Ecofisiología de cereales de invierno

Curso Internacional de la Red METRICE
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Efecto de la fertilización nitrogenada en el desarrollo fásico y floral

Universitat de Lleida

ESCOLA TÈCNICA SUPERIOR D'ENGINYERIA AGRÀRIA (ETSEA)

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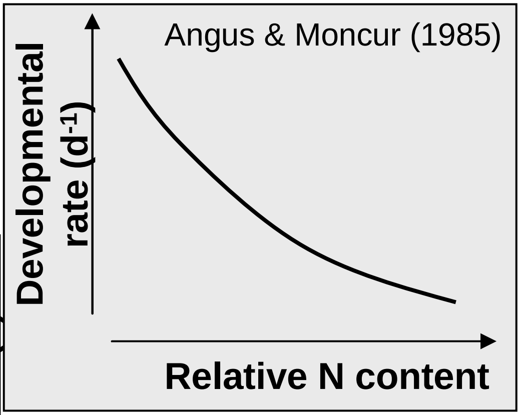
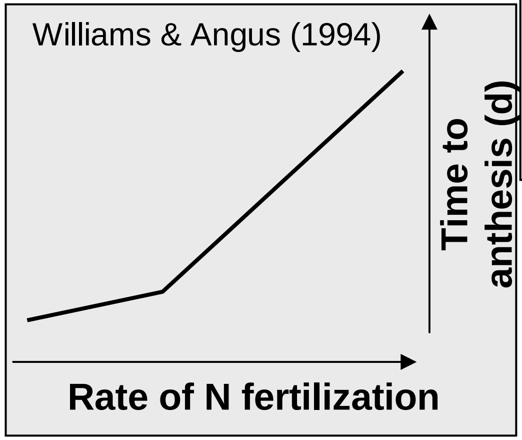
- Timing of crop flowering is critically important in determining yield
- Shifts in timing can alter both the number of grains and their average weight, through the crops being exposed to more or less favourable combinations of radiation and temperature
- The most important environmental factors regulating time to flowering in wheat and barley are daylength and temperature (via the positive effects of temperature and through vernalisation).
- However, in several studies aimed at exploring yield responses to nitrogen (N) fertilisation in cereals and other crops, effects of N availability on time to anthesis have been reported
- Characteristically, the effects of N on crop phenology are noted, but there has not been any systematic attempt to analyse the occurrence and importance of these effects across a broad spectrum of reports

- Information on N effects on flowering time is highly dispersed in the literature
- There is a large degree of variation in reported effects of N fertilisation on phenology, both in crop and non-cultivated plant species and in many occasions it is a simple comment made in the report rather than a deeply analysed trait.
- Perhaps the conflicting reports were based on the level of N stress explored in each case
- Angus and Moncur (1985) and Williams and Angus (1994), in the only published model proposed for these responses in wheat, suggested a non-linear response of flowering time to N application





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- This might explain why in some cases there is a developmental response (highly N stressed controls), while in others phenology is largely unaffected by fertilisation (mildly to moderately N stressed controls).
- We attempted to shed light on this issue through a meta-analysis of reports, published during the last twenty years in high-impact journals specializing in agriculture, of the effects of fertiliser nitrogen on time to either heading or anthesis in wheat and barley, using crop yield responses as a proxy for crop nitrogen status.
- We restricted our coverage to crops grown outdoors to avoid the effects on development and yield which frequently occur in the low-irradiance conditions typical of controlled environment experiments (as well as in many glasshouse studies).
- In addition, we have only covered experiments in which nitrogen was applied at sowing or up to the onset of stem elongation

Fig. 1. Hypothetical response function for delay in flowering (heading or anthesis) in wheat and barley to the degree of N-stress experienced by the unfertilised control (reflected in the magnitude of the yield response to N). Insets show schematic response functions embodied in data reported for wheat (upper-left inset; Angus and Moncur, 1985) and rice (bottom-right inset; Williams and Angus, 1994).

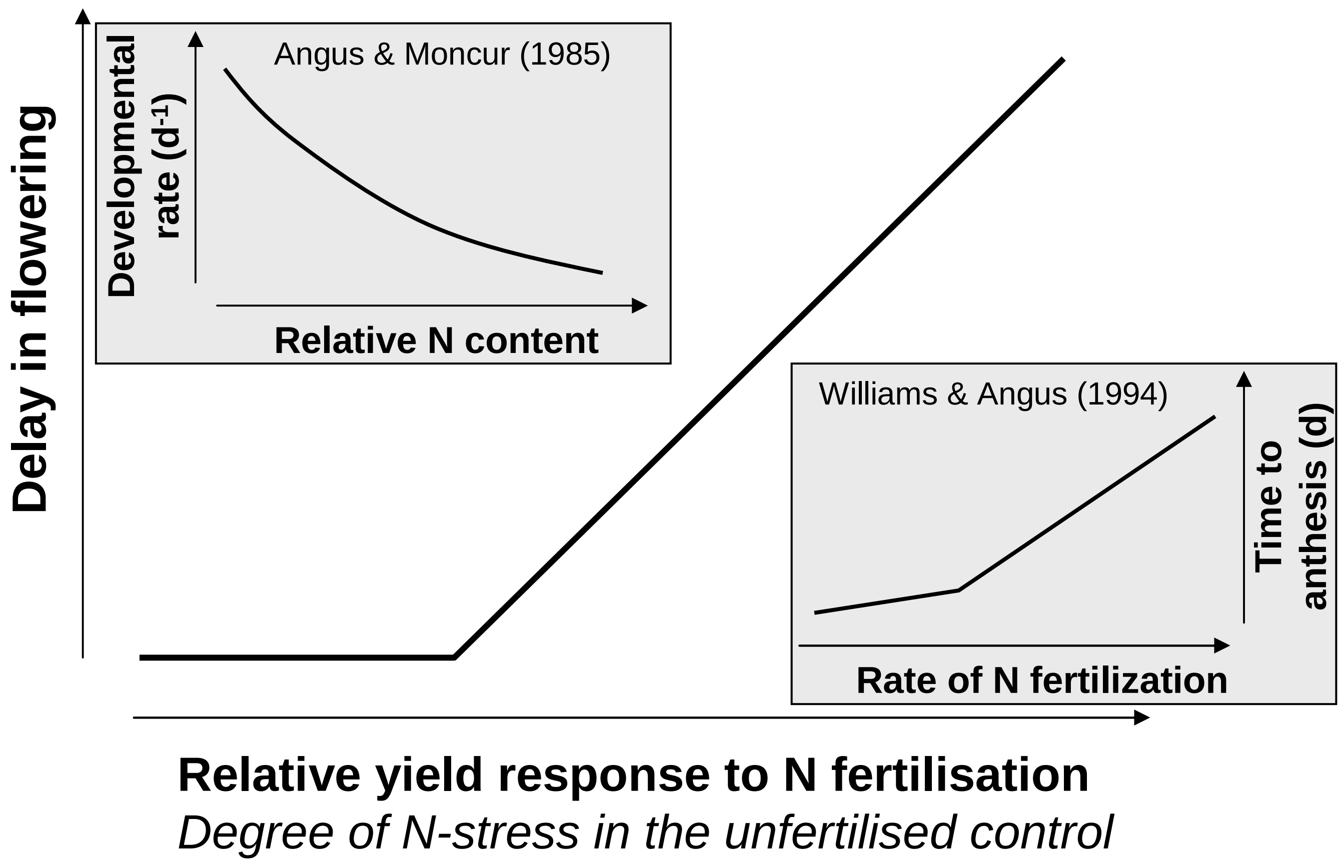

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Table 1. Journals scanned for relevant articles during the 1990-2010 period and number of tagged articles per journal. Search strings used: TITLE (“nitrogen and wheat”) and TITLE ("nitrogen and barley”).

Journal	Number of articles meeting search criteria
Agricultural and Forest Meteorology	4
Agronomy Journal	142
Agronomy and Sustainable Development.	267
Agricultural Water Management	15
Annals of Applied Biology	11
Australian Journal of Agricultural Research	56
Australian Journal of Experimental Agriculture	43
Crop Science	37
European Journal of Agronomy	52
Field Crops Research	78
Journal of Agricultural Science (Cambridge)	120
Journal of Agronomy and Crop Science	112
Journal of Plant Nutrition and Soil Science	19
Plant and Soil	174
Total	**1130**

Table 2. List of articles published during the 1990-2010 interval and personal communication from which data was extracted.

Reference*	Main treatments
Abbate et al., 1995	1 wheat genotype x 2 years x 4 N levels
Arisnabarreta and Miralles, 2004 Arisnabarreta and Miralles, 2006	2 years x 4 barley genotypes x 2 N levels
Arisnabarreta and Miralles, 2010	2 barley genotypes x 2 N levels
Barraclough et al., 1989 Porter, 1993	1 wheat genotype x water x 2 N levels
Birch and Long, 1990	3 barley genotypes x 5 N levels
Delogu et al., 1998	3 years x 1 barley genotype x 1 wheat genotype x 3 N levels
Dreccer et al., 2000	1 wheat genotype and 3 N levels
Ferrise et al., 2010	1 wheat genotype x 2 years x 2 sowing dates x 4 N levels
Fischer, 1993 Fischer et al., 1993	2 exps x 1 wheat genotype x different N levels x timing of N applications
Guarda et al., 2004	4 years x 16 wheat genotypes x 3 N levels
Hocking and Stapper, 2001	1 wheat genotype x 3 sowing dates x 2 N levels
Kernich and Halloran, 1996	2 exps x 2 barley genotypes x 2 N levels
Martre et al., 2006 Triboi et al. 2003	1 wheat genotype x 3 initial N conditions
Newton, 2001	1 wheat genotype x 4 stubble conditions x 2 N levels
Peltonen, 1993	2 wheat genotypes x 2 N levels
Prystupa et al., 2003	1 barley genotype x 2 N levels x 3 P levels

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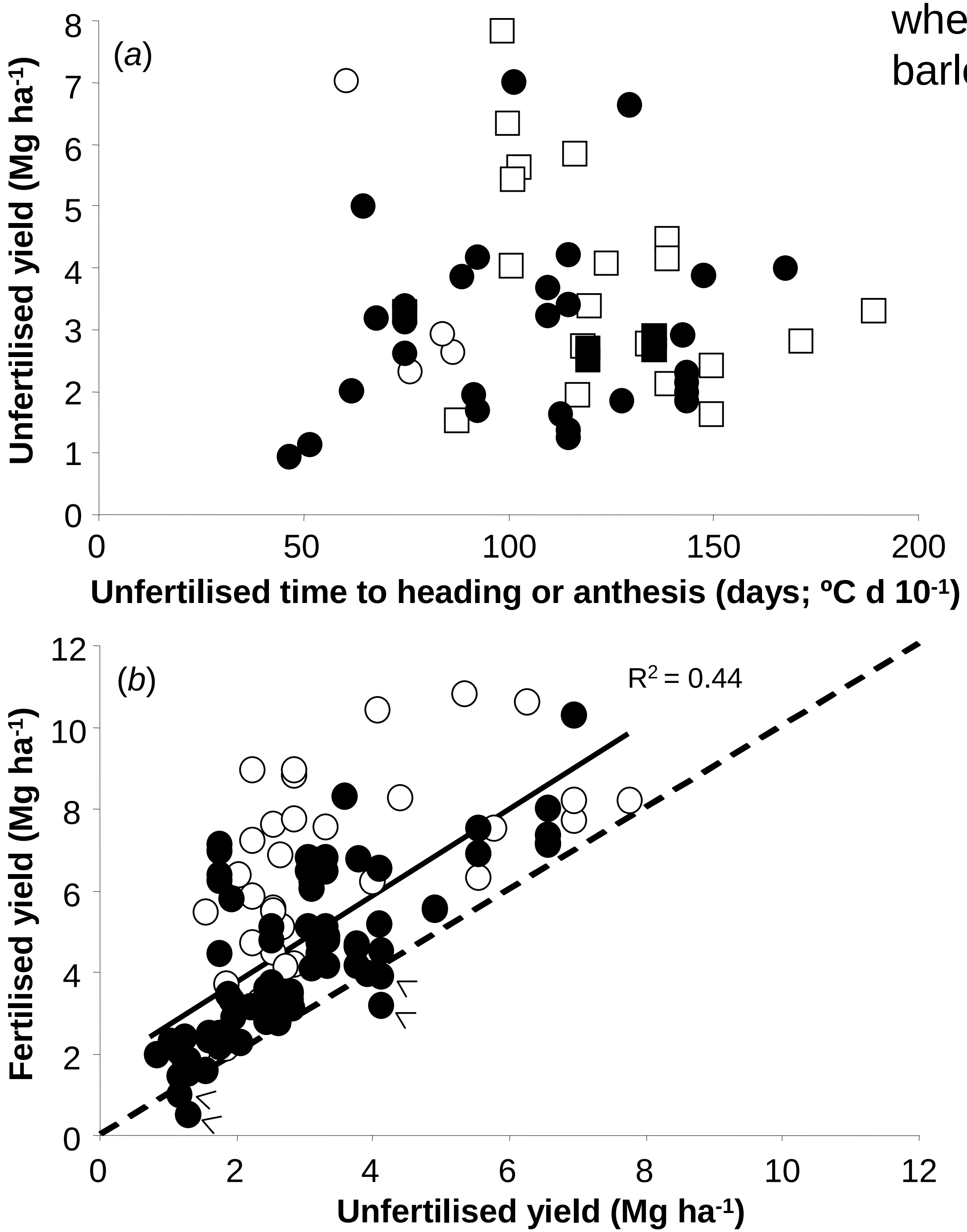

wheat (closed symbols)
barley (open symbols)

Many data-points are not visible as they overlap

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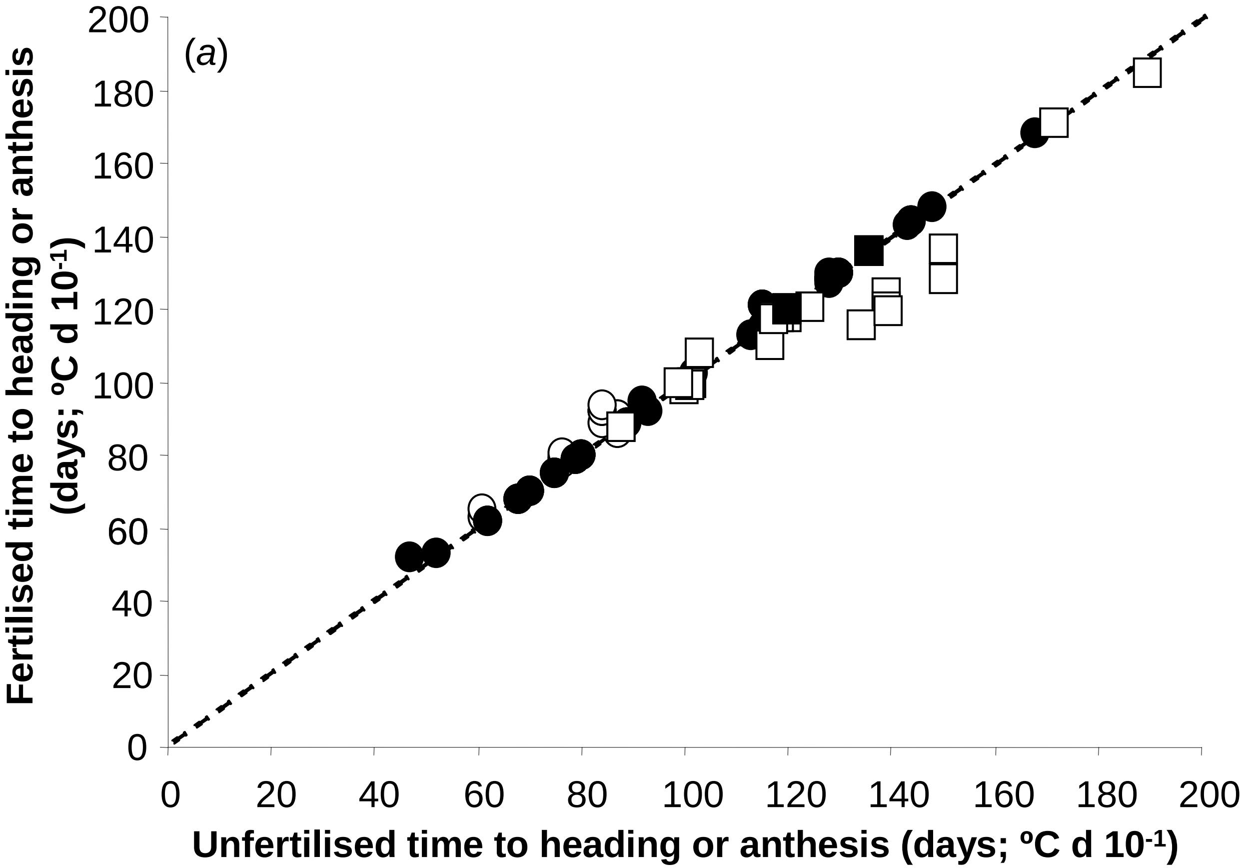

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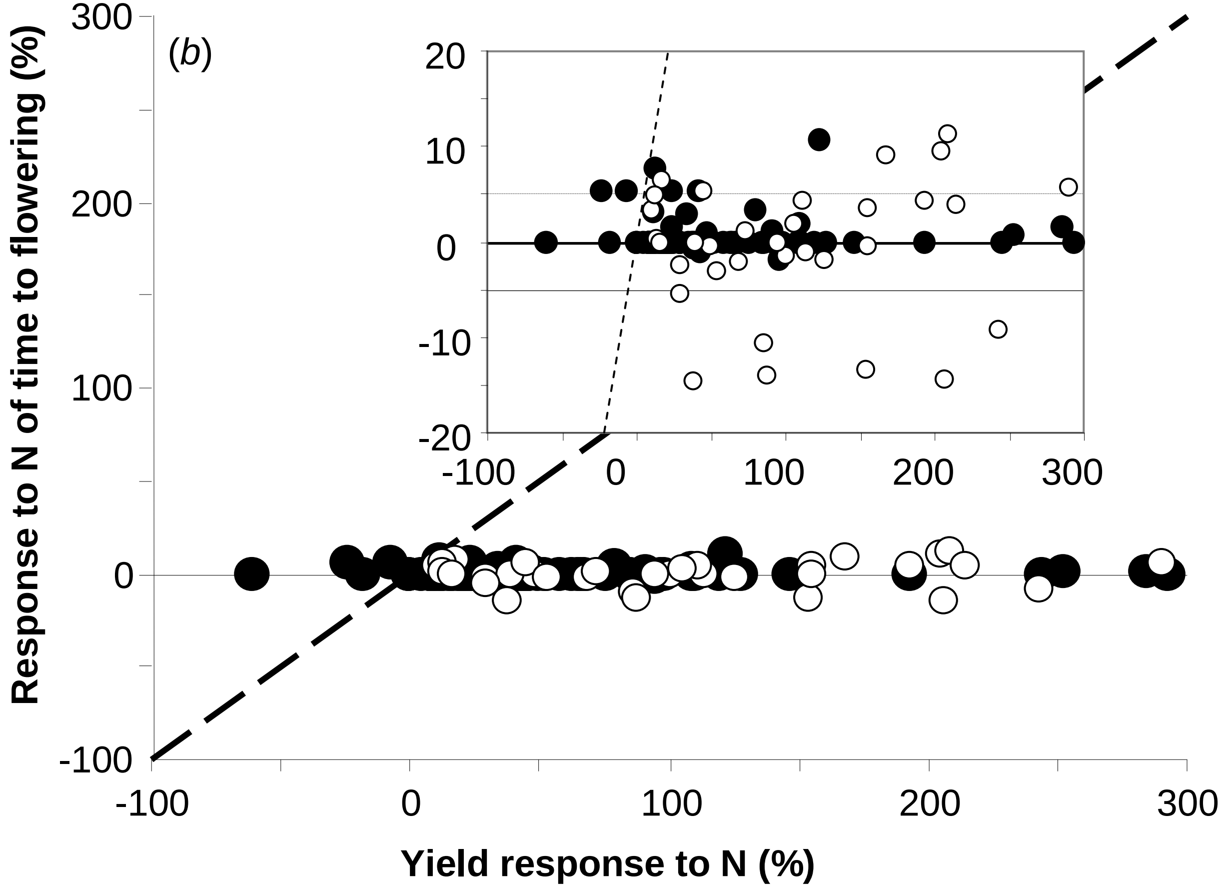

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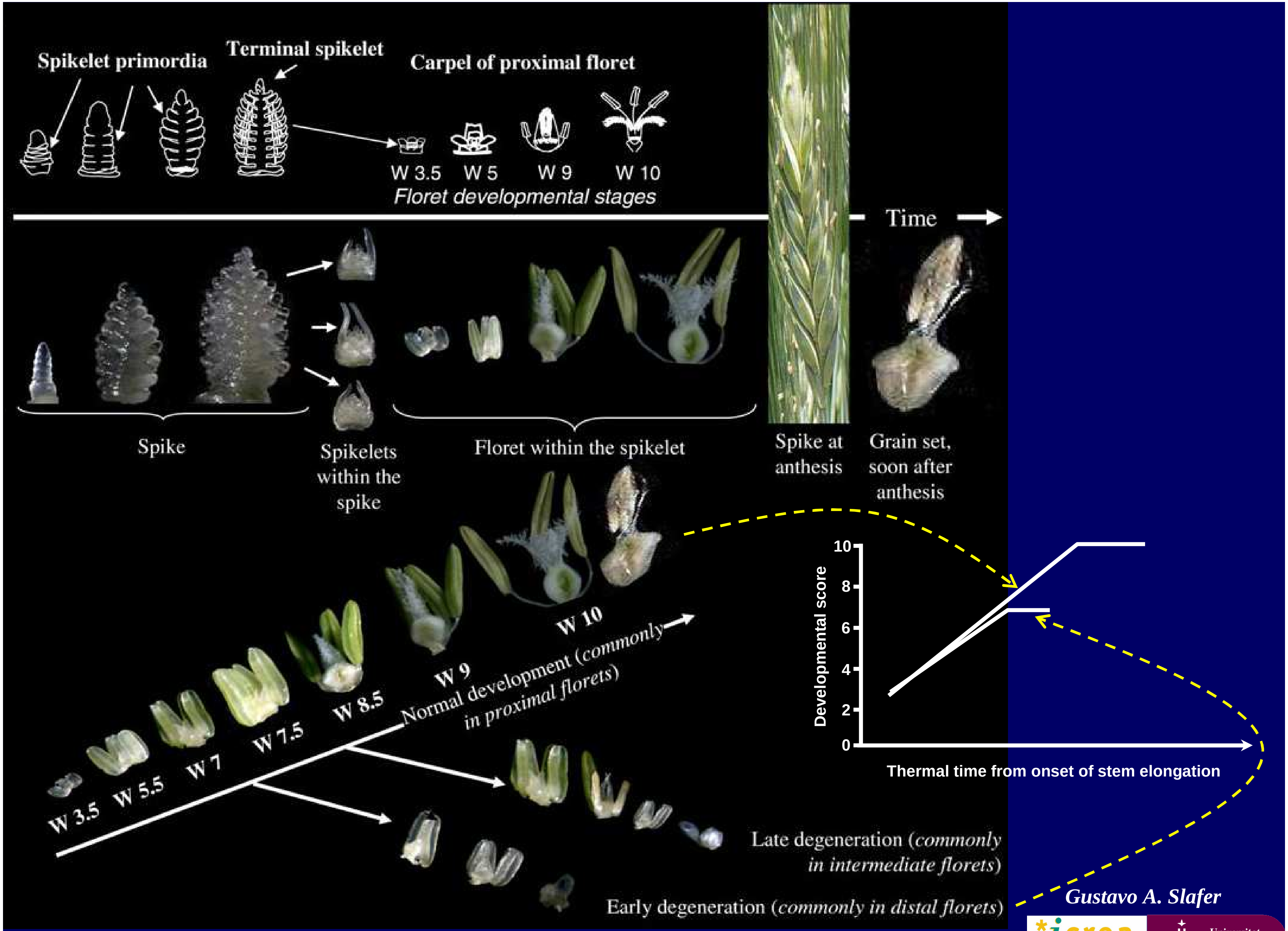

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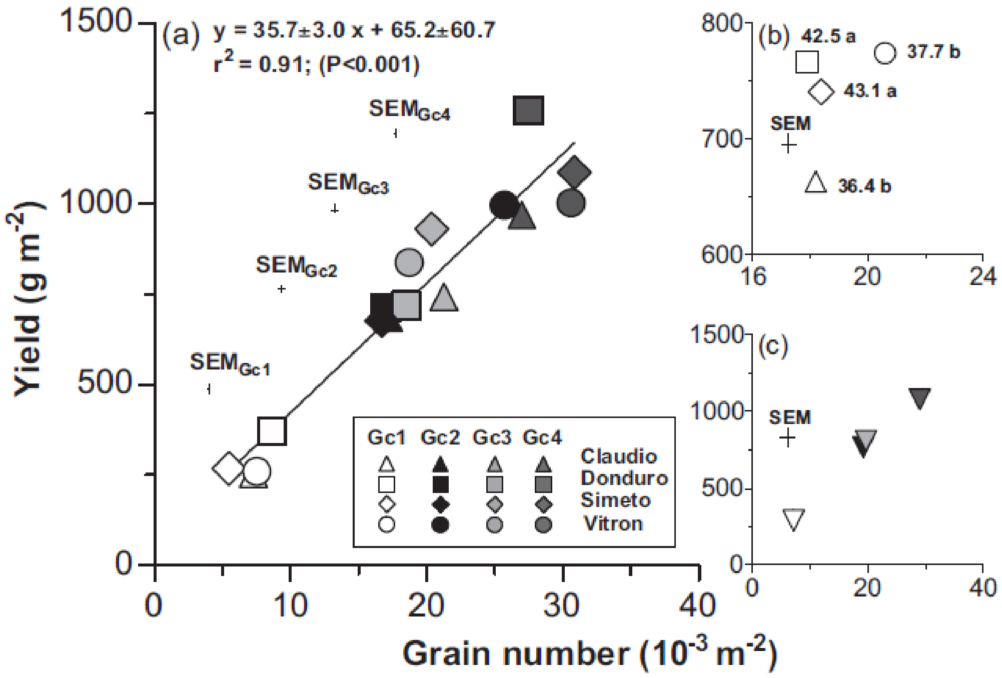
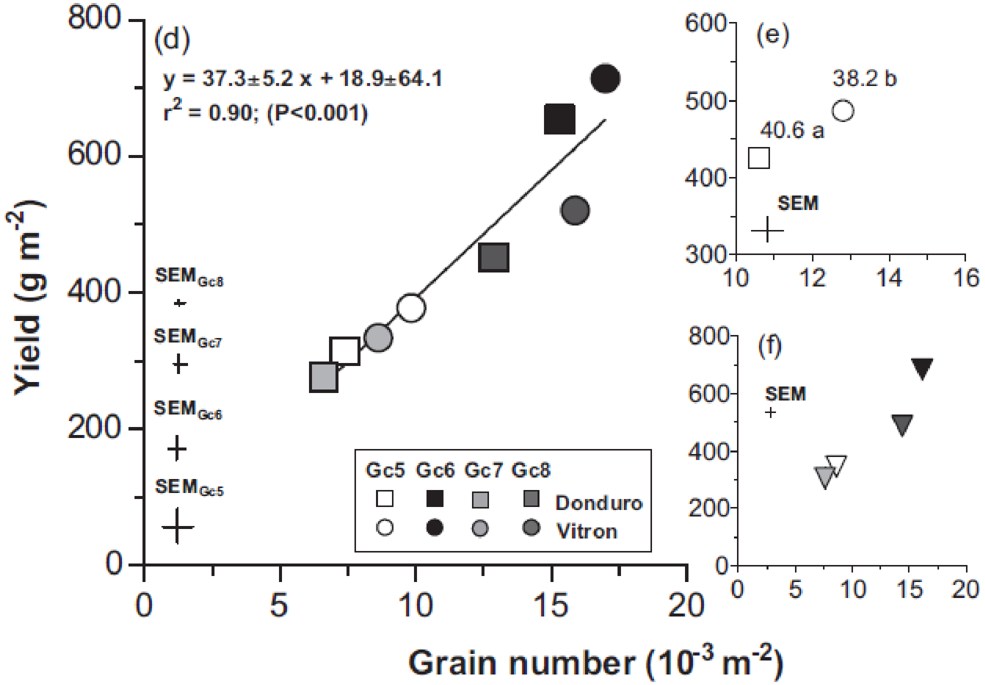
Growing season	Experiment	Experimental design	Chemical and physical soils properties	Experimental approaches	Sowing date and density	Experimental treatments			Growing condition label (Gc)
						Water availability	N availability	Cultivars	
2008–09	1	Completed randomised design (3 replicates)	pH: 8.2 ECe (dS/m): 0.13 Organic matter (Walkey + Black) (%): 0.25 Soil textural class(USDA): Loamy sand Clay (%): 3.9 Sand (%): 80.8 Silt (%): 15.3	Crops in large containers outdoors	28 Nov. 08 300 plants m^{-2}	Irrigated[a]	**50 kgN ha^{-1}**	**Claudio** **Donduro** **Simeto** **Vitron**	Gc 1
							250 kgN ha^{-1}	**Claudio** **Donduro** **Simeto** **Vitron**	Gc 2
	2	Randomised block design (3 replicates)	pH: 8 ECe (dS/m): 0.34 Organic matter (Walkey + Black): 3.11 Soil textural class(USDA): Sandy clay loam Clay (%): 27.8 Sand (%): 46.4 Silt (%): 25.8	Field	24 Nov. 08 300 plants m^{-2}	Rainfed	130 kgN ha^{-1}	**Claudio** **Donduro** **Simeto** **Vitron**	Gc 3
	3		pH: 7.9 ECe (dS/m): 0.85 Organic matter (Walkey + Black): 4.14 Soil textural class(USDA): Clay loam Clay (%): 28.3 Sand (%): 38.4 Silt (%): 33.3	Field	12 Dec. 08 300 plants m^{-2}	Irrigated[b]	580 kgN ha^{-1}	**Claudio** **Donduro** **Simeto** **Vitron**	Gc 4
2009–10	4	Completed randomised design (3 replicates)	pH: 8.2 ECe (dS/m): 0.13 Organic matter (Walkey + Black) (%): 0.25 Soil textural class(USDA): Loamy sand Clay (%): 3.9 Sand (%): 80.8 Silt (%): 15.3	Crops in large containers outdoors	26 Nov. 09 250 plants m^{-2}	**Irrigated**[a]	**50 kgN ha^{-1}**	**Donduro** **Vitron**	Gc 5
							250 kgN ha^{-1}	**Donduro** **Vitron**	Gc 6
						Rainfed	**50 kgN ha^{-1}**	**Donduro** **Vitron**	Gc 7
							250 kgN ha^{-1}	**Donduro** **Vitron**	Gc 8

Ferrante, Savin & Slafer. 2012. Field Crops Research, 136:52-64





Gc1 vs Gc2 — N-fertilisation

Gc3 vs Gc4 — Water+N-fertilisation

Gc5 vs Gc6
Gc7 vs Gc8 } ***N-fertilisation***

Ferrante, Savin & Slafer. 2012.
Field Crops Research, 136:52-64

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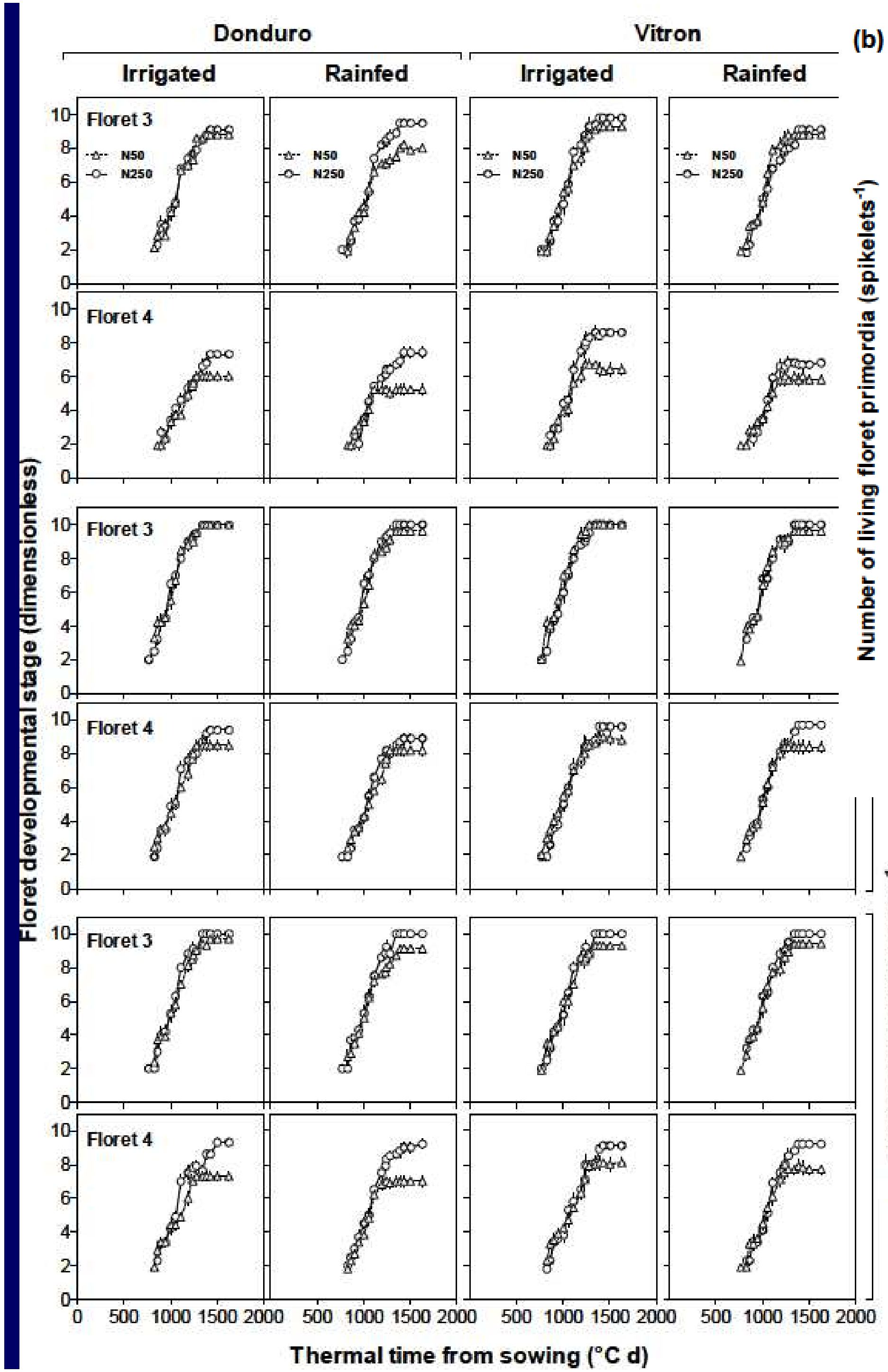

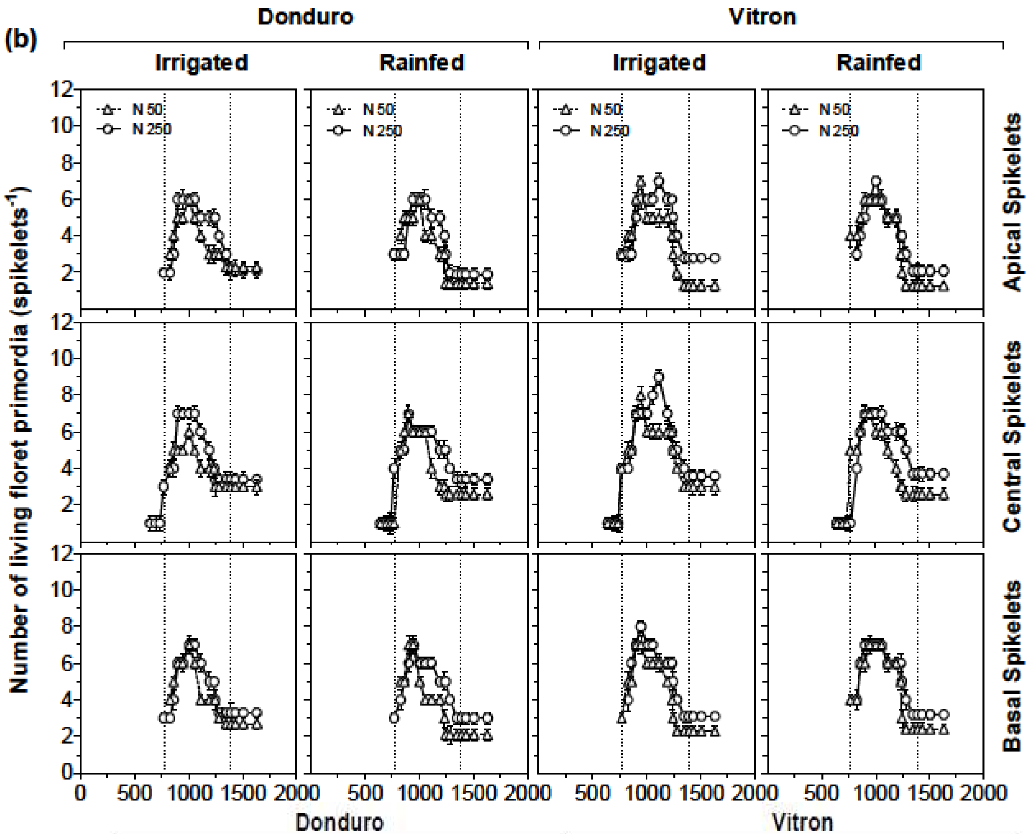

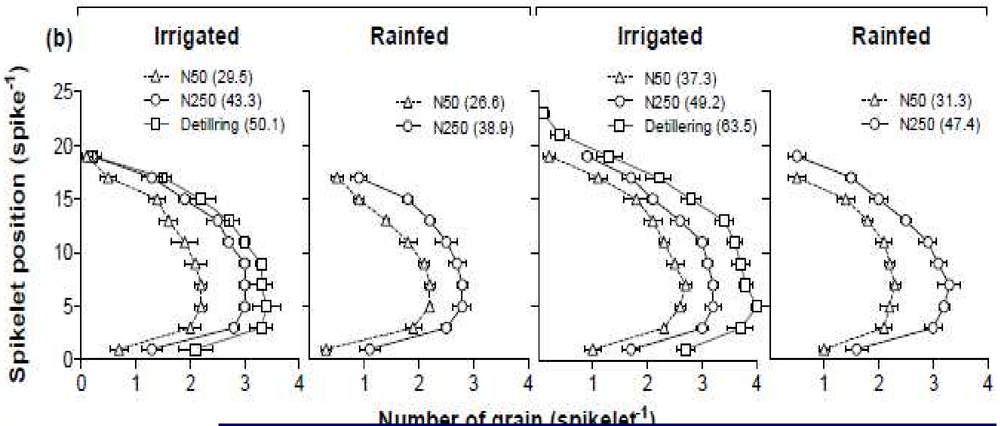

Ferrante, Savin, Slafer. 2012. Journal of Experimental Botany *in press*

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Conclusions

Crop phenology did not show a consistent pattern of response to N fertilisation

The lack of consistent response was not dependant on the level of N-stress of the unfertilised control (or to the level of yield responsiveness)

We demonstrated here that the mechanism operates through accelerating rate of floret development, which caused a higher rate of survival of the rather large number of floret primordia that are normally initiated in all spikelets of wheat

This, in addition, confirms that floret survival is a major determinant of grain number in wheat and that the process seems to be mediated by resource availability (González, Miralles & Slafer, 2011)

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