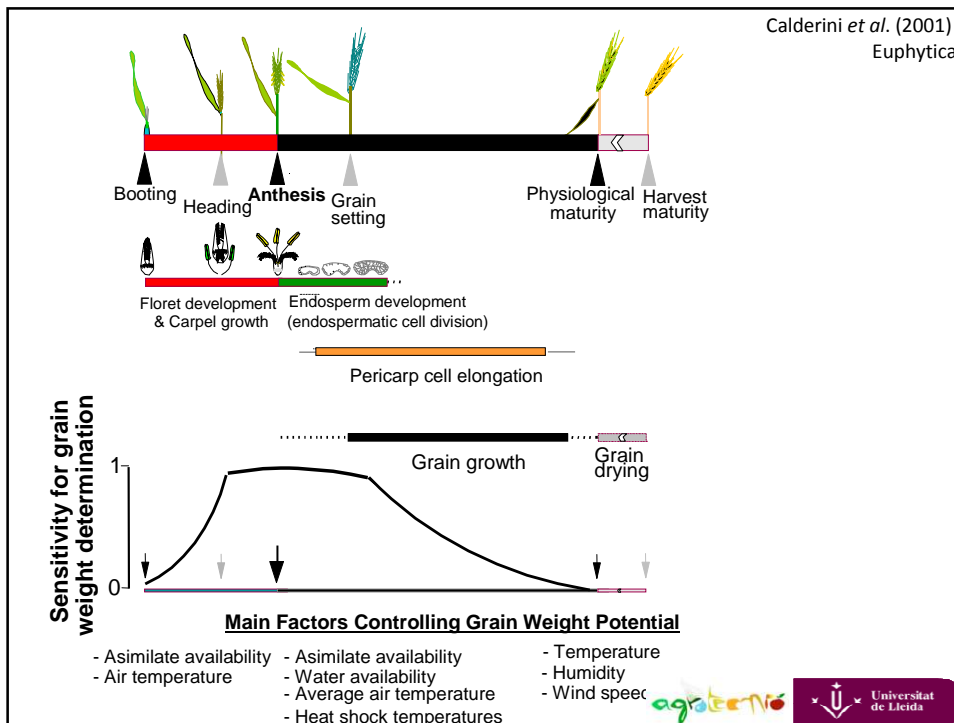
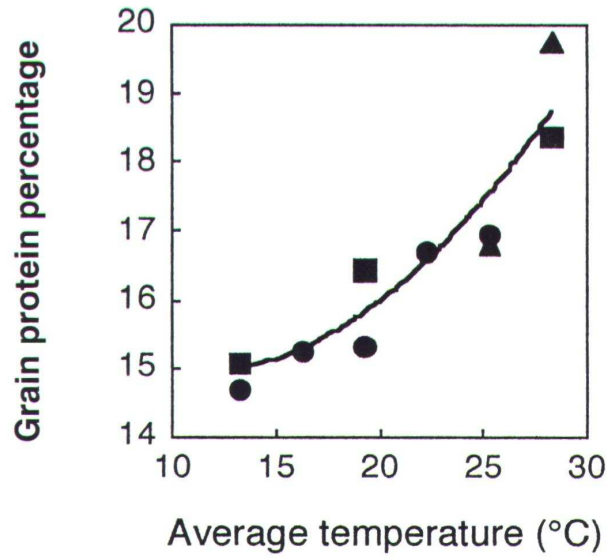
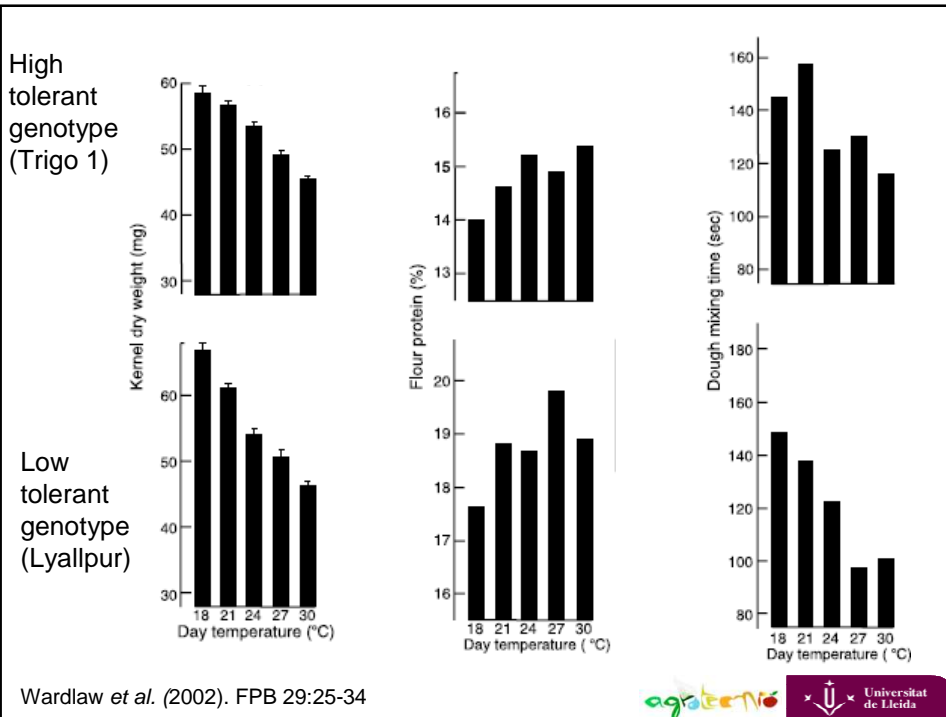




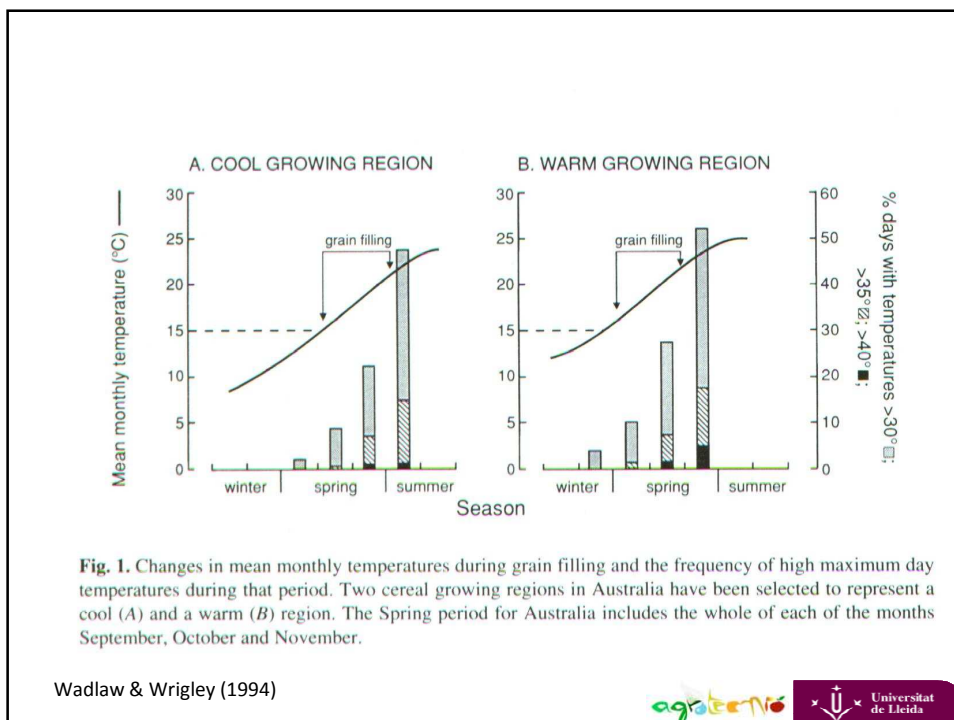
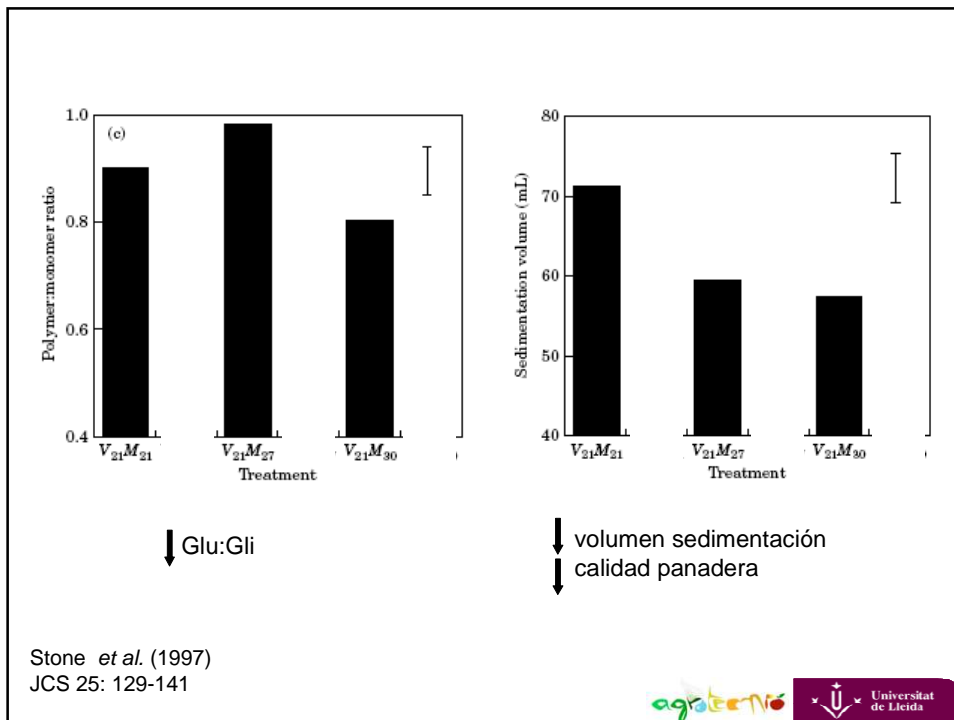
FIGURE 8.10. The Effect of Moderately High Temperature on Grain Protein Percentage of Wheat

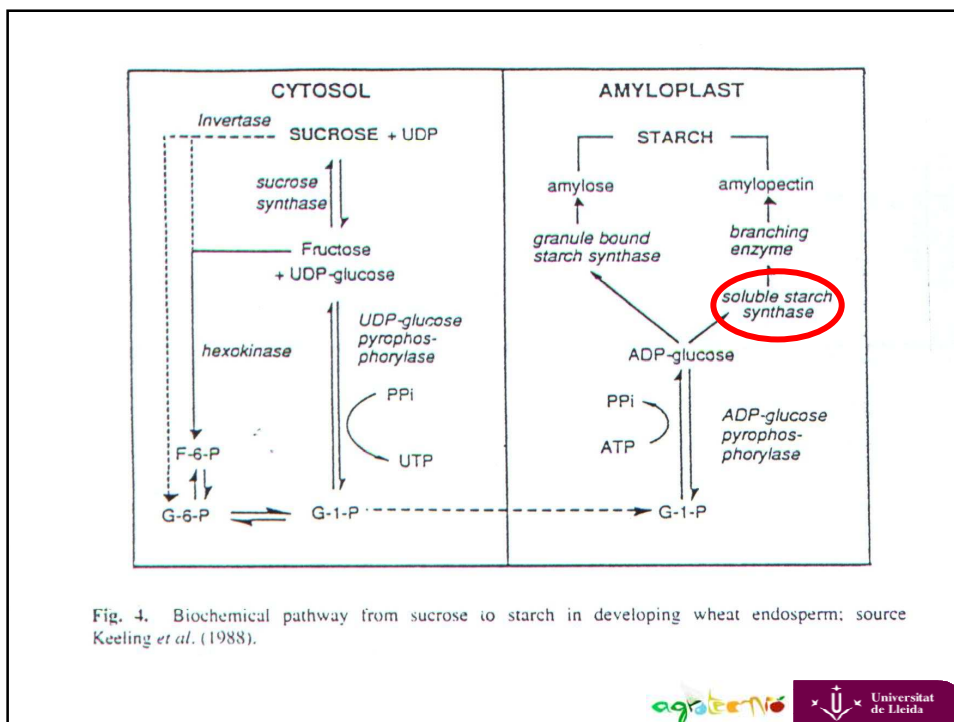
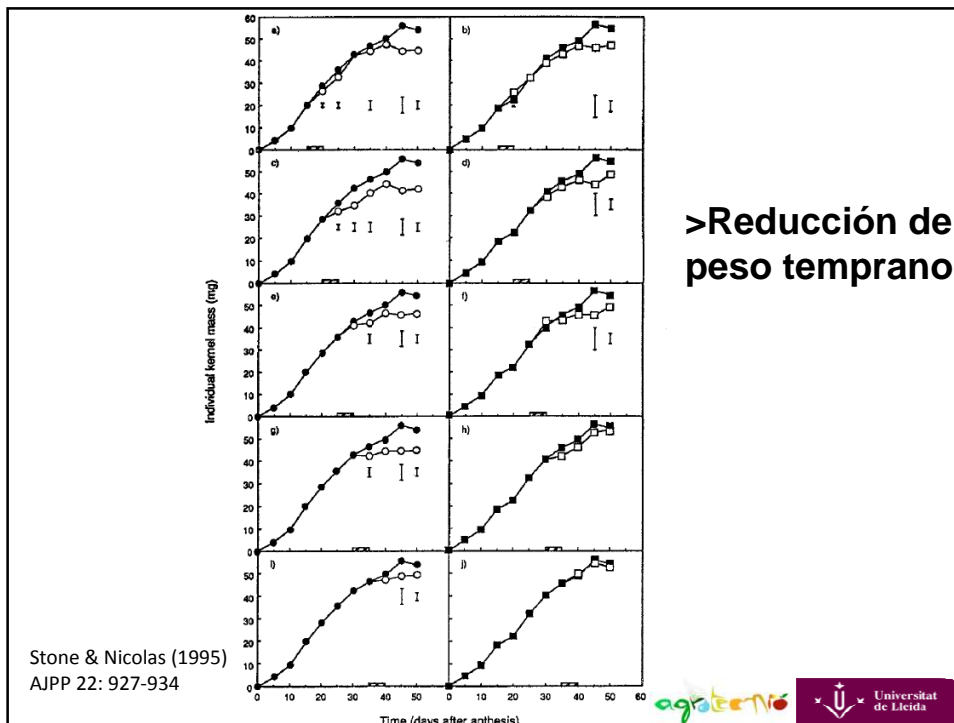


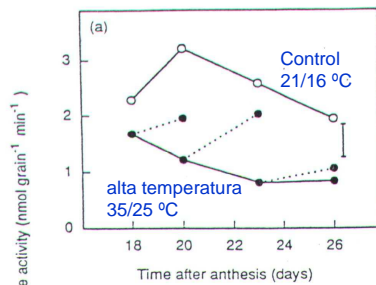
Stone (2001)



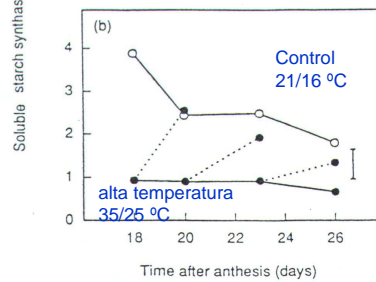
Wardlaw *et al.* (2002). *FPB* 29:25-34







Low tolerant genotype



High tolerant genotype

Hawker & Jenner (1993)  
AJPP 20: 197-209



**Altas temperaturas**



**Reducen el peso de los granos**



**efecto sobre desarrollo de los granos (menor tasa y duración el período)**    **efecto directo sobre los granos**

Ford *et al.* 1976  
Bhullar & Jenner 1983, 1986  
Wardlaw *et al.* 1980  
Jenner 1991  
Hawker & Jenner 1993  
Passarella *et al.* 2002



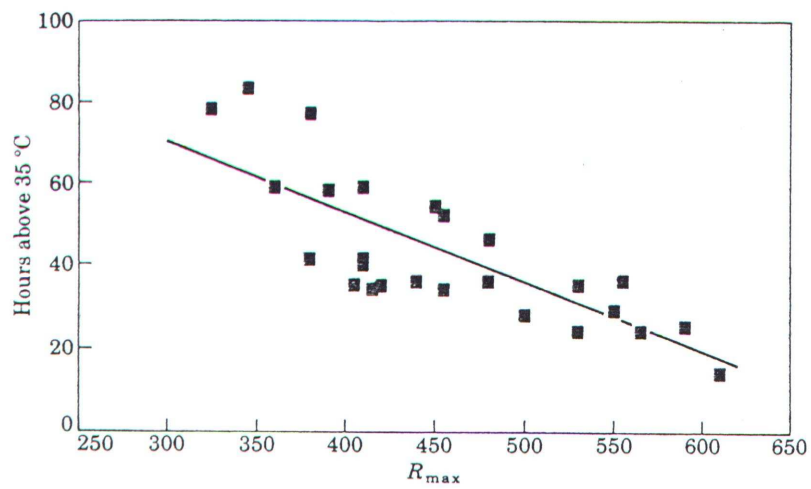
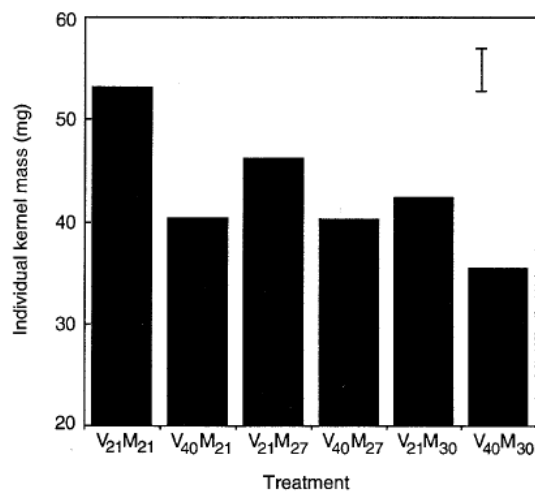


FIGURE 3. Variation in dough strength ( $R_{max}$ ) for N.S.W. crop samples of Prime Hard wheat for seasons 1960 to 1989 with mean cumulative hours above 35 °C during 75 days starting 1 October at three sites (Moree, Myall Vale and Narrabri). The correlation coefficient for this data was  $-0.787$  ( $P < 0.001$ ). Reproduced from Blumenthal *et al.* (1993)

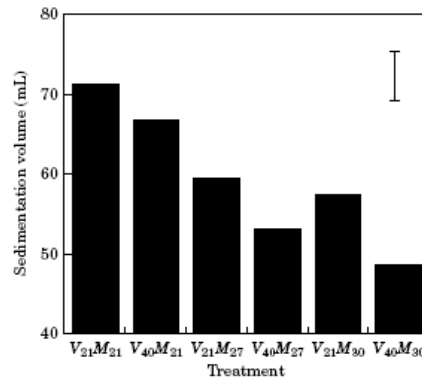
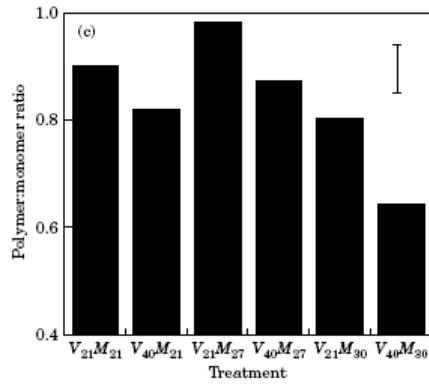
JCS 18:3-21

Blumenthal *et al.*<sup>20</sup>



Stone *et al.* (1995)  
AJPP 22:9345-954





Stone *et al.* (1997)  
JCS 25: 129-141



Summary of gluten proteins that showed significant changes in relative abundance in response to temperature, drought or fertilizer treatments in 2-DE/MS studies. + indicates that proteins increased, - indicates that proteins decreased, +/- indicates that some proteins increased while other proteins in the class decreased.

	High temperature			Drought	Fertilizer		
	Majoul <i>et al.</i> , 2003	Dupont <i>et al.</i> , 2006a,b	Yang <i>et al.</i> , 2011		Yang <i>et al.</i> , 2011	Grove <i>et al.</i> , 2009	Dupont <i>et al.</i> , 2006a,b
α-gliadins	+	+	+/-	-	+	+	+
γ-gliadins							
ω-gliadins			-			+	+
LMW-GS		-	+	+/-	+	-	-
HMW-GS		+				+	+

Altenbach (2012)  
JCS



## Mensajes principales

- Altas temperaturas modifican la síntesis de almidón y proteínas. Cambian la proporción de cada uno de estos componentes, pero también el tipo de proteínas o almidón. El efecto depende del momento en que ocurra, la intensidad del estrés y el genotipo.
- Falta mayor conocimiento sobre la fisiología de la síntesis de los diferentes compuestos en relación a los factores ambientales y moleculares