Estabilidad del rendimiento de trigo y cebada en una zona mediterránea y uso de la fertilización N para mitigar el estrés hídrico

Roxana Savin, *UdL*
C. Mariano Cossani, *CIMMYT*
L. Gabriela Abeledo, *UBA*
Gustavo A. Slafer, *UdL*

GA Slafer - Research Professor of *ICREA*
Crop Physiology Lab
Department of Crop & Forest Sciences
University of Lleida

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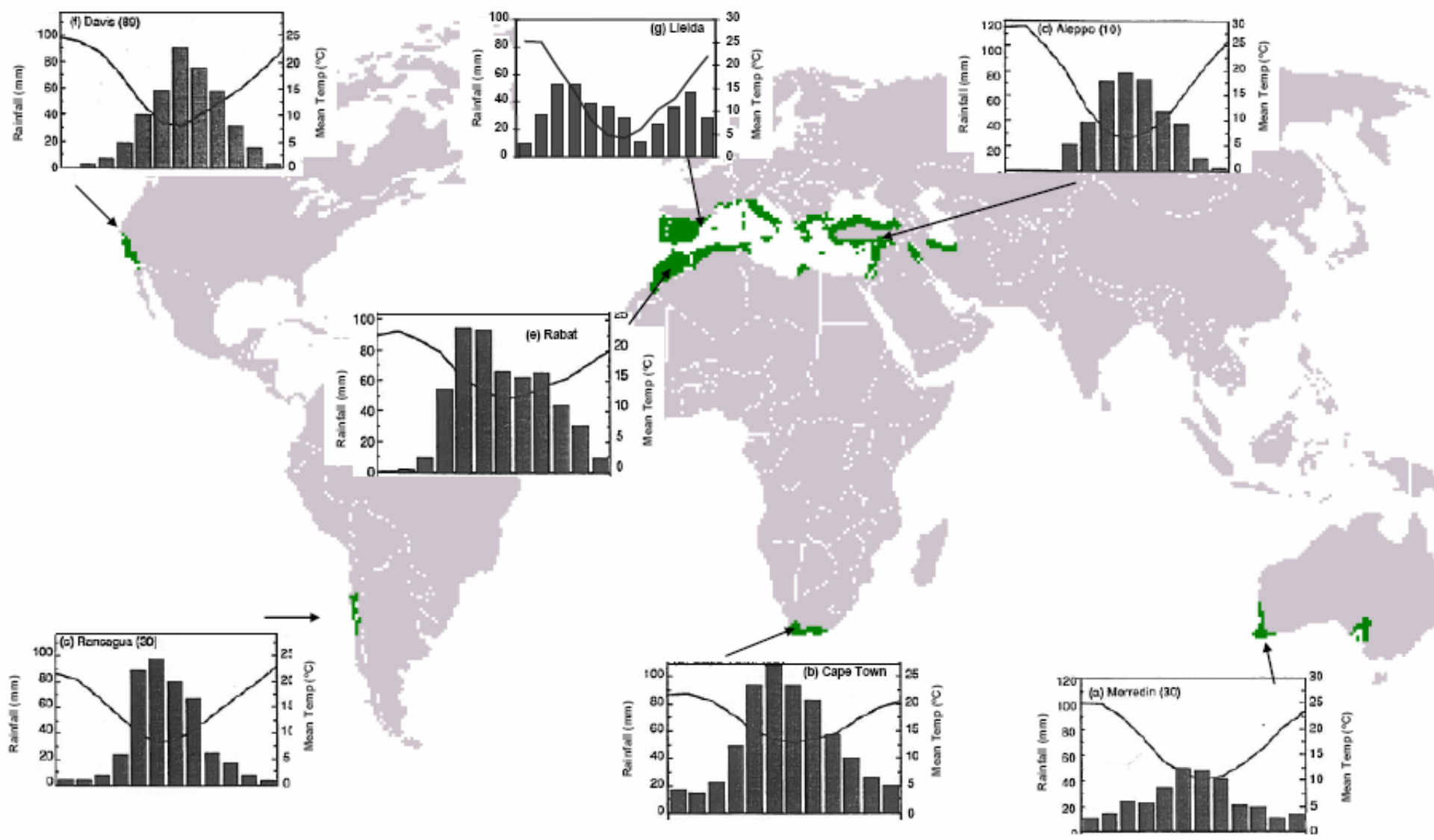

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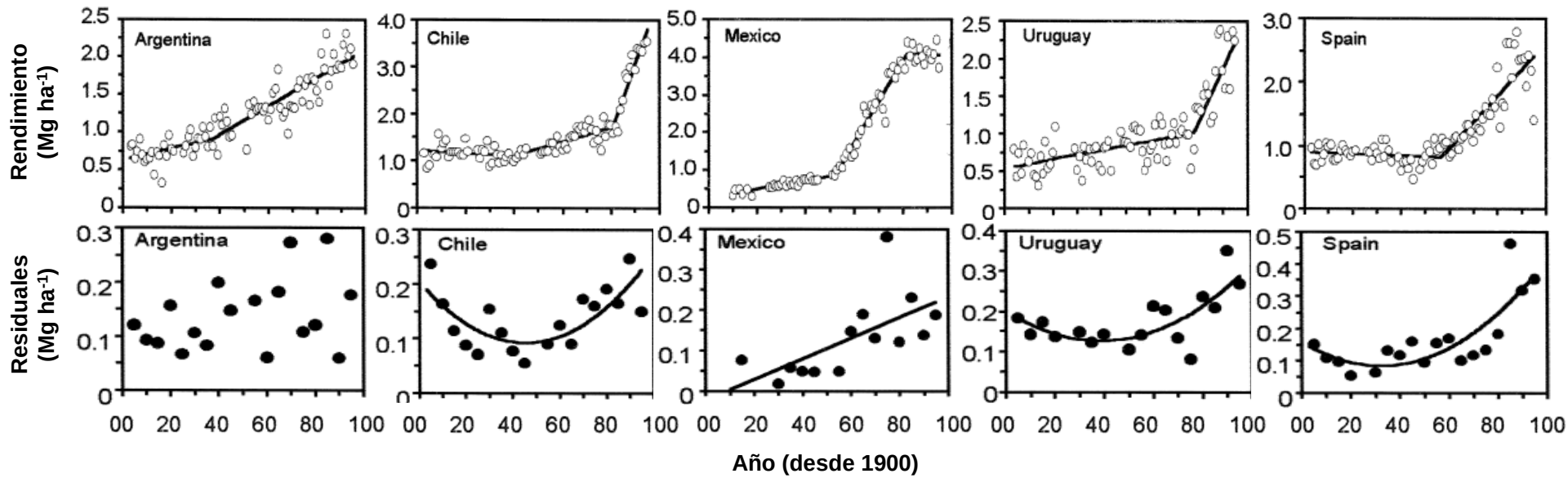
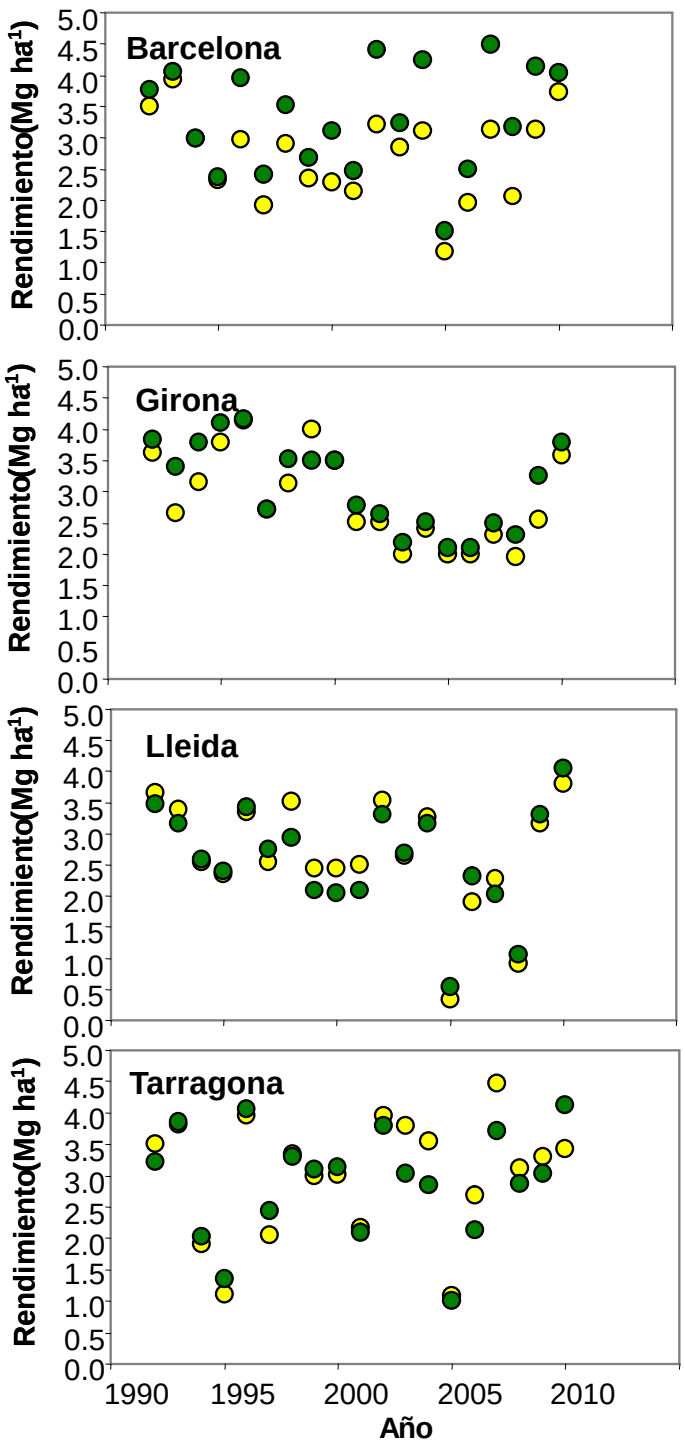
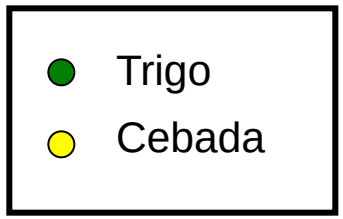
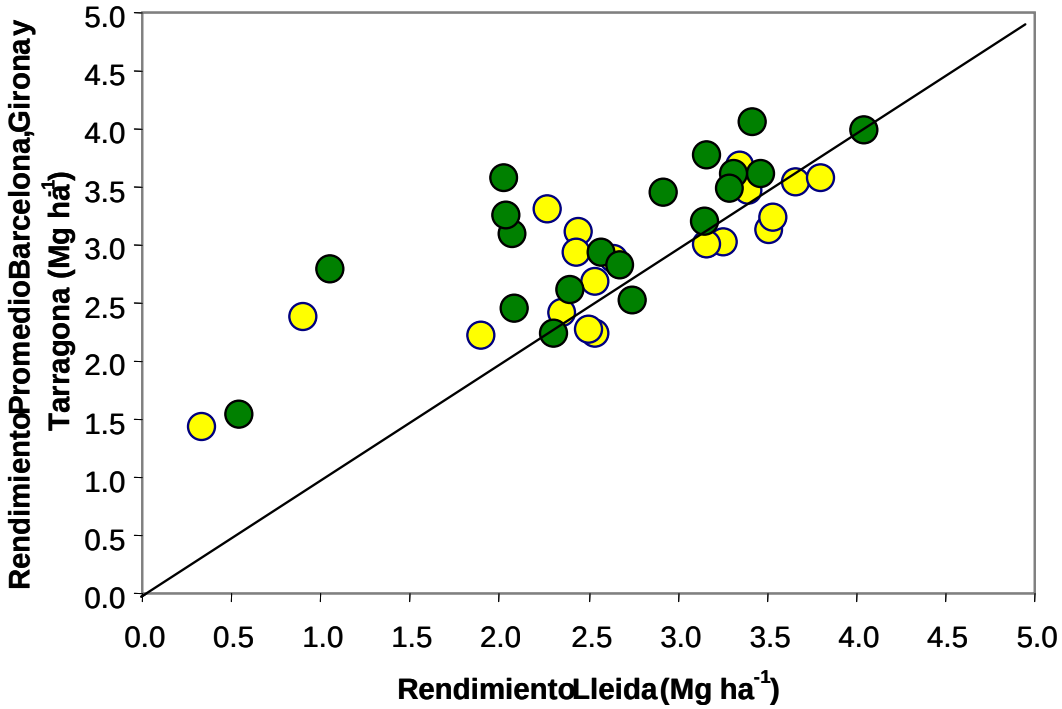

Rendimiento (Mg ha-1)
Residuales (Mg ha-1)
Argentina
Chile
Mexico
Uruguay
Spain
Año (desde 1900)







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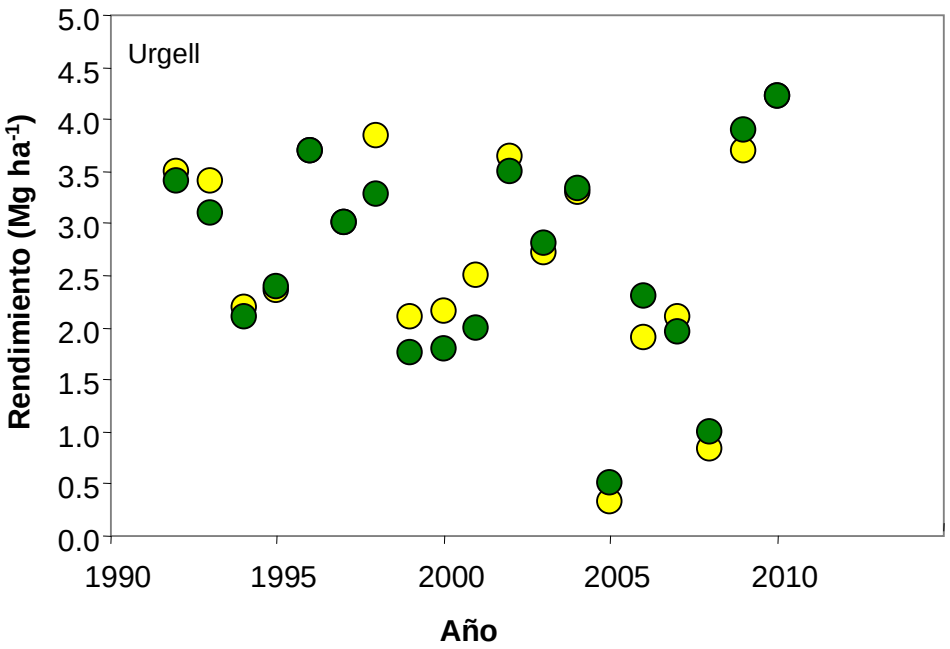

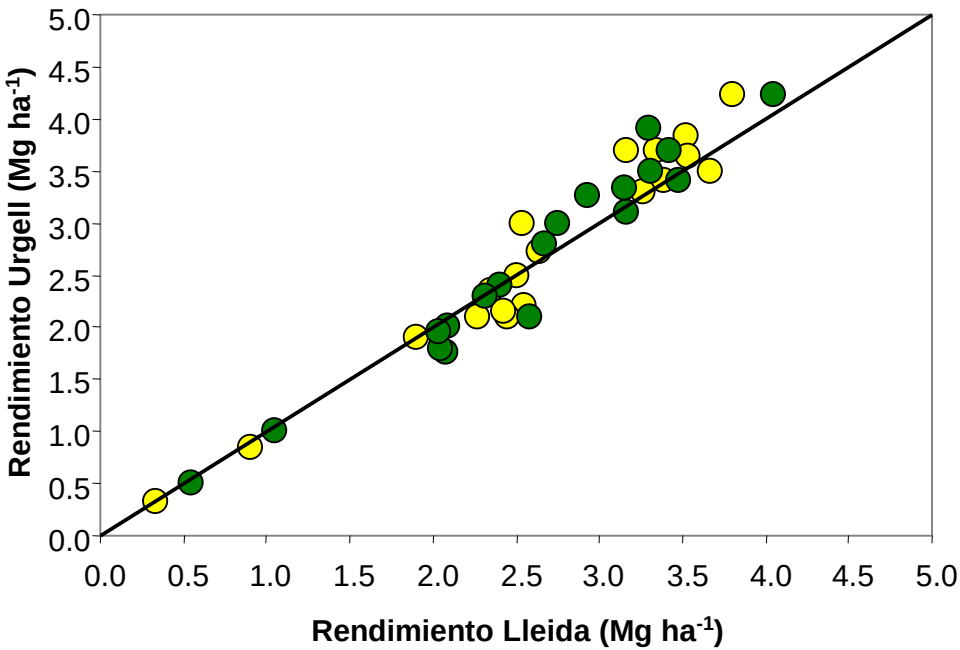

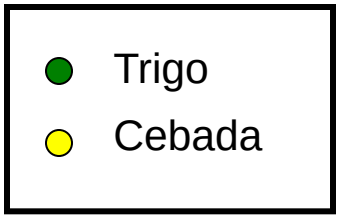

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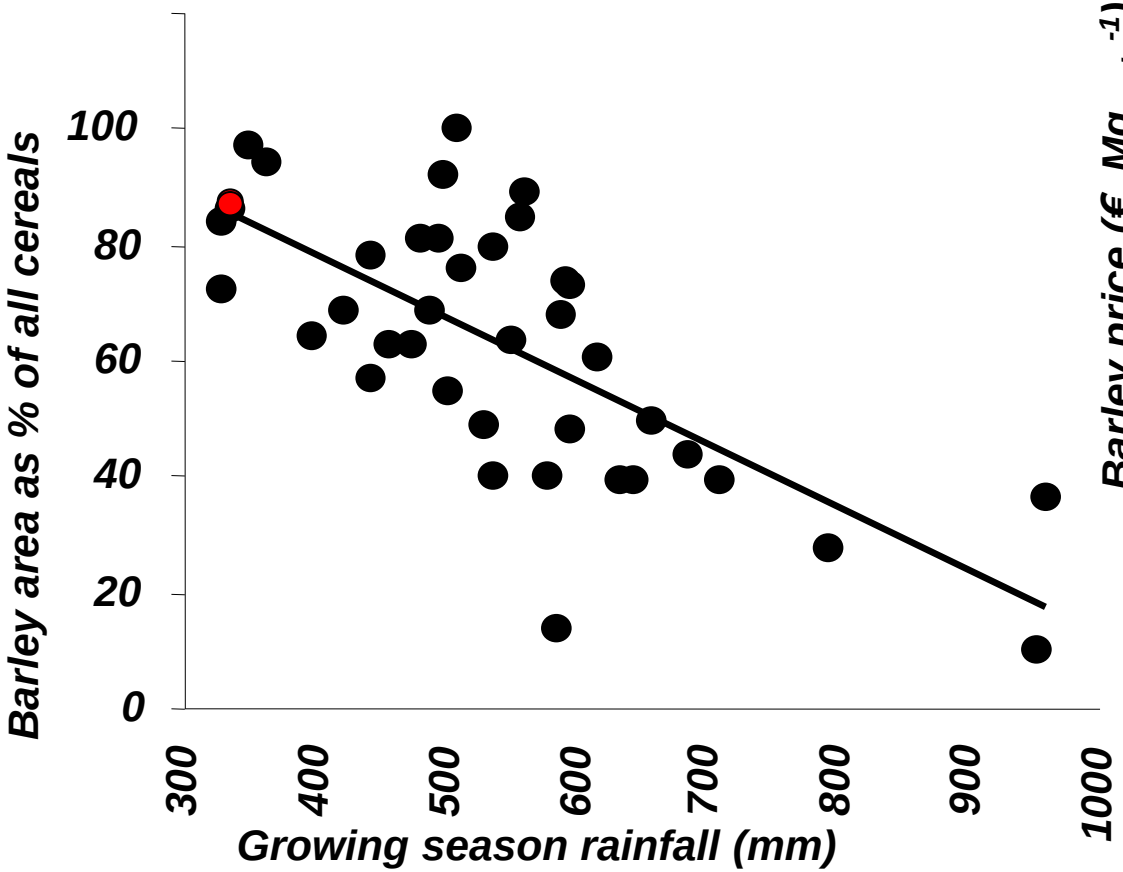
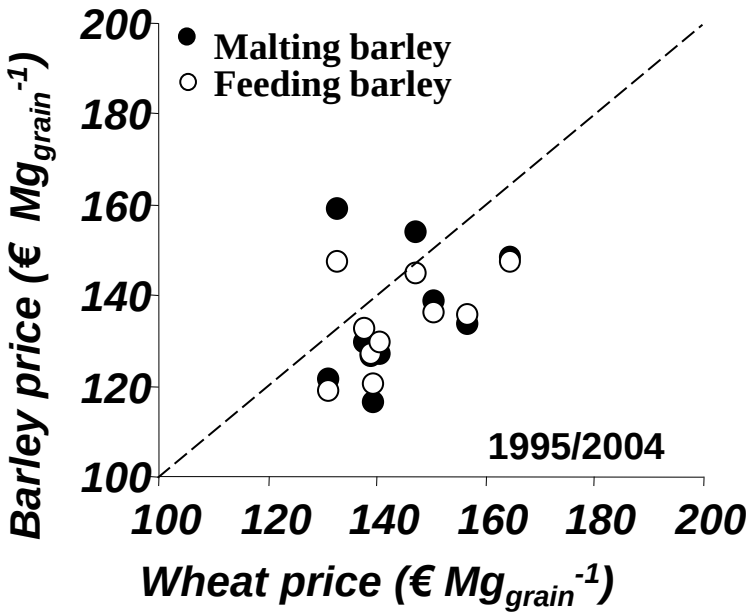
In Catalonia…





Lower price

General farmer belief…

Barley yields are higher, or its components had more stability, than wheat in severe stress conditions…

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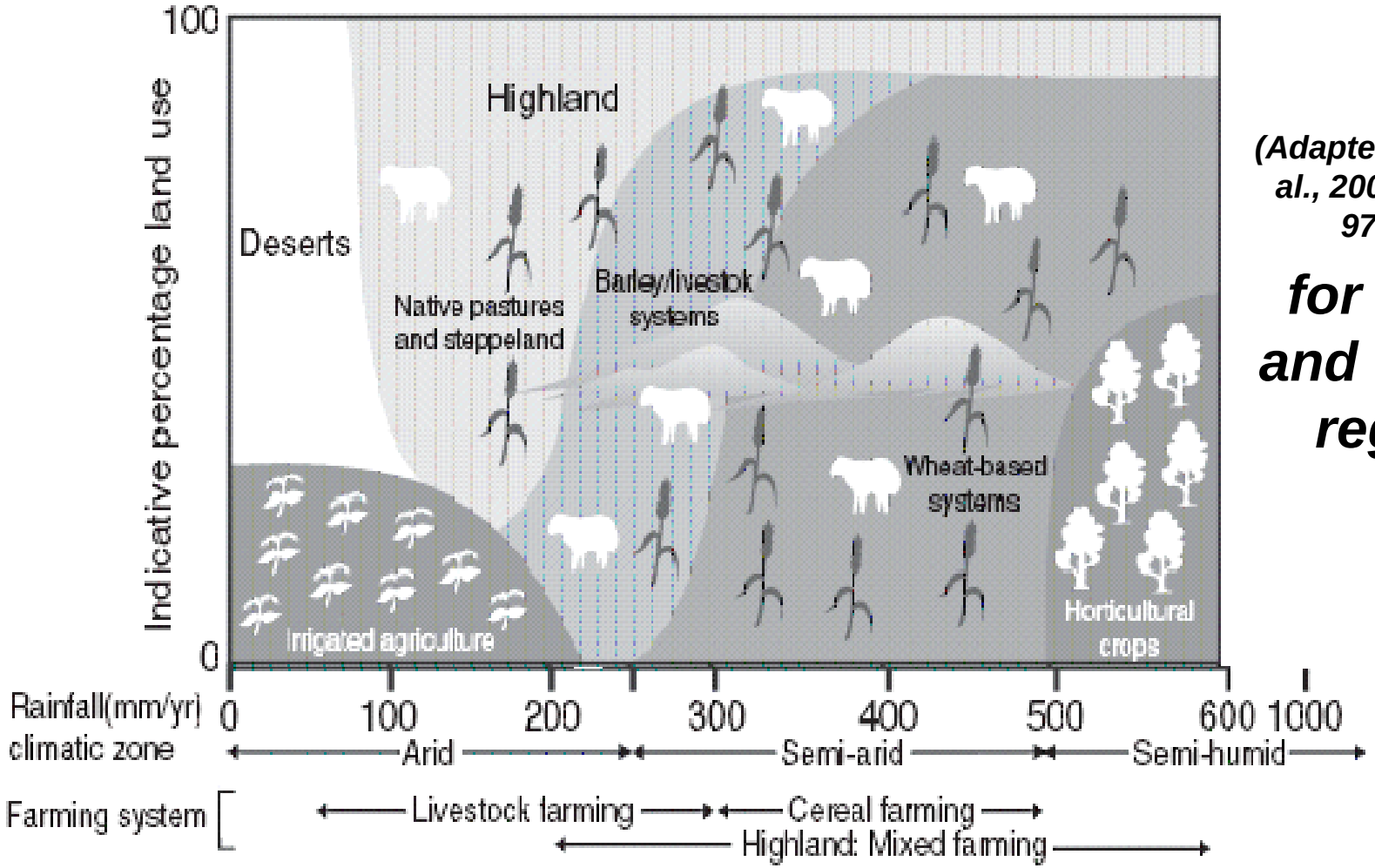

(Adapted from Ryan, et al., 2008 Adv. Agron. 97, 273-319)

for Syria and WANA region

Lopez-Bellido (1982) defined a similar situation for the south of Europe

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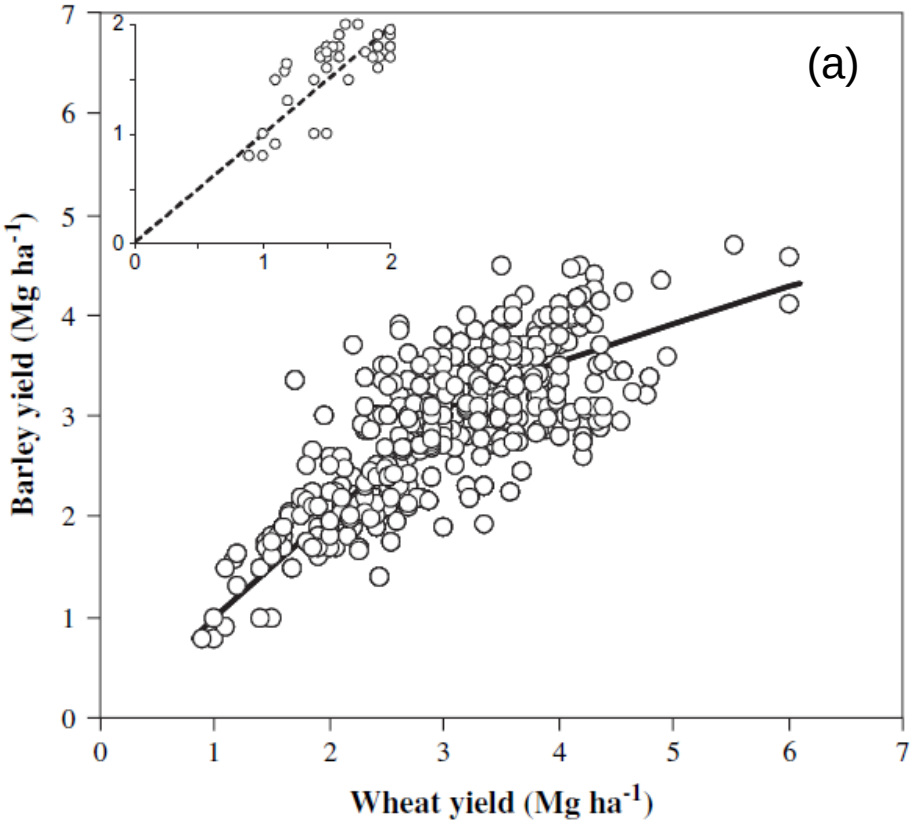

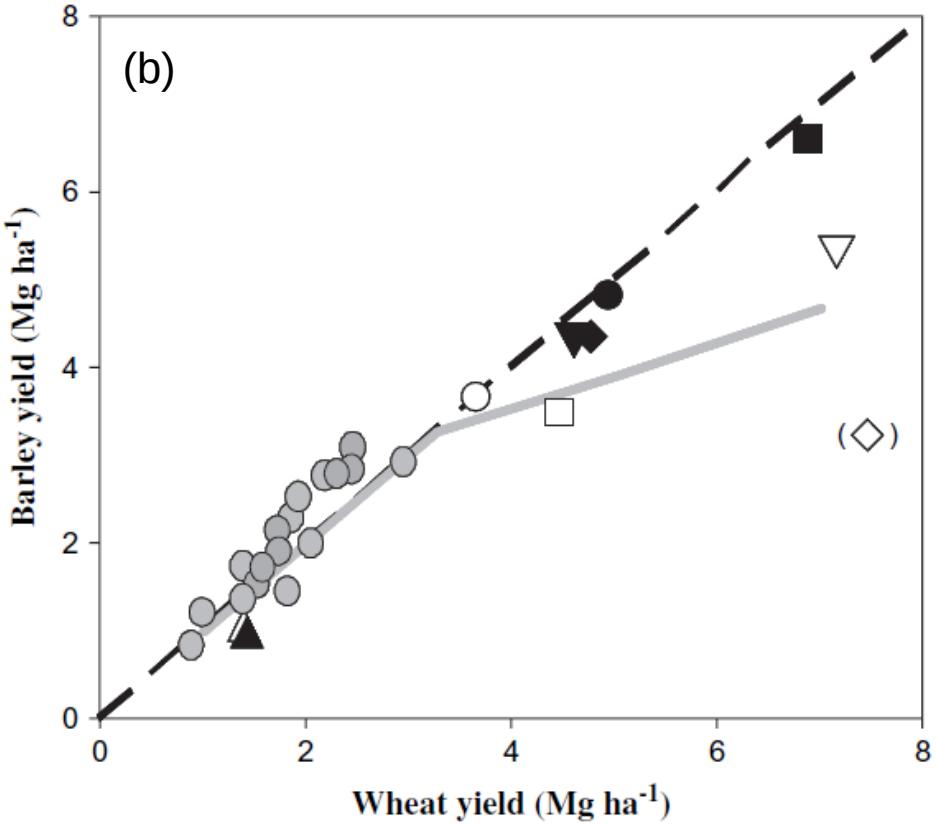

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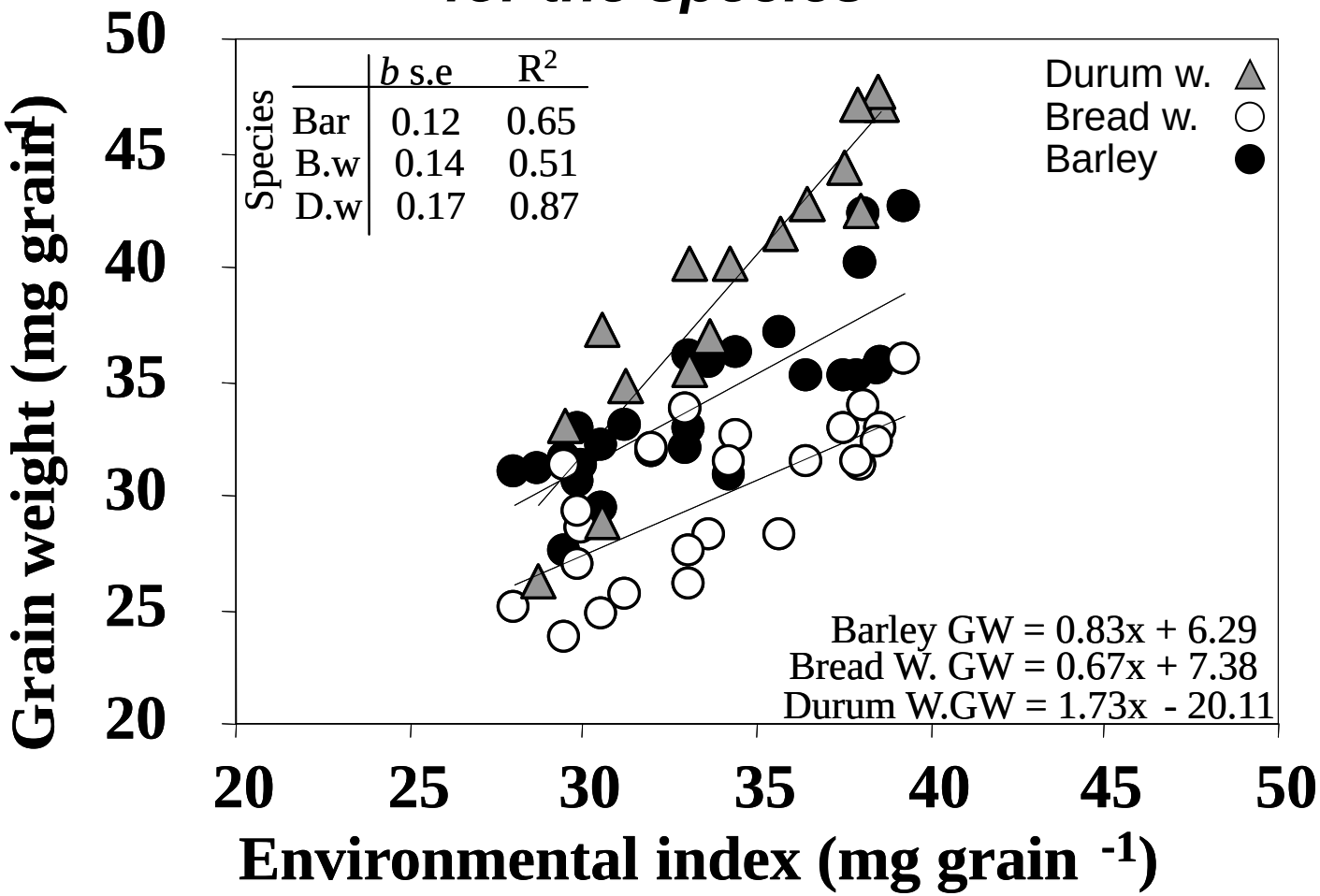
An environmental index from 28.1 to 39.3 mg was explored for the species



Grain weight variation was explained by both Maximum Grain Filling Rate and Duration of Grain Filling for the three species

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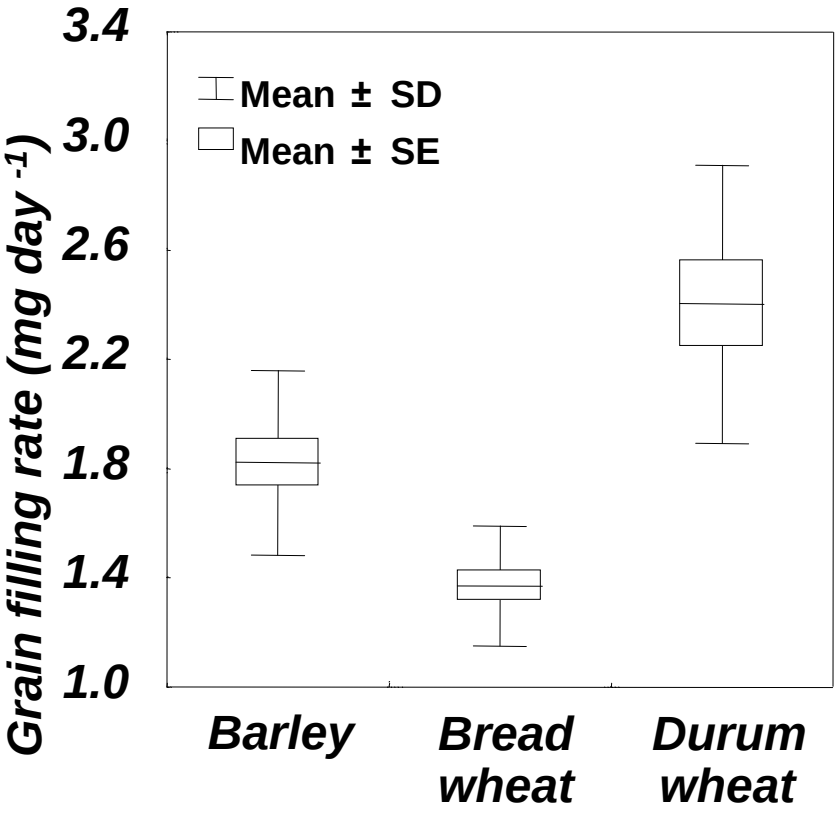
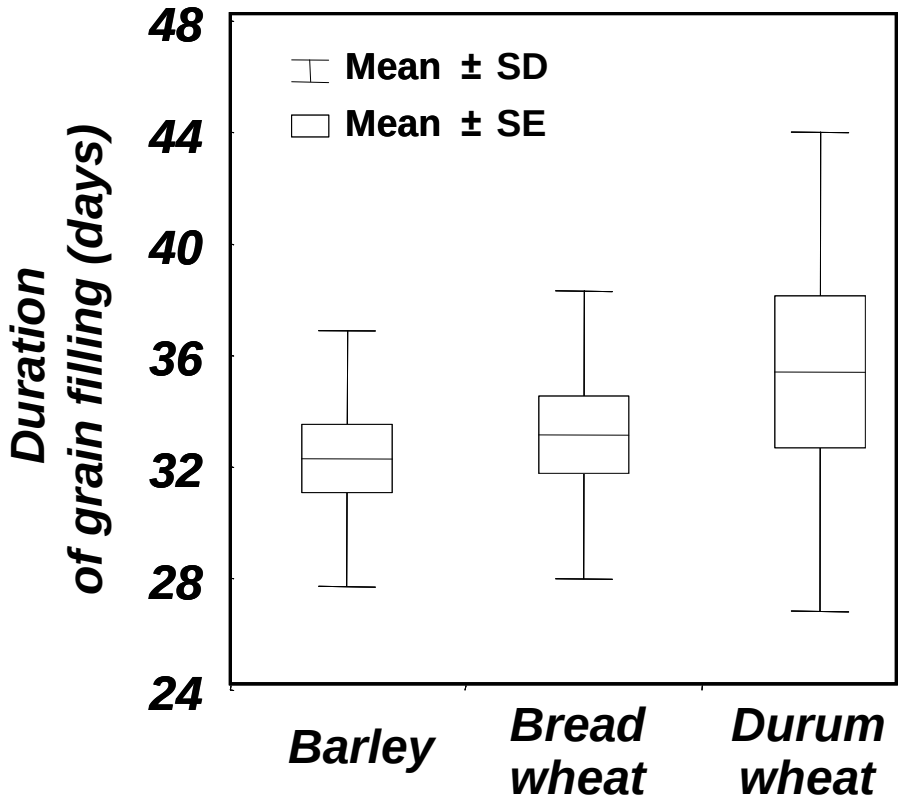
Durum wheat presented the highest range explored of Grain Filling Rate and Duration of Grain Filling





Bread wheat had similar or more stability than barley in terms of MGFR and DGF

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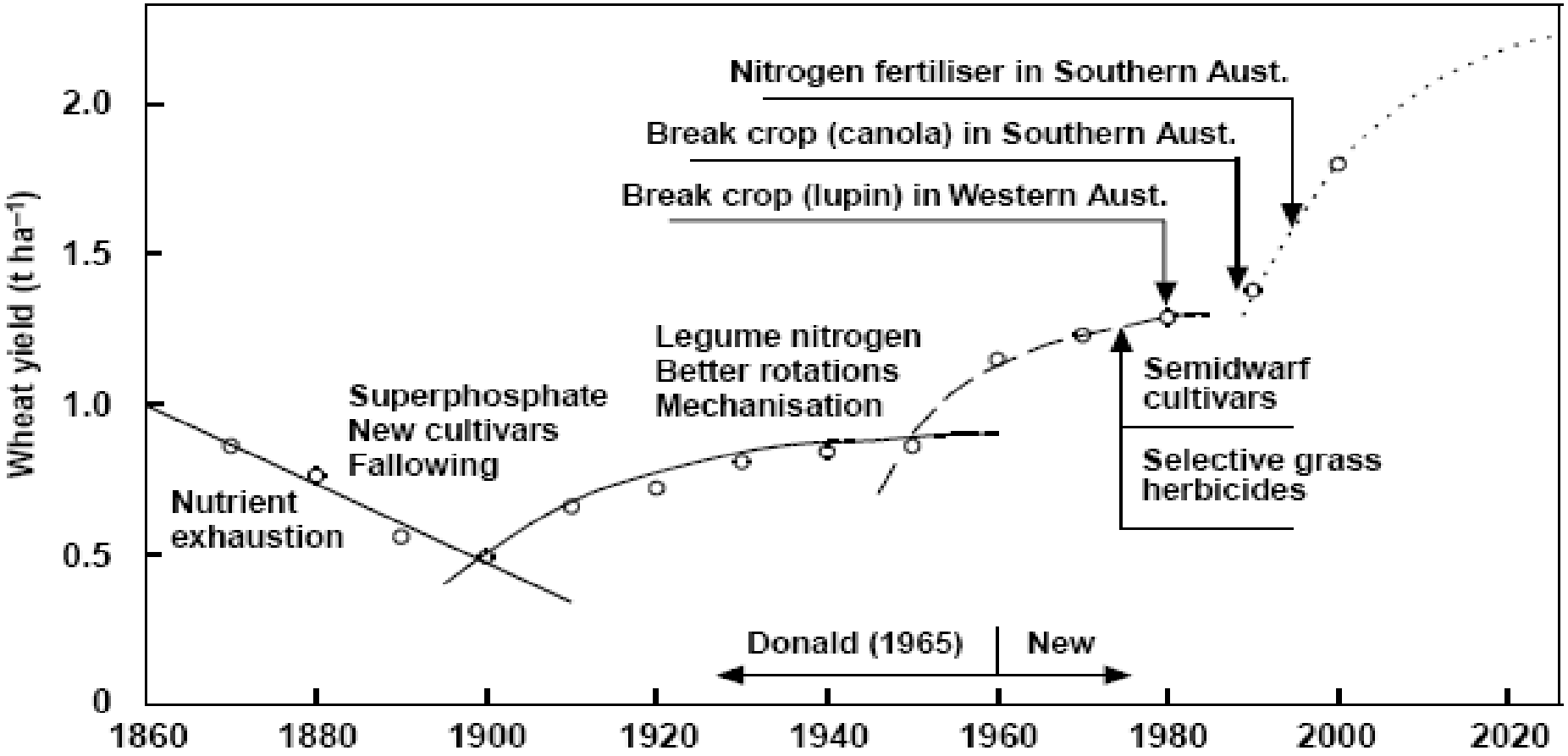
Naturally, the problem with lack of yield stability are the cases in which yield is low (on the other end we see the same characteristic as favourable and call it “responsiveness”).

Identifying traits to select for so that newer cultivars may maintain responsiveness when the environmental condition is better than average while reducing yield penalties in stressful conditions,

and/or

Designing strategies to reduce the penalty imposed by water stress on yield … but these strategies may not include irrigating in Mediterranean conditions, as opportunities to have good quality water available are more than limited

would be instrumental for breeding and management



As there are only limited or no possibility of increasing irrigation, N fertilization may be a way to increase the efficiency in use the limited water and to capture more resources (fertilizing water-stressed crops may sound anti-intuitive)

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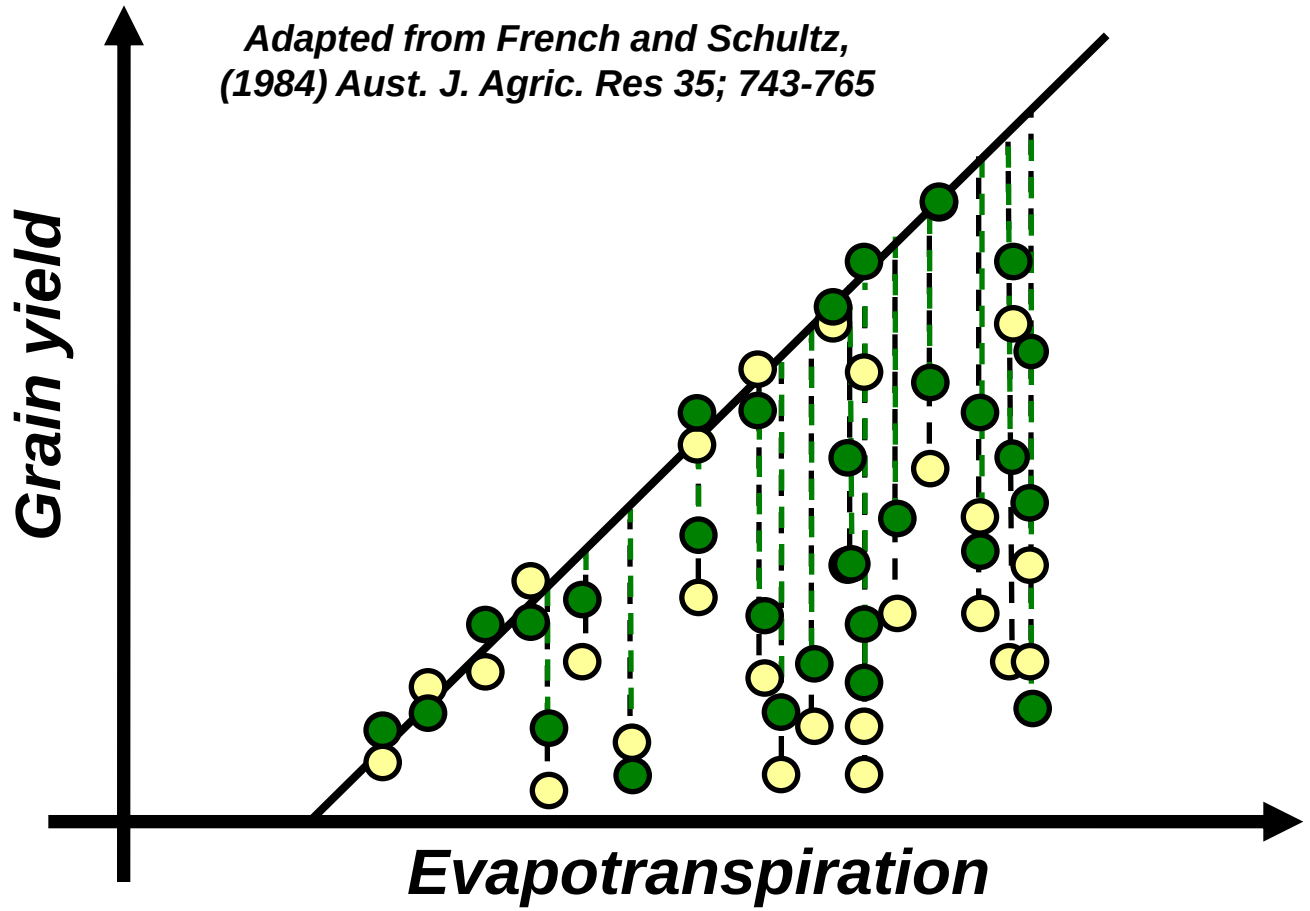
N fertilization allow increasing grain yield at a particular level of evapotranspiration decreasing differences between maximum and actual yields



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Field experiments in Agramunt (Catalonia, Spain)

We rent farmer fields, and we sown, and grew the crops using the usual farm work practices and farmer's machines

Experiments

Exp. I (2004/05)

Exp. II (2005/06)

Exp. III (2006/07)

Exp. IV (2006/07) late sowing

Barley

Bread wheat

Durum wheat

Cultivars were chosen to represent successful modern cultivars sown in the region

A wide range of N fertilization

0 to 200 Kg N ha supplied

Two water regimes

Exp.	Specie	Sowing date	Water regime	Nitrogen ($Kg_N\ ha^{-1}$)
I	Barley Bread wheat	16-Nov-04	Rainfed Irrigated	0 and 200
II	Barley Durum wheat Bread wheat	28-Nov-05	Rainfed Irrigated	0-50-100 and 150
III	Barley Durum wheat Bread wheat	06-Nov-06	Rainfed Irrigated	0-75 and 150
IV	Barley Durum wheat Bread wheat	22-Feb-07	Rainfed	0 and 150

	Initial water content (mm)	*Initial N (1m depht)* ($Kg_N\ ha^{-1}$)
I	83	34
II	240	115
III	201	150
IV	153	143

Picture by CM Cossani

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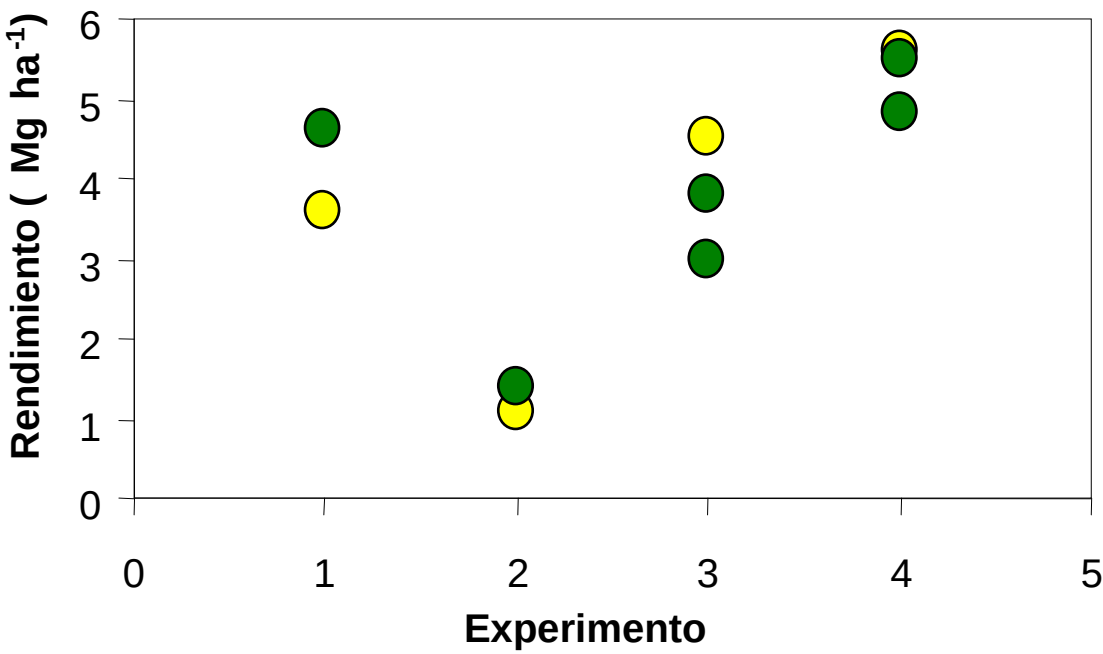

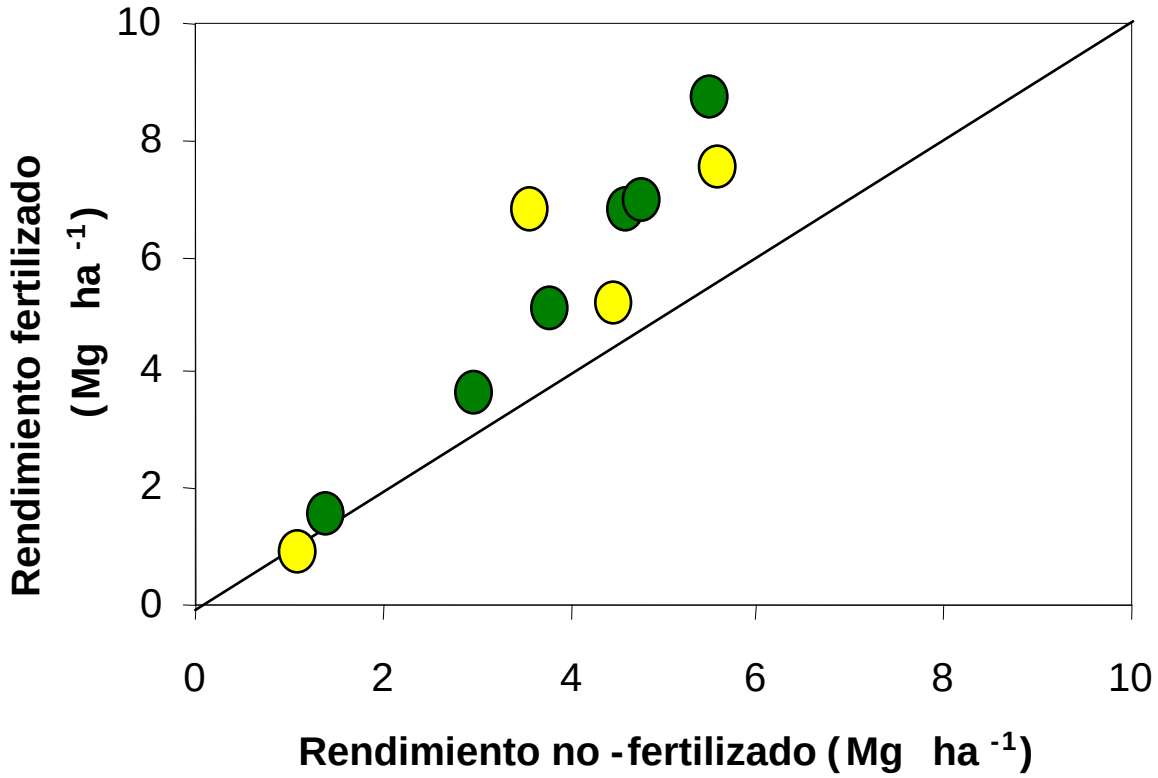

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- Simulated experimental conditions:
  - Anza and Soissons
  - Agramunt, Catalonia (NE Spain)
  - 17 continuous growing seasons (1989-2007)

Simulation of attainable yield:
- N availability at sowing:
50, 100, 150, 200, and 250 kg_N ha^{-1}
- Water availability: rain-fed conditions

Simulation of potential yield:
- N availability: non limiting
- Water availability: non limiting

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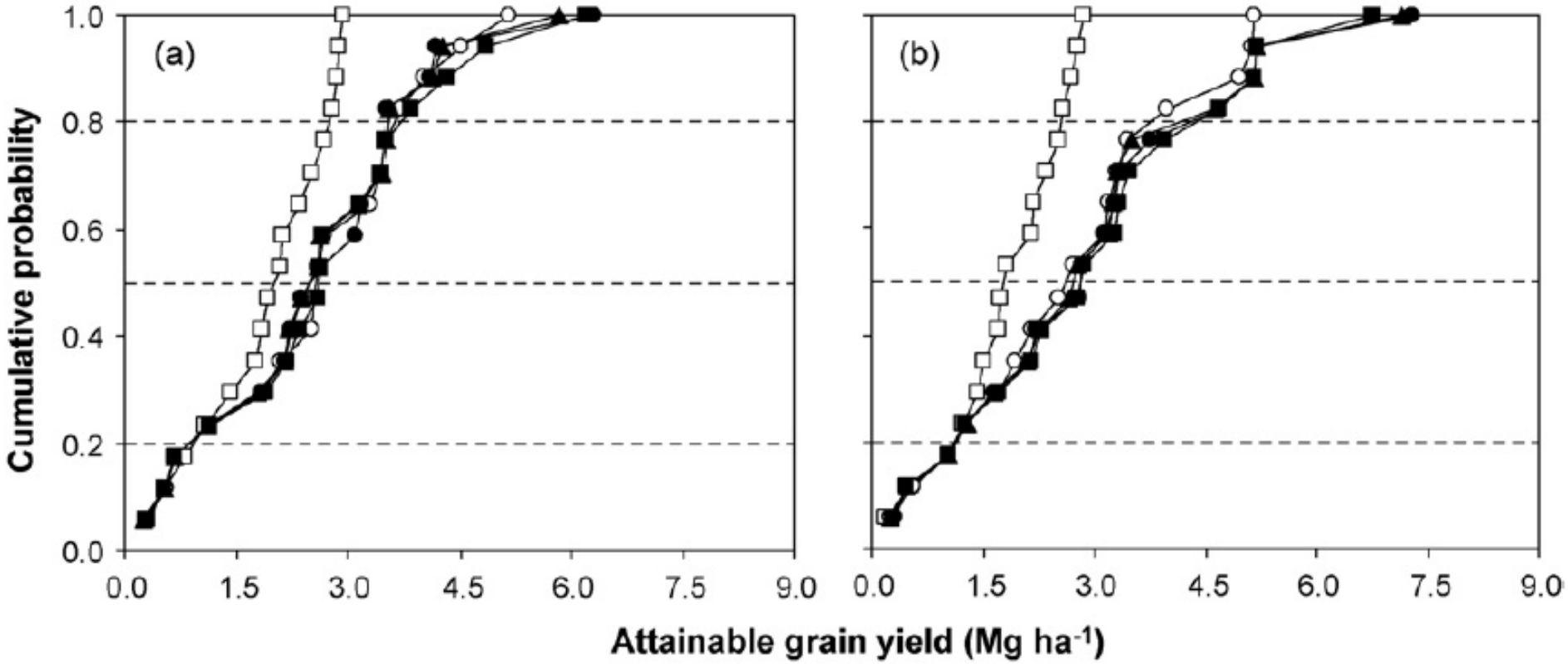

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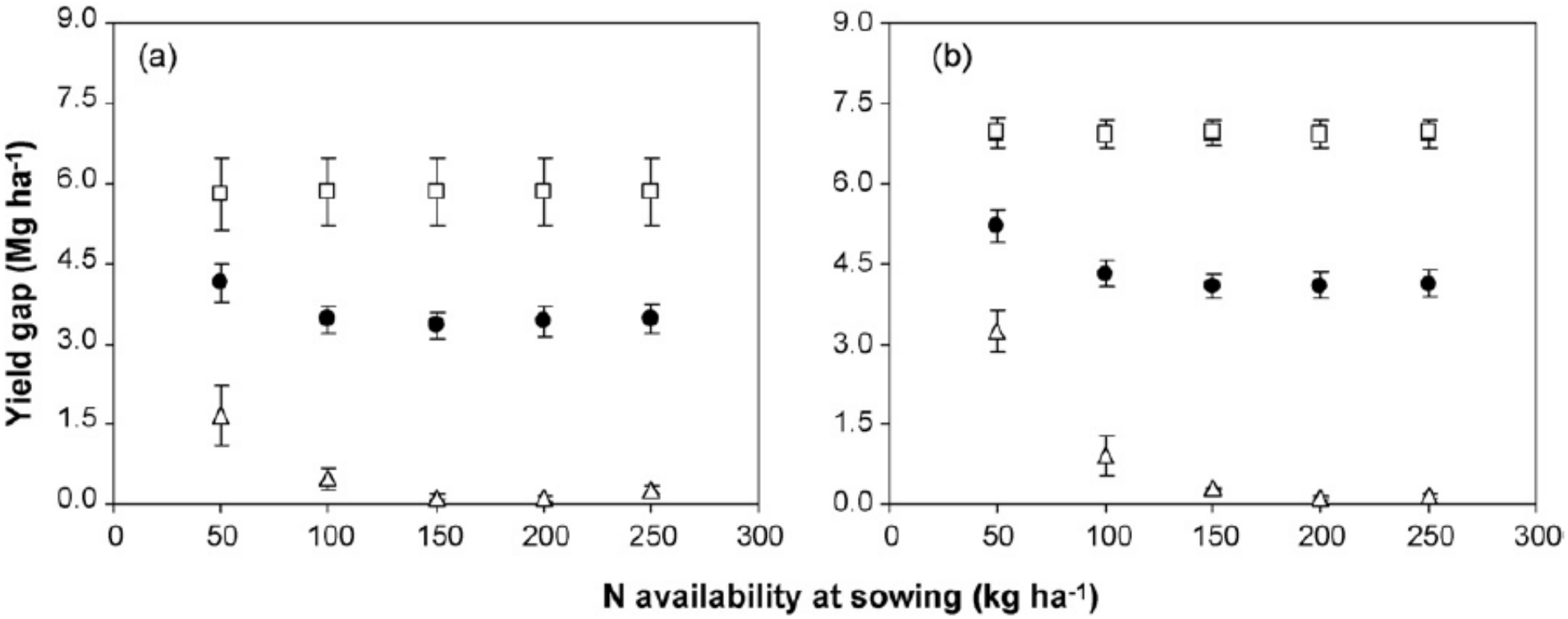

● promedio de los años simulados
□ los tres años con mayor diferencia de rendimientos
△ los tres años con mayor diferencia de rendimientos

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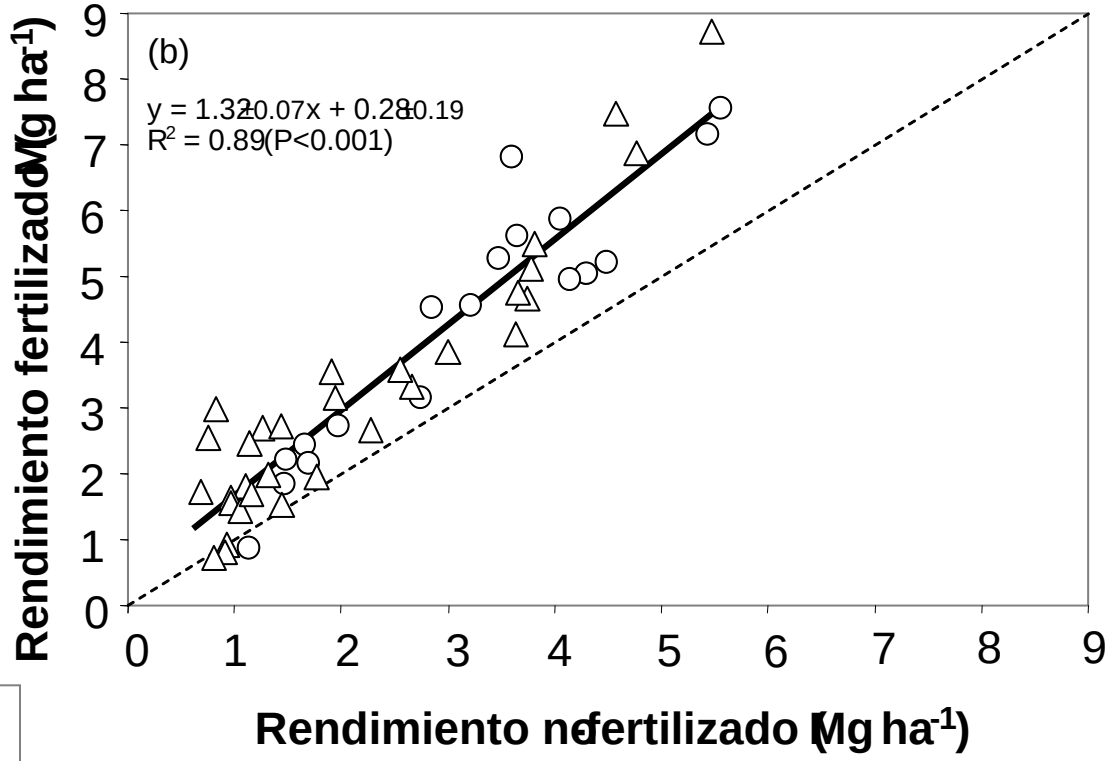
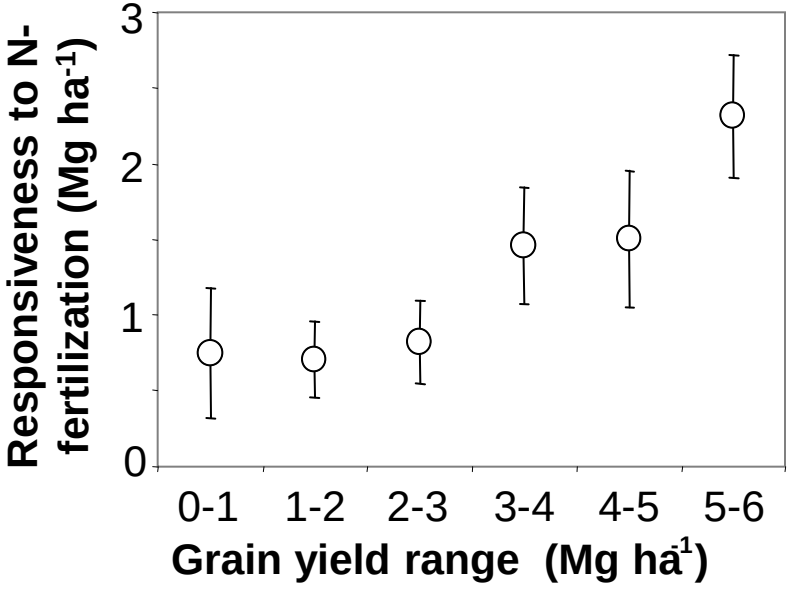
Red de 16 experimentos (localidades x años) con fertilizaciones con N en trigo y cebada en condiciones de secano en diferentes áreas de la cuenca del Mediterráneo

Marruecos
Jordania
Italia
España

Proyecto WatNitMED





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Merchouch Experimental Station 2007

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Domaine Experimental de Sidi El Aidi

Rainfed, unfertilised

Rainfed, fertilised

Top view

Canopy level view

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Prueba piloto en campos de agricultores en Túnez

Table 1. Crop information for all the experimental cases at sowing time and soil properties.

Case	Location	Sowing date	Cultivar	Sowing density (kg ha^{-1})	Organic matter (%) (0–20 cm)	Mineral N in soil at sowing (kg N ha^{-1})	Soil bulk density (0–20 cm)	Soil bulk density (20–40 cm)	Soil bulk density (40–60 cm)	pH
1	Béja	04 Dec 07	Karim	220	3.0	37	1.25	1.23	1.40	8.00
2	Béja	15 Nov 07	Karim	200	2.9	48	1.38	1.50	1.48	8.15
3	Béja	07 Dec 07	Karim	180	2.8	39	1.50	1.50	1.40	8.20
4	Béja	20 Nov 07	Karim	180	2.8	55	1.35	1.28	1.32	8.30
5	Béja	20 Nov 07	Karim	200	3.2	106	1.42	1.45	1.44	8.30
6	Béja	18 Nov 07	Karim	200	3.3	96	1.50	1.45	1.44	8.15
7	Béja	18 Nov 07	Khiar	250	2.7	44	1.38	1.40	1.28	8.00
8	Béja	20 Nov 07	Razak	140	2.9	89	1.28	1.33	1.41	8.10
9	Béja	06 Dec 07	Karim	200	3.1	79	1.43	1.38	1.44	8.00
10	Siliana	15 Nov 07	Razak	180	1.5	41	1.33	1.25	1.25	8.00
11	Siliana	20 Nov 07	Maali	180	1.8	23	1.33	1.32	1.56	8.05
12	Siliana	20 Nov 07	Razak	180	2.1	47	1.54	1.50	1.32	8.15
13	Siliana	17 Nov 07	Razak	160	1.2	48	1.54	1.50	1.32	8.15
14	Siliana	15 Nov 07	Oum Rabi	160	1.8	35	1.44	1.31	1.29	8.00
15	Siliana	20 Nov 07	Razak	180	2.0	20	1.25	1.32	1.34	7.95
16	Siliana	10 Nov 07	Karim	160	2.1	34	1.33	1.34	1.42	8.20
17	Siliana	15 Nov 07	Razak	180	2.2	24	1.45	1.55	1.34	8.00
18	Siliana	10 Dec 07	Razak	160	1.6	45	1.24	1.36	1.28	8.05
19	Siliana	05 Dec 07	Karim	180	n.a.	47	1.33	1.26	1.23	8.20
20	Siliana	29 Nov 07	Razak	180	n.a.	33	1.25	1.35	1.33	8.05

Note: Mineral N in soil at sowing represent N availability at 60 cm depth.

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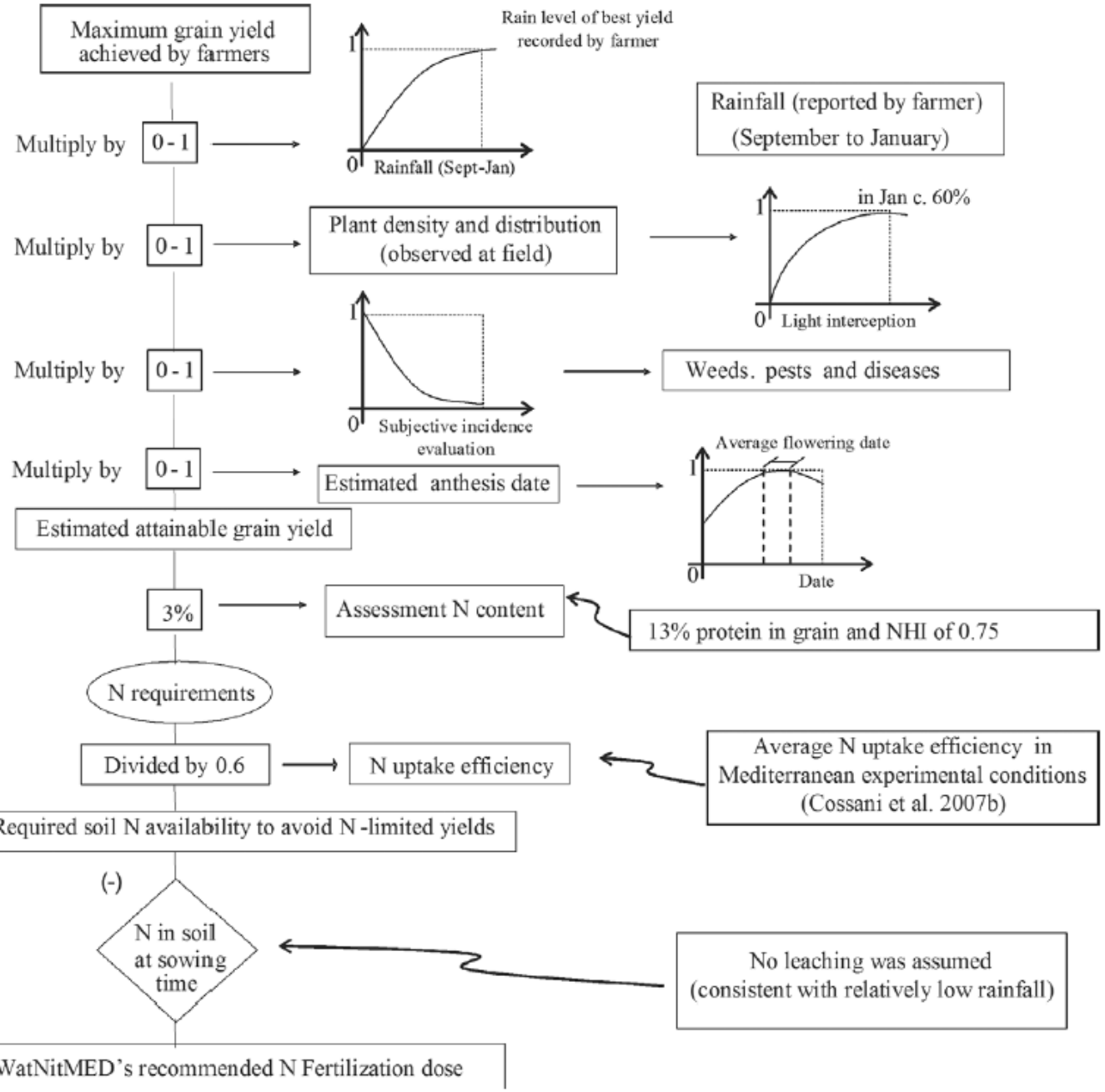

1. Scheme of the procedure used for N recommendation in each of the 20 fields in which the experiment was carried out (for details see text). NHI: nitrogen harvest index.

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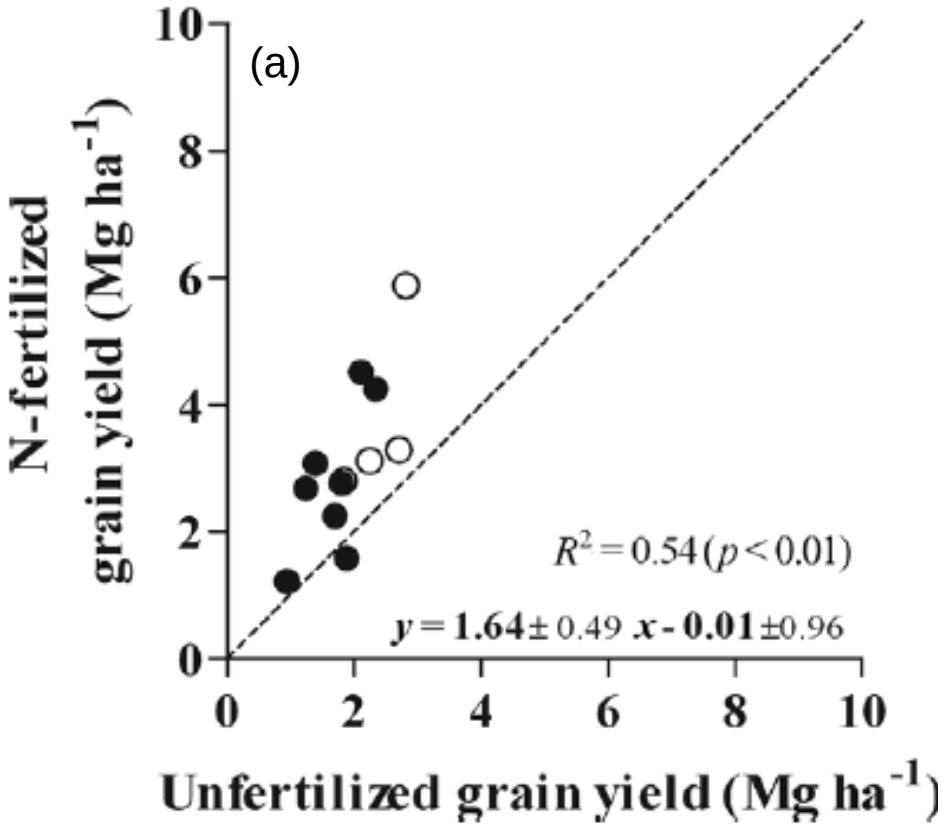

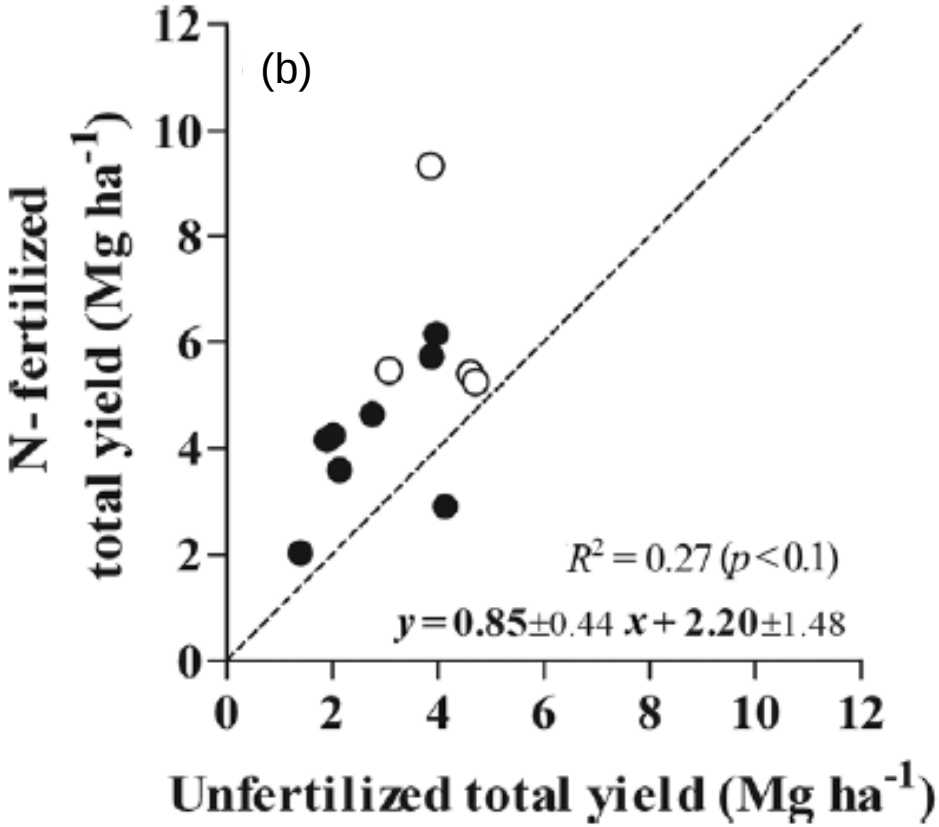

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Final remarks

- **As expected, inter-annual variation in yield was large in the Mediterranean conditions, whether it is seen at the level of State (Spain), country (Catalonia), province (Lleida), County (Urgell), location (Agramunt), or experimental plots**

- **Variability in yield (and components) was similar in barley and wheat, and in both species yield penalties are very large when the year is severely stressful (gap between actual and potential yield as large as 7-8 Mg ha-1, with potential yields lower then in other, non-Mediterranean regions**

- **It might be feasible to mitigate the penalties imposed by water stress through manipulating N fertilization more accurately (particularly in countries in which cereal production is not subsidized; even though it might seem unsound to apply N when the main constraint is water availability** (in real crops the Liebig's law of the minimum doesn't seem apply as compensations among resources through plant acclimations may take place determining that the interplay among factors is what does really counts as shown mainly with models by Sadras [2004, 2005] and empirically by Cossani et al. [2010]).

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Field Crops
European Journal of
Annals of Applied Biology ISSN 0003-4746
Ann Appl Biol 151 (2007) 167–173 © 2007 The Authors
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Field Crops Research 121 (2011) 240–247

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doi:10.1017/S0014479711000044

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IMPROVING WHEAT YIELDS THROUGH N FERTILIZATION IN MEDITERRANEAN TUNISIA

By C. MARIANO COSSANI†‡, CHOKRI THABET§, HAFEDH J. MELLOULI¶ *and* GUSTAVO A. SLAFER†, ††

†Department of Crop and Forest Sciences, University of Lleida, Centre UdL-IRTA, Av. Rovira Roure 191, 25198, Lleida, Spain, §Department of Economy and Rural Development, Institut Supérieur Agronomique de Chott Mériem, Chott Mériem, Tunisia, ¶INRAT (National Agricultural Research Institute of Tunisia, Rue Hedi Karray, 2049 Ariana, Tunisia and ††ICREA (Catalonian Institution for Research and Advanced Studies), Lluís Companys 23, 08010 Barcelona, Spain

Gustavo A. Slafer

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