

Interacción entre el peso el número de granos en líneas doble haploides de trigo Estrategia para evitar la compensación entre ambos componentes del rendimiento

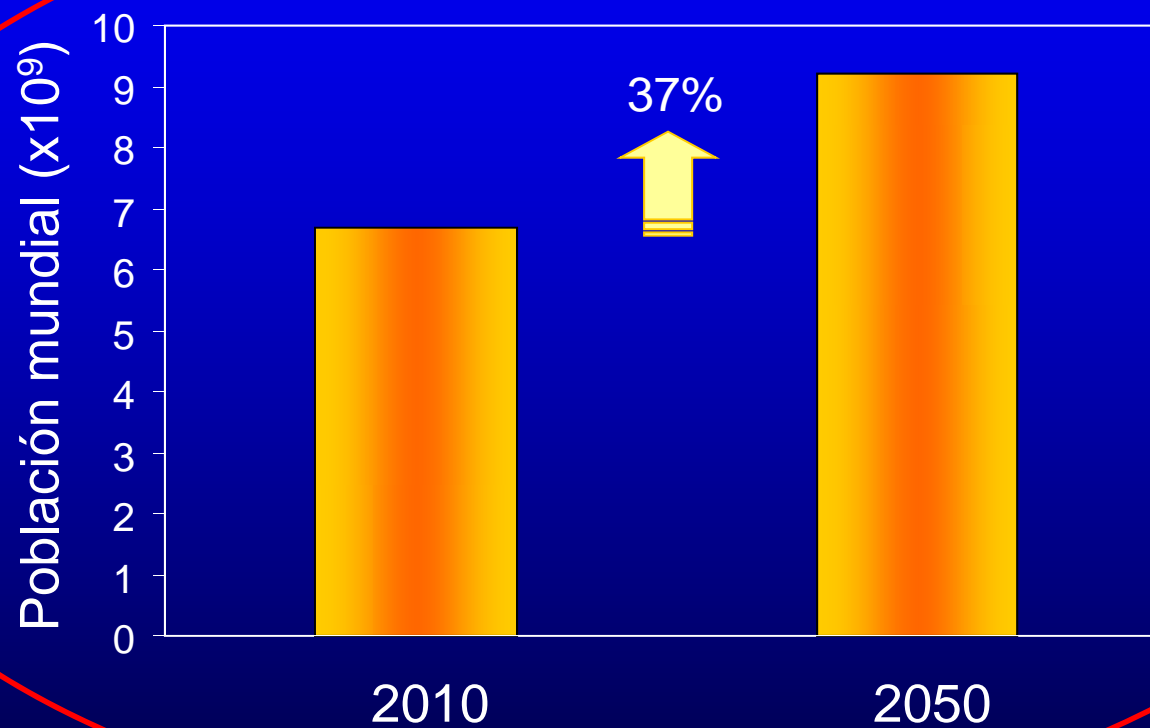
Daniel F. Calderini
Universidad Austral de Chile



Porto Alegre, octubre 2012

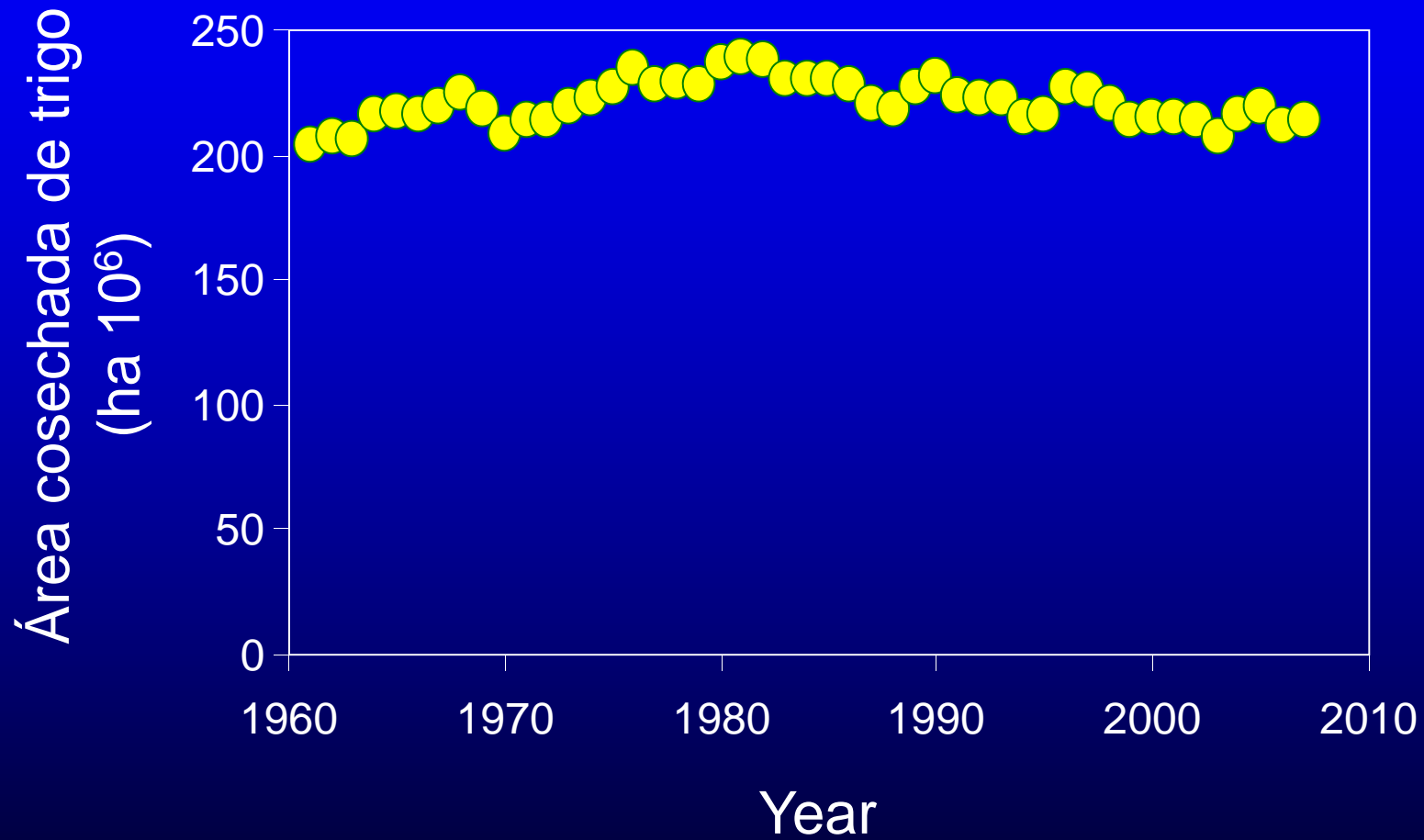
Población Mundial (2010-2050)

Producción amigable ambiente
Cambio Climático



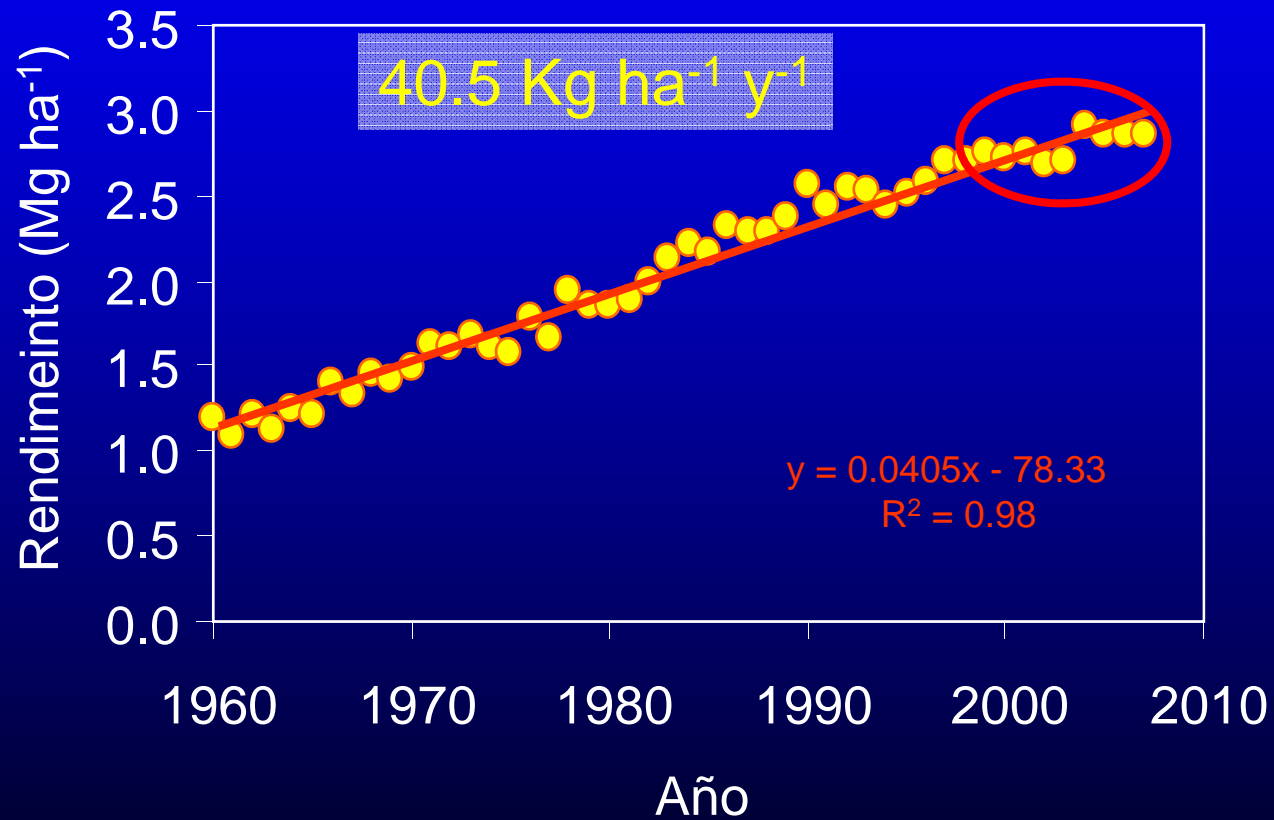
Naciones Unidas (2007)

Área de Trigo (1960-2007)

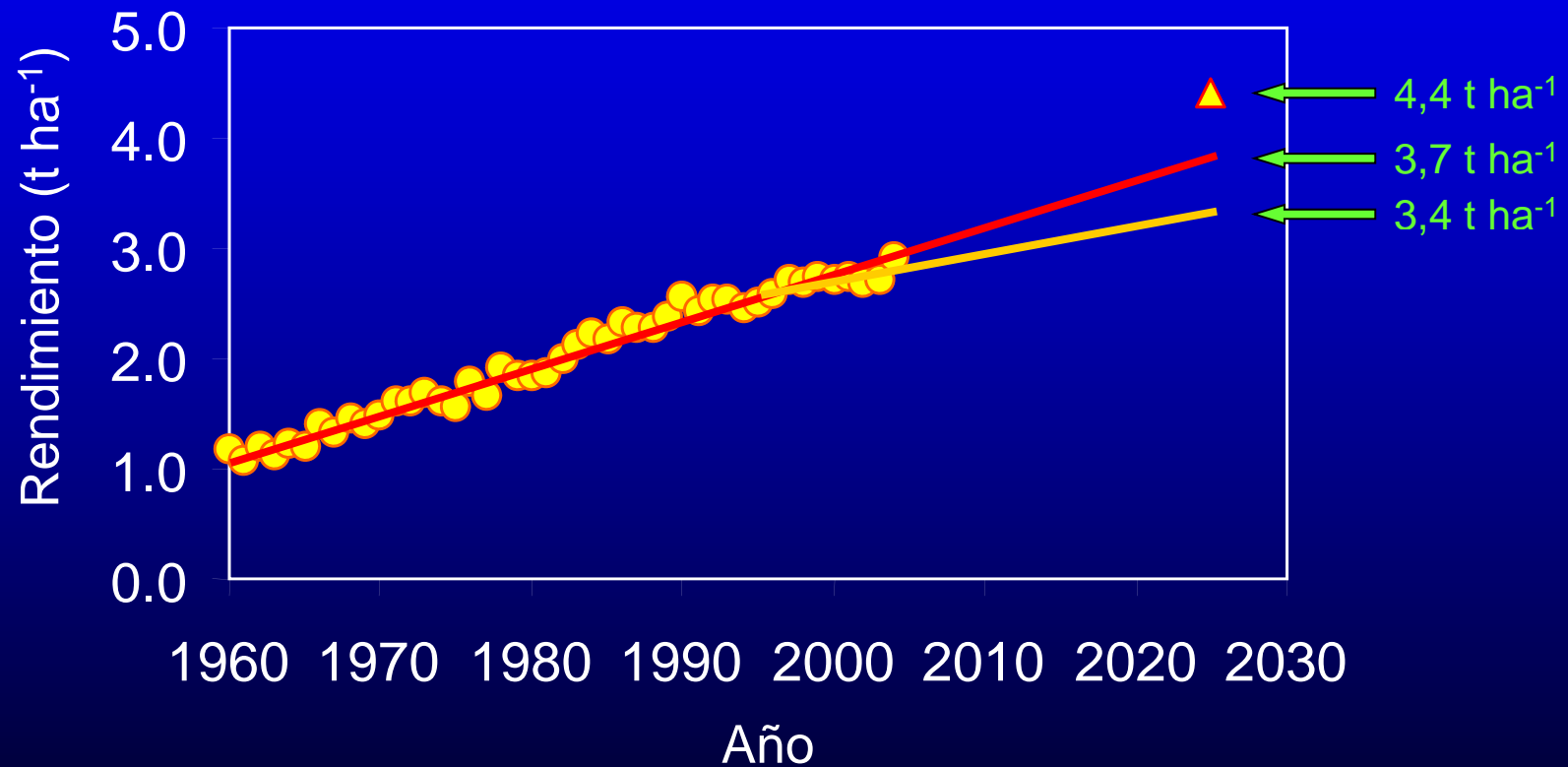


FAO (2010)

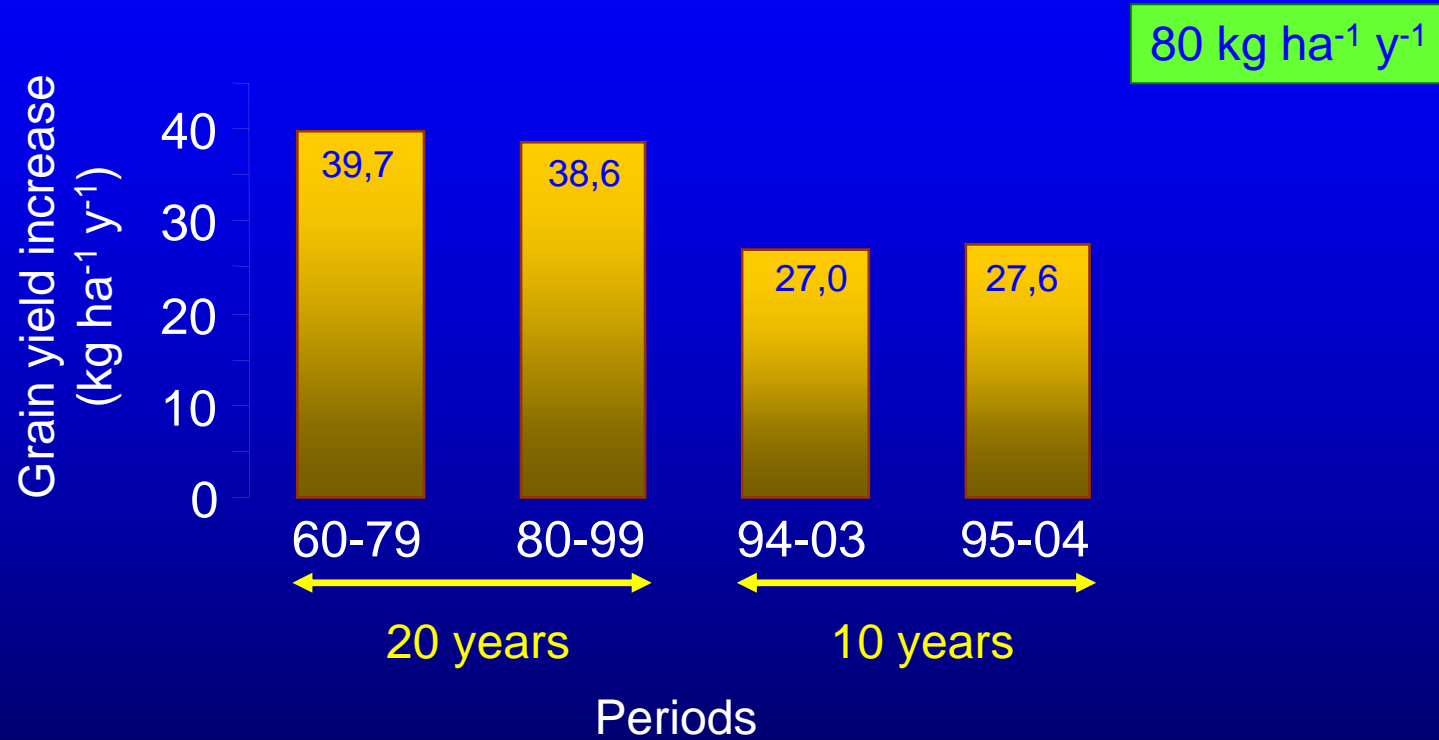
Promedio de Rendimiento Mundial de Trigo (1960-2007)



Proyecciones de Rendimiento de Trigo



World Yield Increase



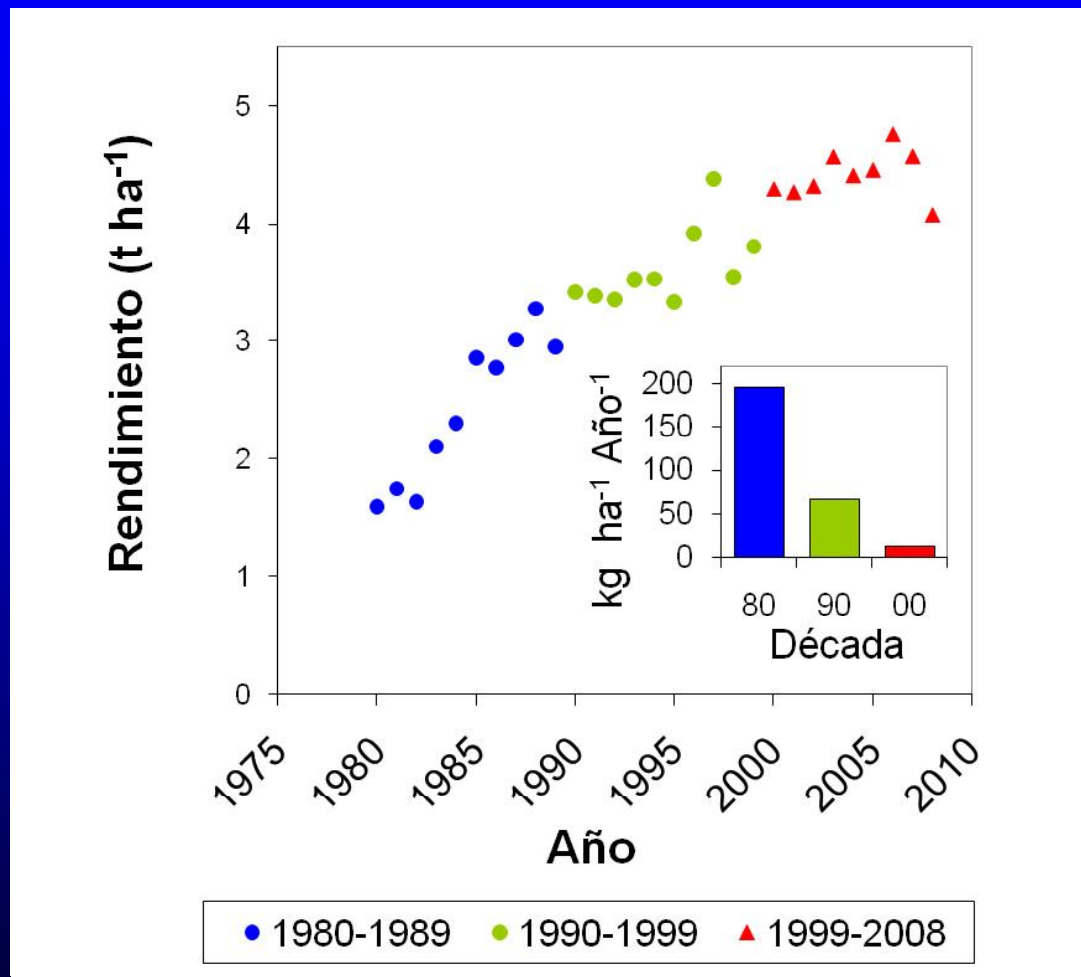
Futura Demanda Mundial de Alimentos

Rendimiento (t ha⁻¹)

	Actual		Estimado (año 2025)	
Trigo	2,8	— 57% →	4,4	80 kg ha ⁻¹ y ⁻¹
Arroz	3,1	— 71% →	5,3	110 kg ha ⁻¹ y ⁻¹
Maíz	4,1	— 41% →	5,8	85 kg ha ⁻¹ y ⁻¹

Bynes & Bumb (1998)
Fischer & Edmeades (2010)

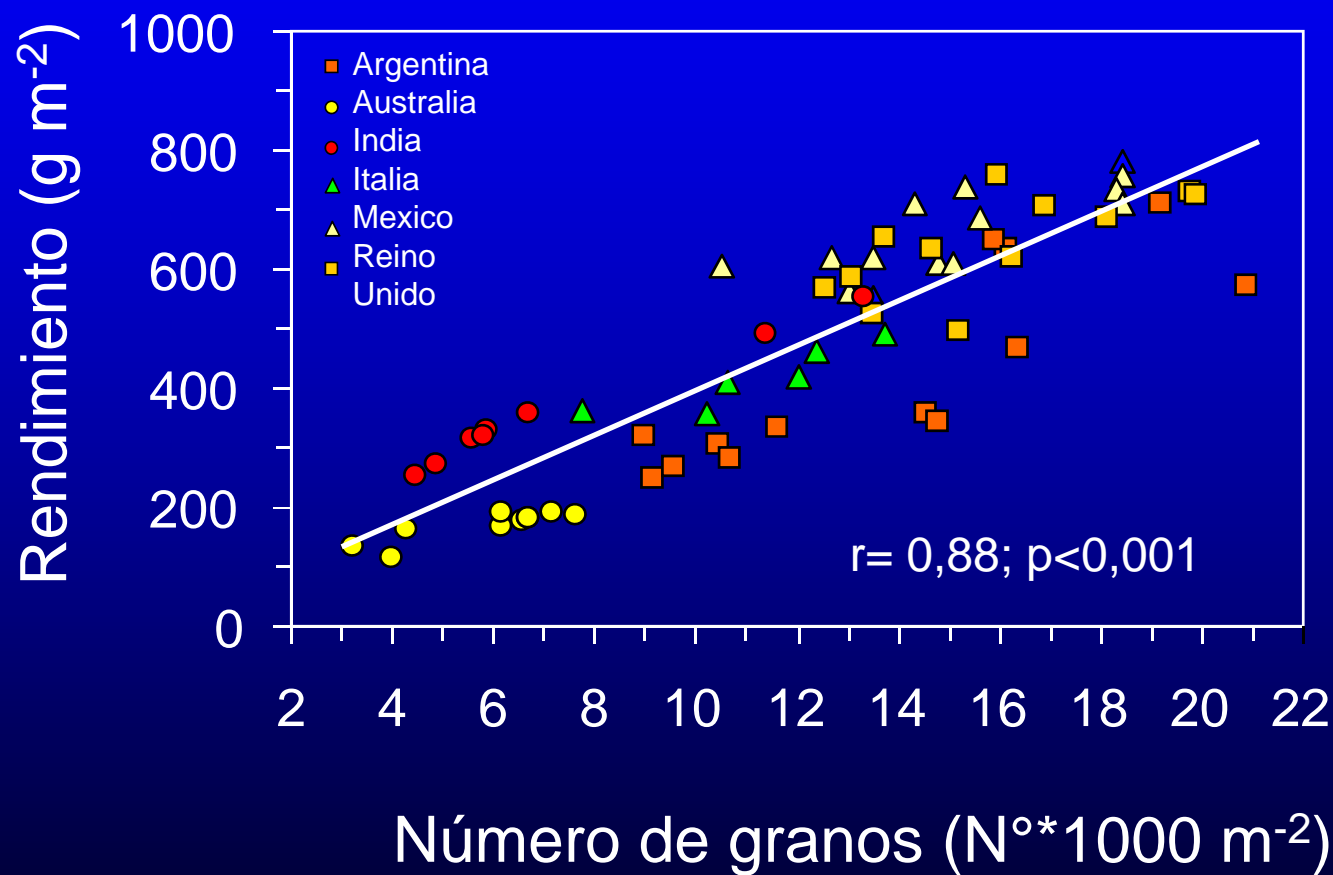
Rendimiento Medio de Trigo en Chile



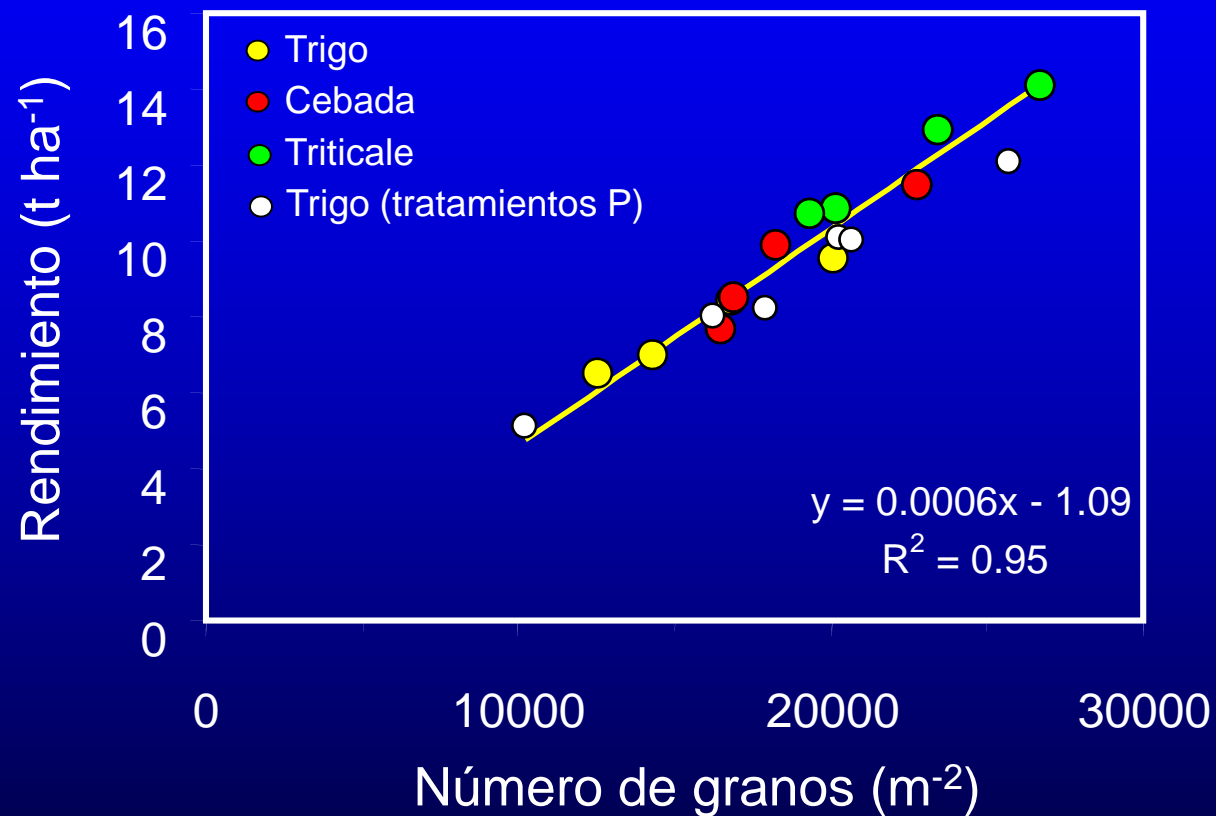
El Incremento Futuro del Rendimiento

$$\text{Rendimiento} = \text{Granos m}^{-2} \times \text{Peso de Grano}$$

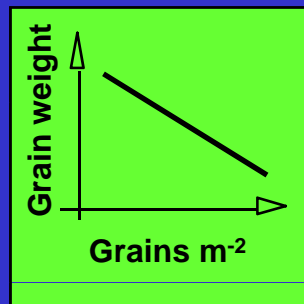
El número de granos es el componente mejor asociado con el aumento de rendimiento



Relación entre el rendimiento y el número de granos



Yield



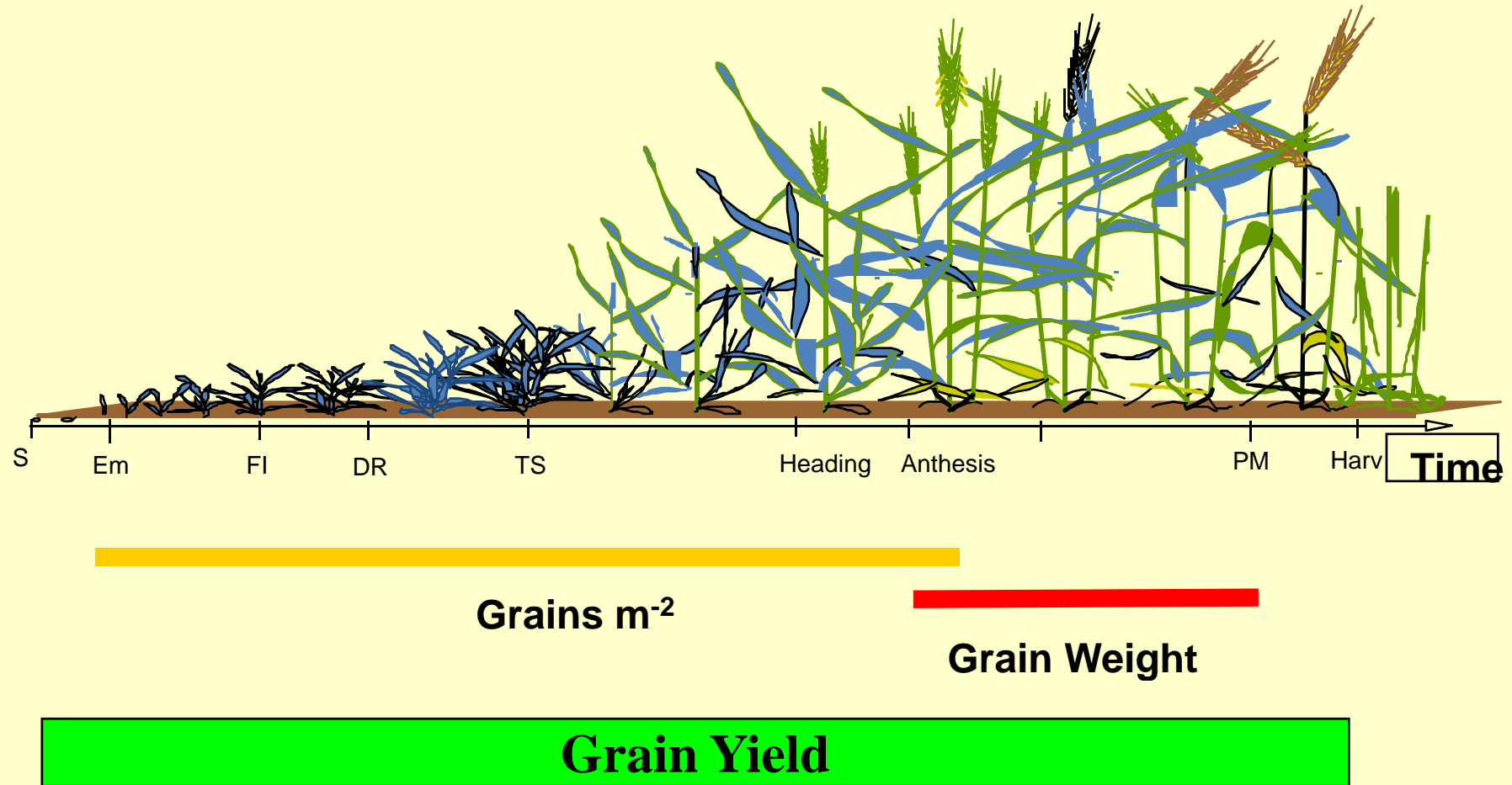
Grains
per m²

Grain
weight

Slafer (1998)

¿Limitación por fuente de asimilados durante el llenado de granos?

Determination of Yield Components



Adapted from Slafer & Rawson (1995)

Relación Fuente:Destino post-antesis en trigo

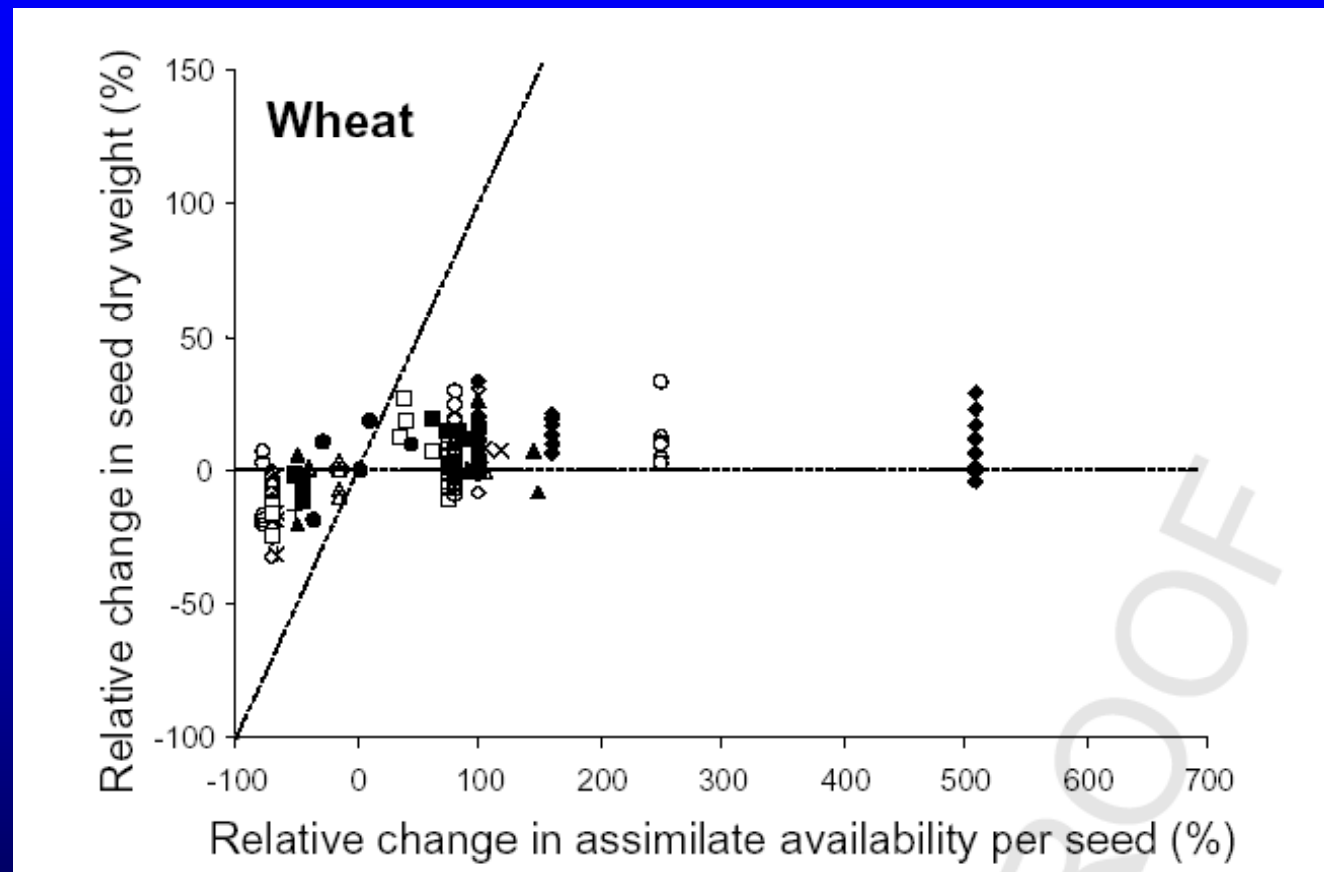


Fig. 2. Relationship between wheat relative change in seed dry weight and the relative change in potential assimilate availability per seed produced during seed-filling in a number of experiments. Dashed lines stand for the theoretical slopes of 1 (full source limitation) and 0 (full sink limitation).

Relación Fuente:Destino en Ambientes Mediterráneos

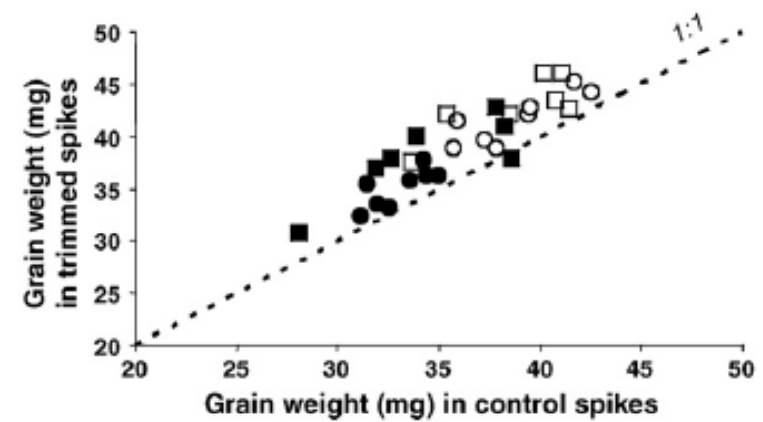
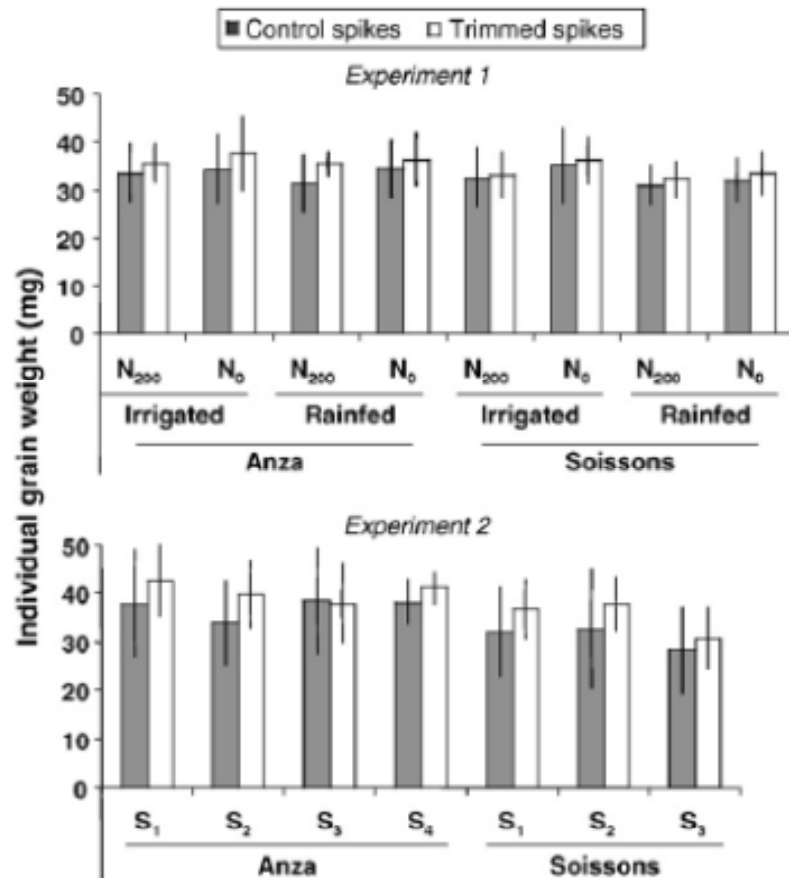
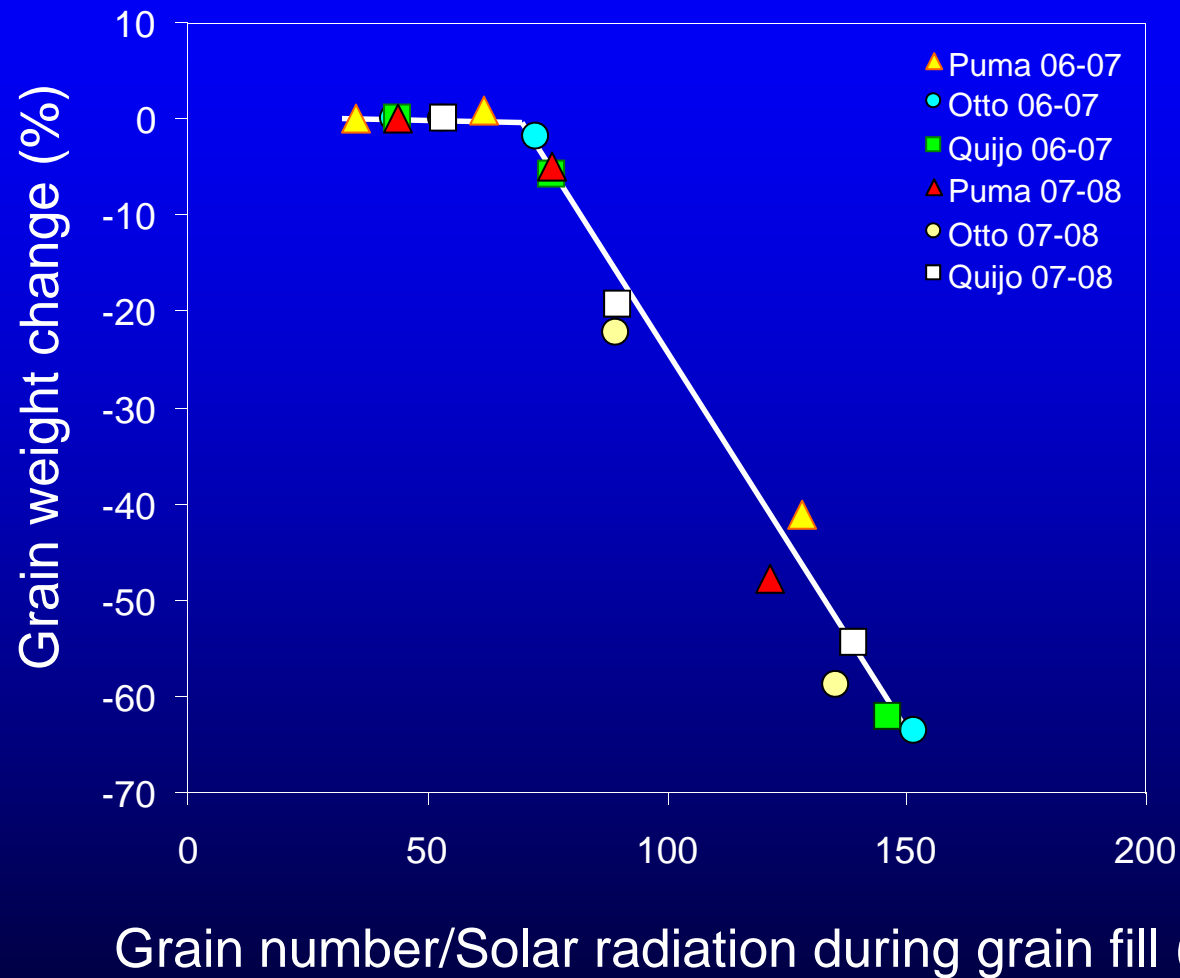


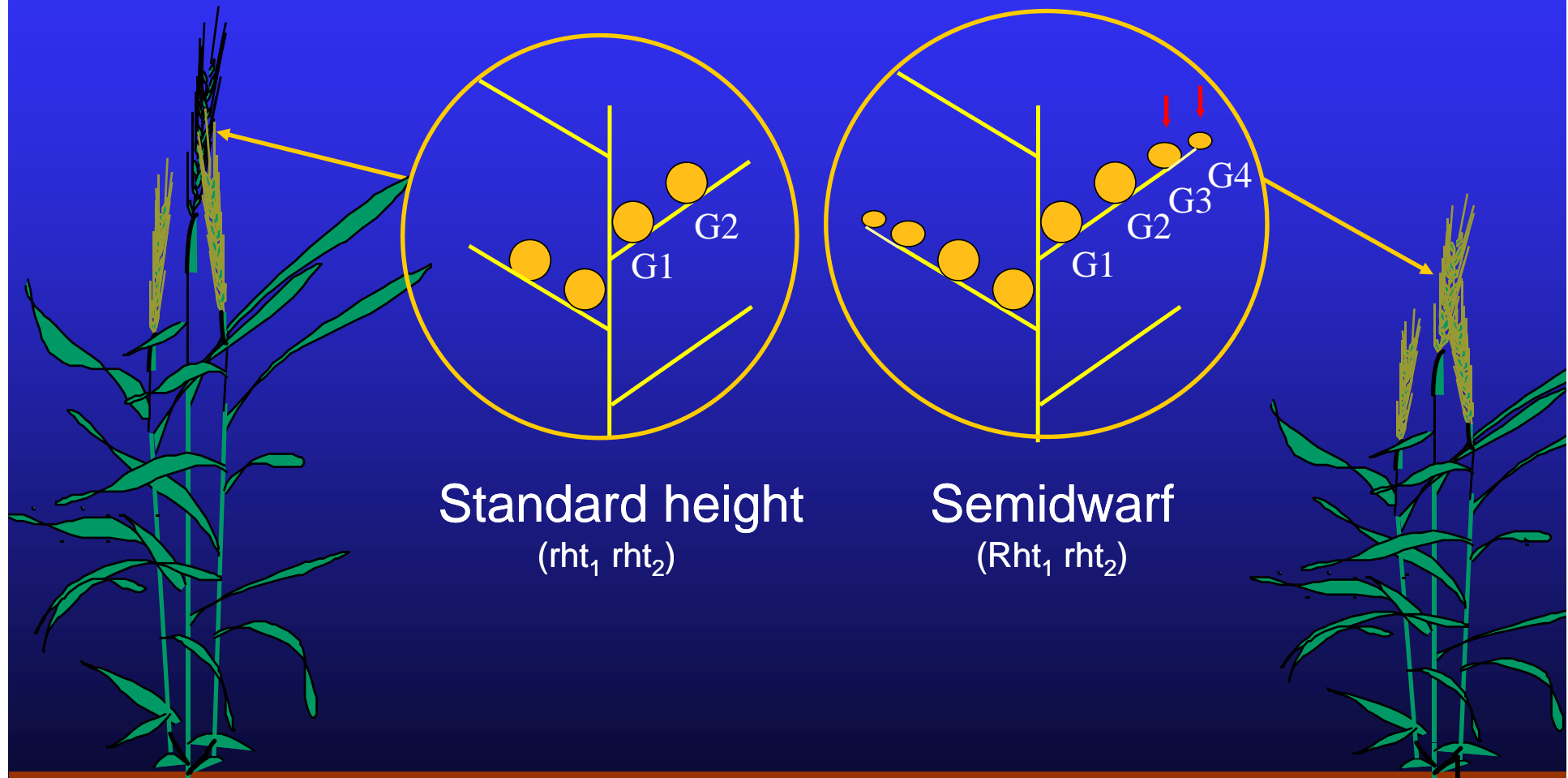
Fig. 4. Averaged grain weight for all grains in the spikes (closed symbols) and for only the proximal grains in central spikelets (open symbols) in trimmed spikes plotted against the same variable in the control spikes for each background treatment in experiments 1 (circles) and 2 (squares). Dashed line represents the 1:1 ratio.

Grain weight response to source-sink ratios



Trade off between TGW and GN could be due to the setting of smaller grains in distal positions of spikes

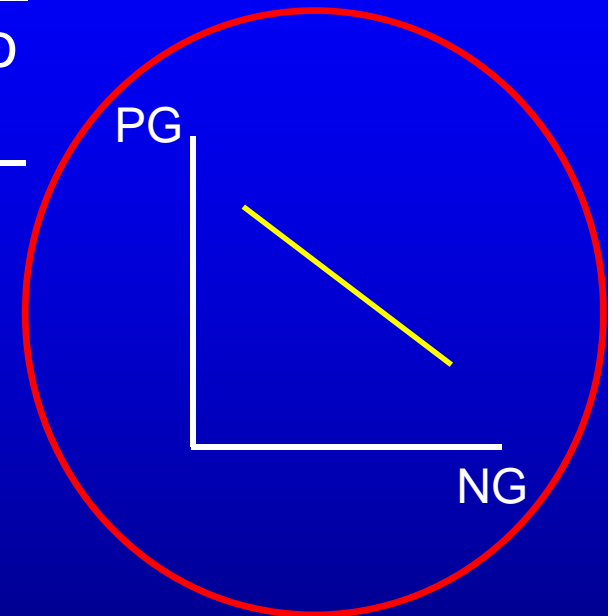
(Miralles & Slafer, 1995; Acreche & Slafer, 2006)



¿Existen compensaciones entre el peso y el número de granos?

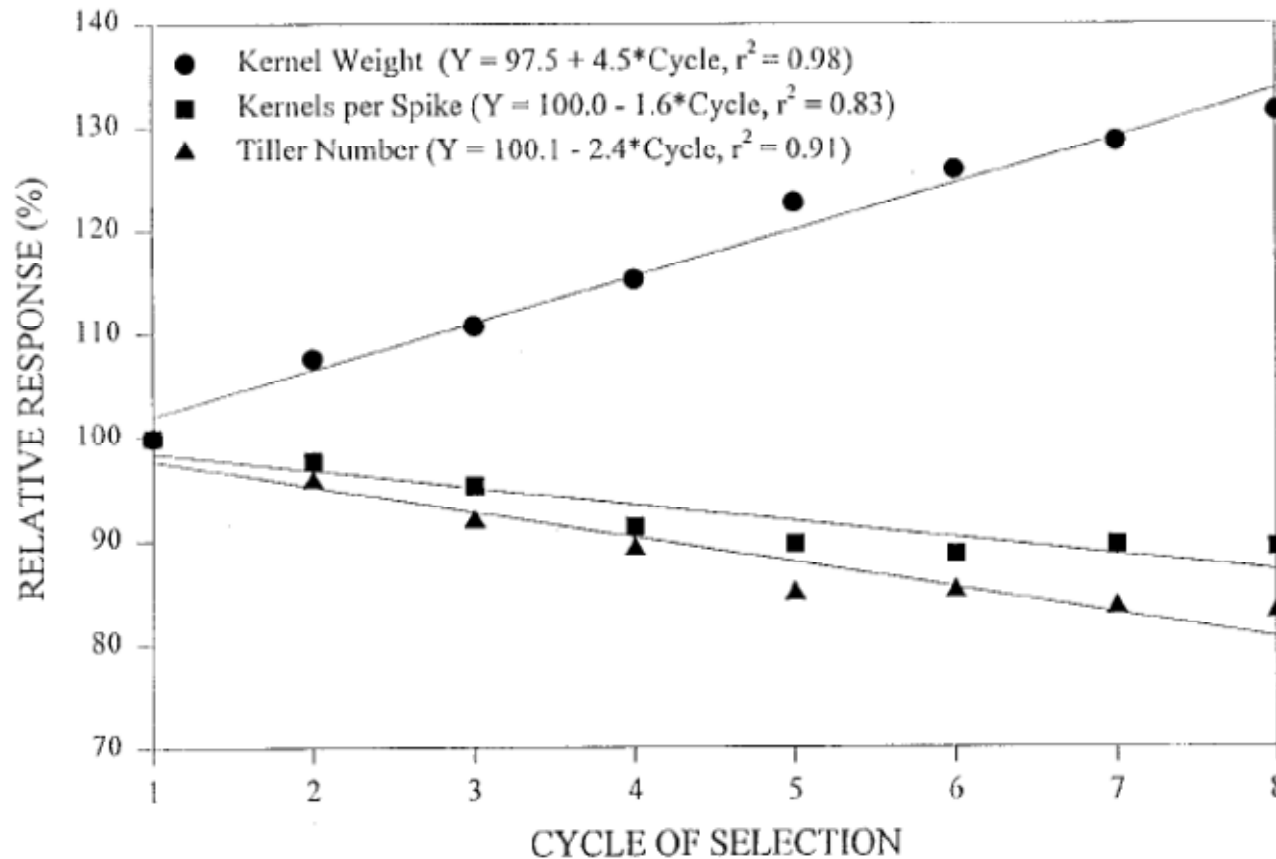
Selección Recurrente para Peso de Grano en Trigo

Ciclo	Peso de Grano (g)	Rendimiento (kg ha ⁻¹)
1	37.2	4065
2	40.0	4142
3	41.2	3888
4	42.9	3845
5	45.6	3797
6	46.8	3855
7	47.9	3920
8	48.9	3968



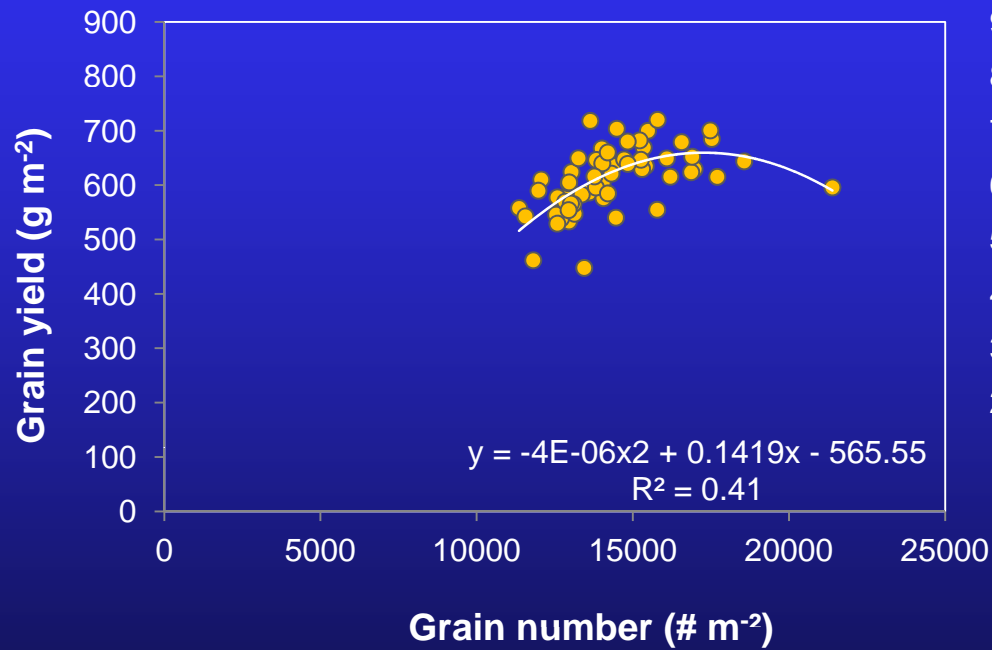
Wiersma et al. (2001)
Crop Science

Efecto de la Selección Recurrente para Peso de Grano Sobre los Componentes del Rendimiento

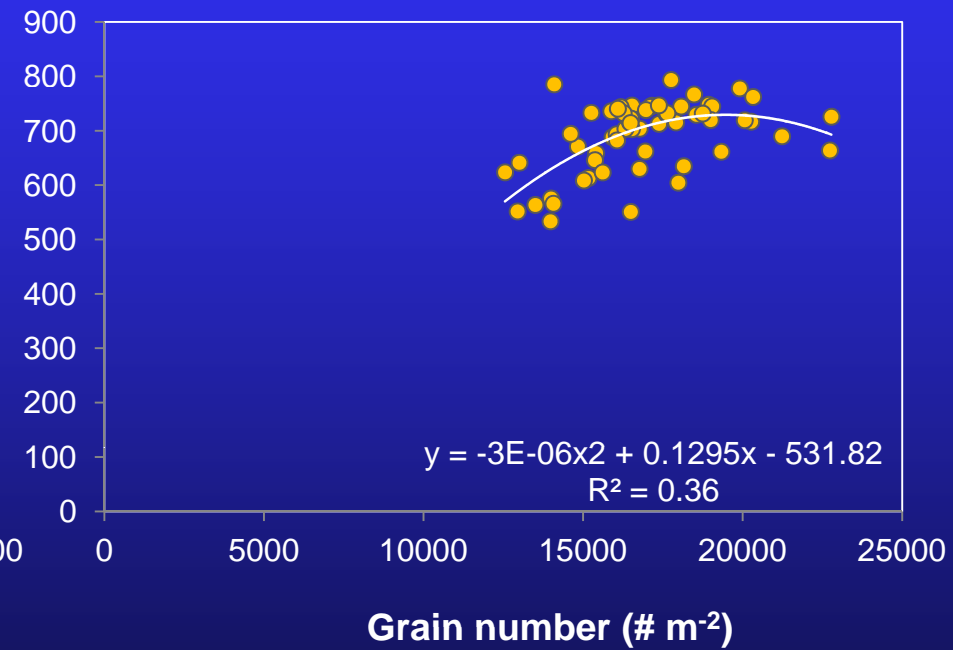


Relationship between yield and grain number CIMCOG

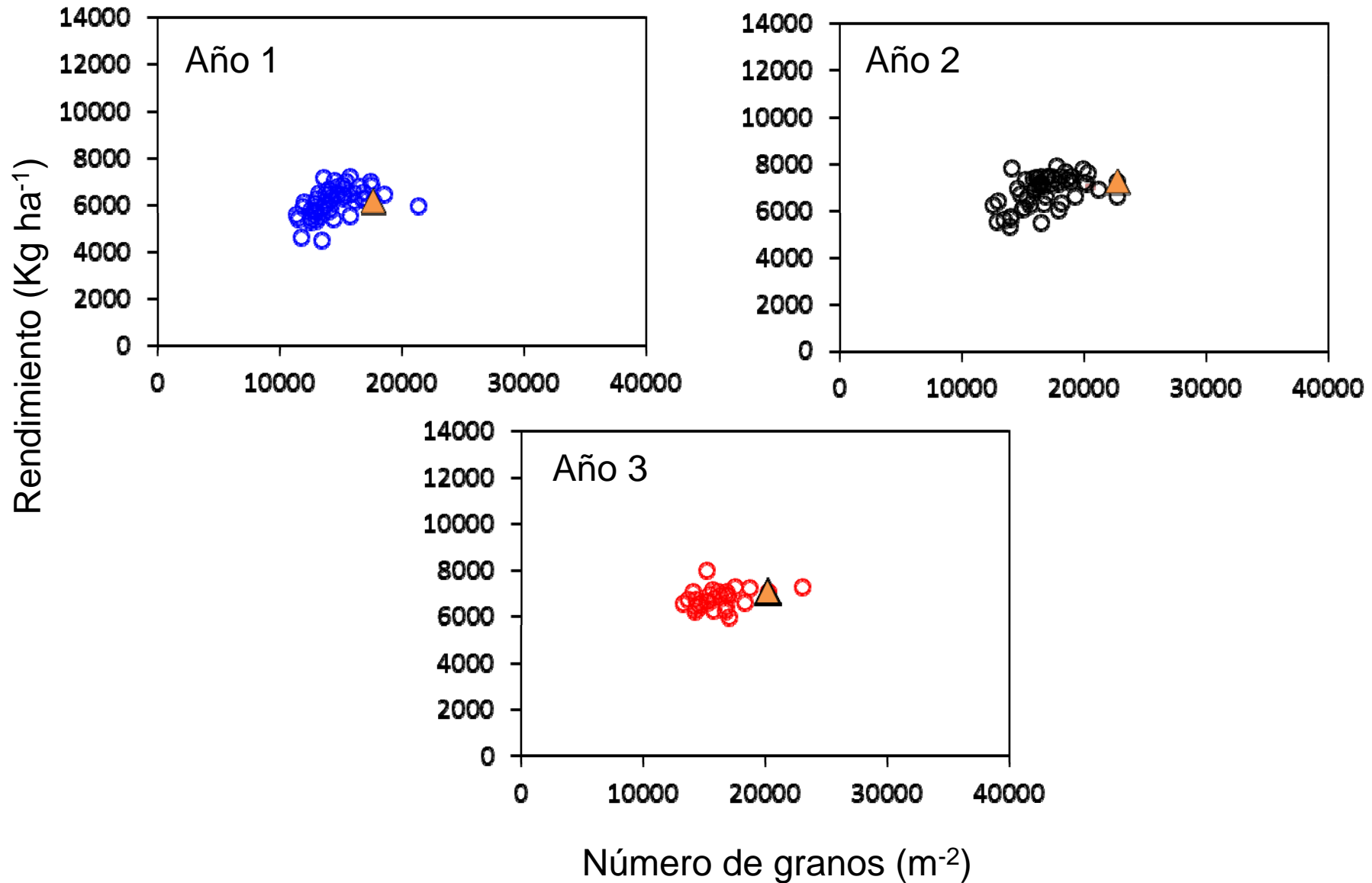
BEDS



FLATS

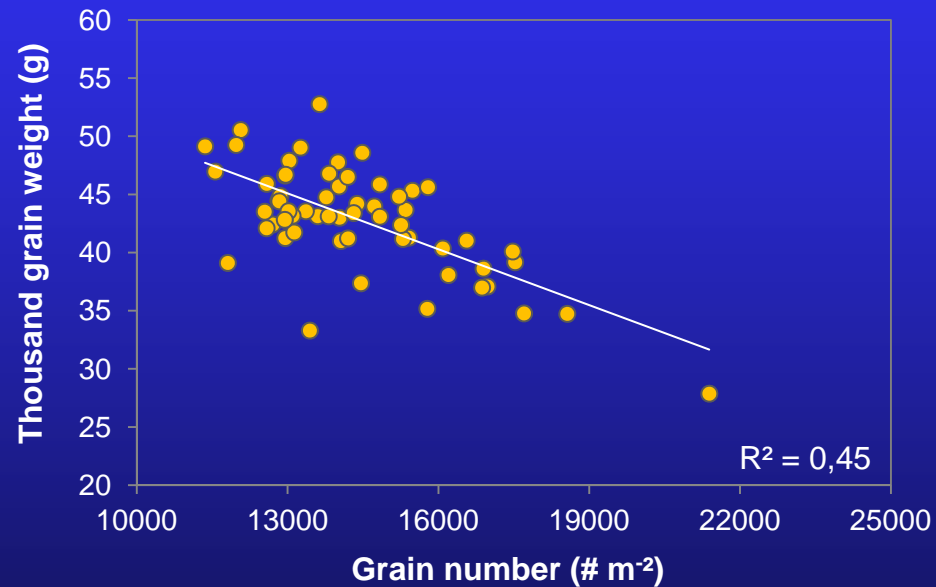


Genotipos CIMCOG

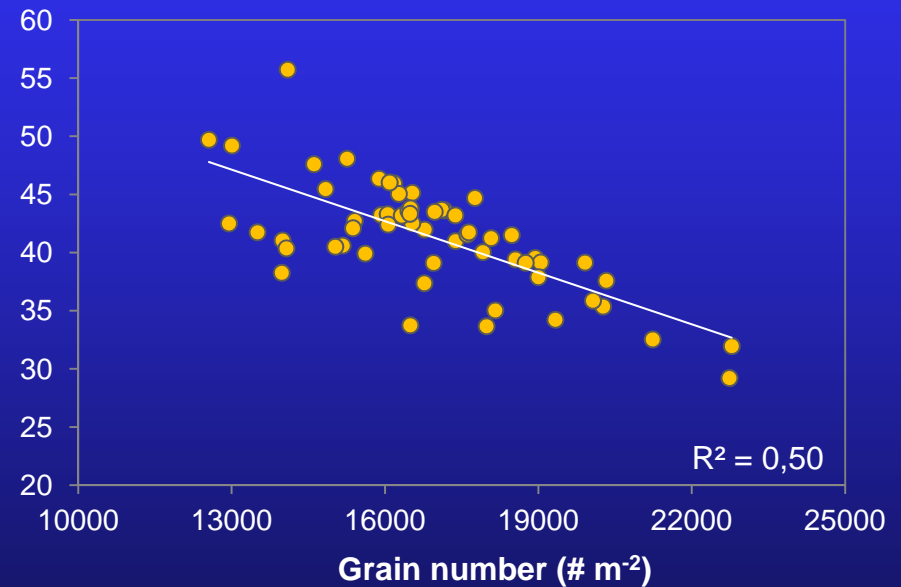


Trade off entre peso y número de granos en genotipos CIMCOG

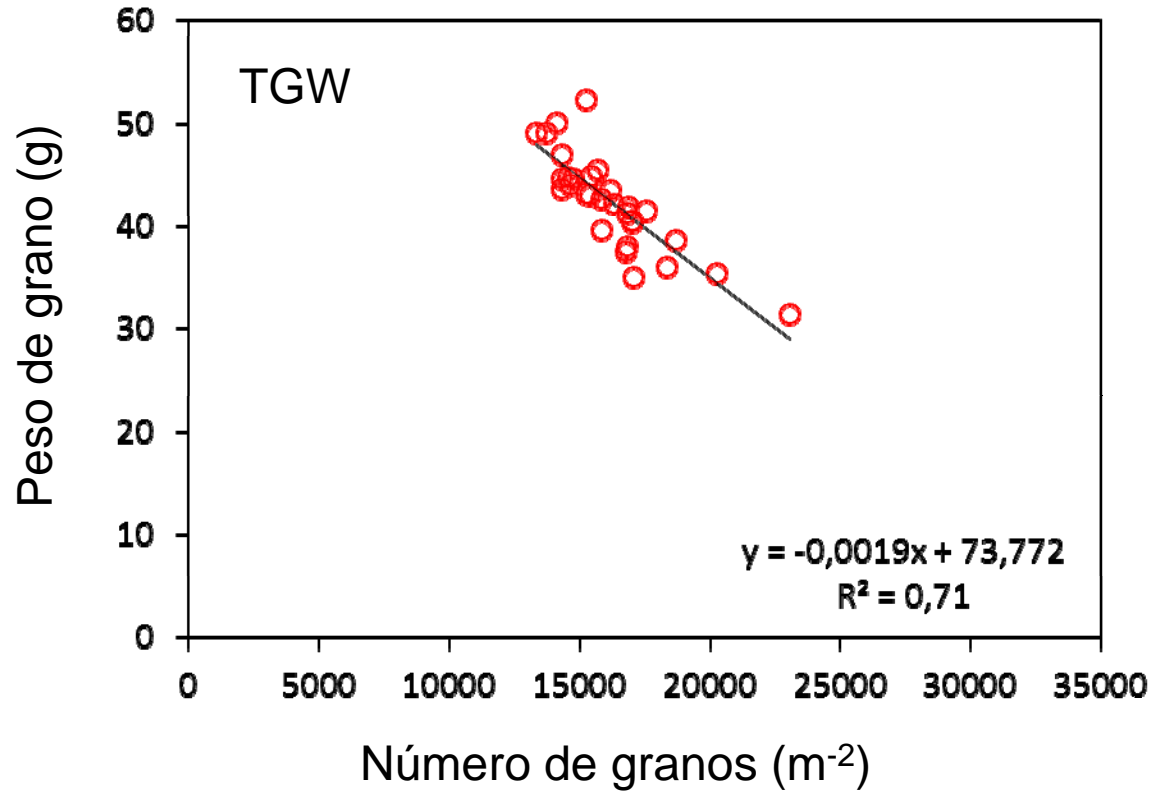
BEDS



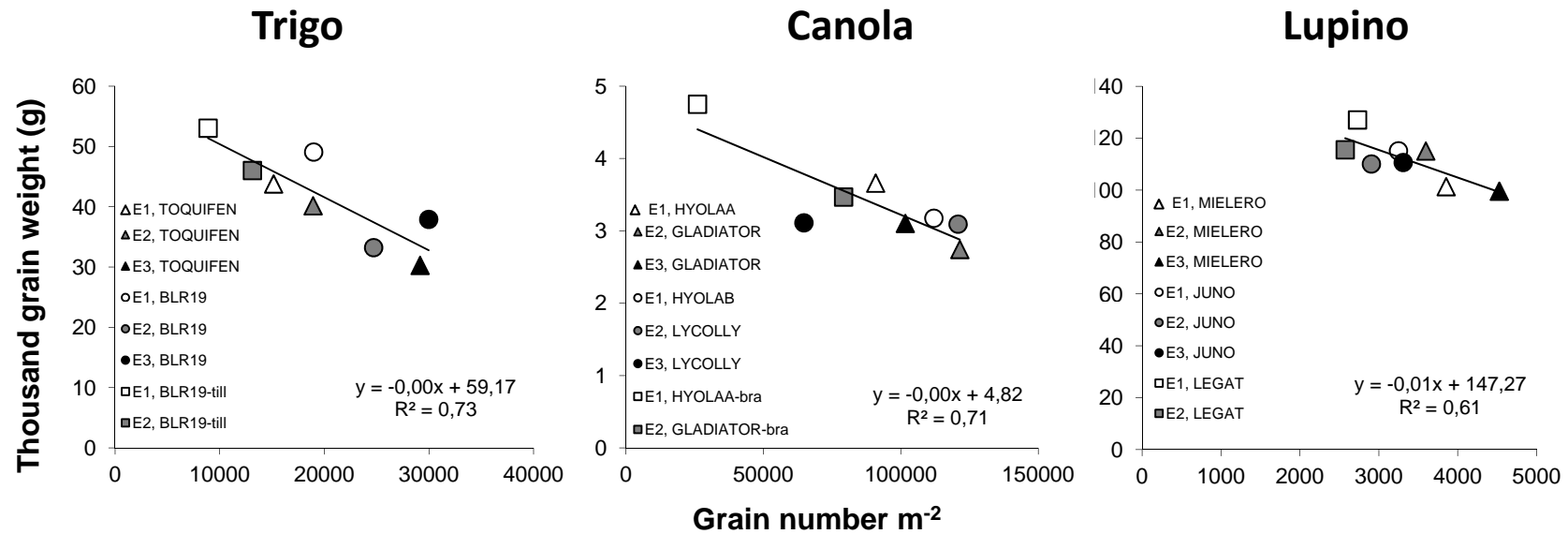
FLATS



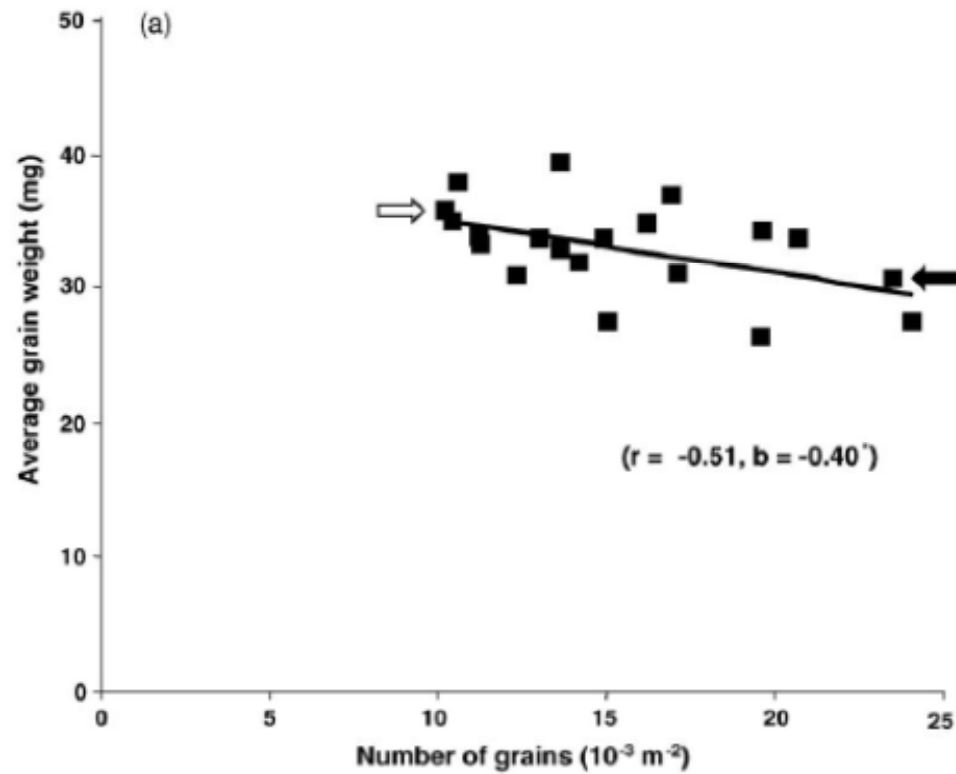
Genotipos CIMCOG



Relación entre peso y número de granos

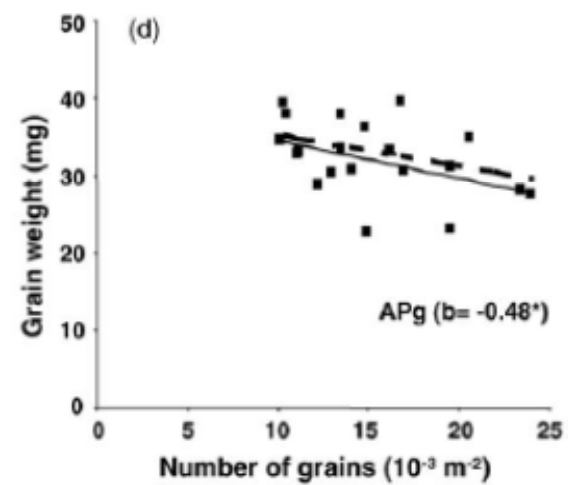
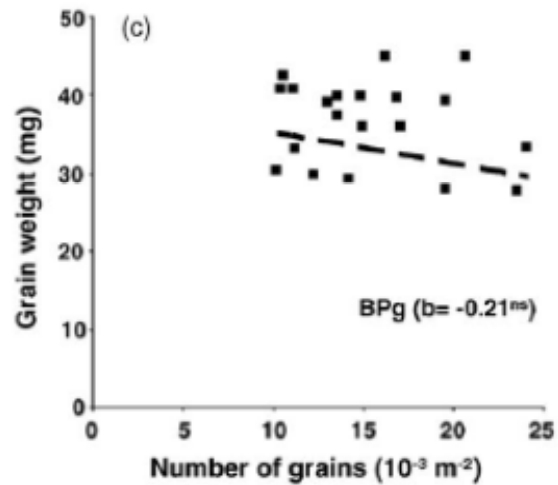
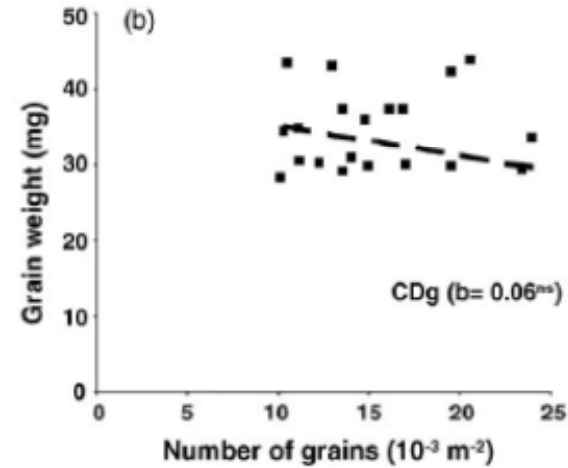
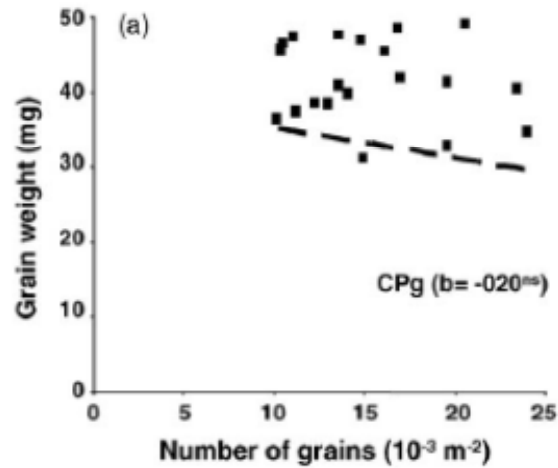


Relación entre el Peso y Número de Granos en Trigo



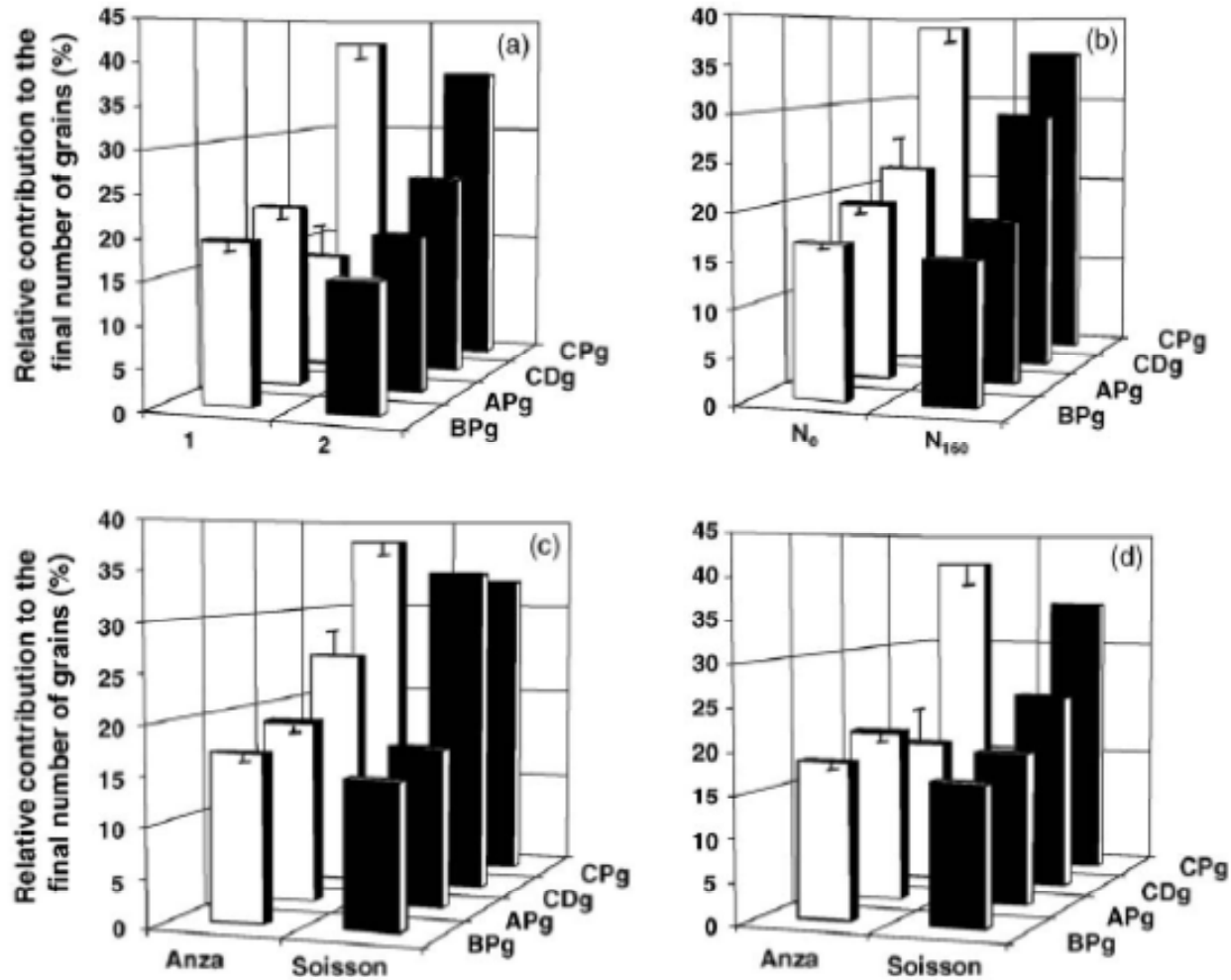
Acreche & Slafer (2006)
Field Crops Res.

Relación entre el Peso y Número de Granos en Trigo en Posiciones de Grano



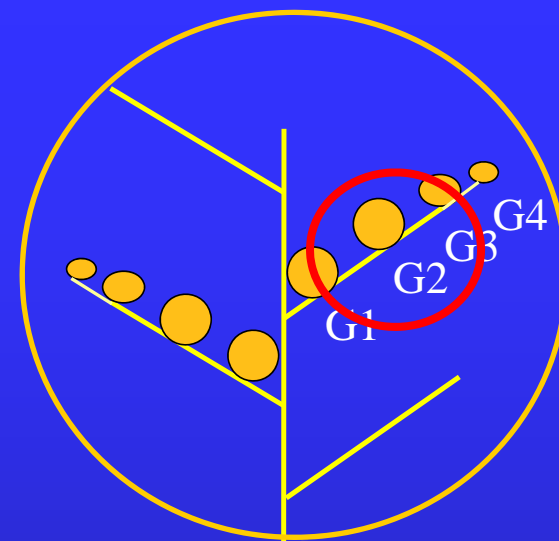
Acreche & Slafer (2006)
Field Crops Res.

Contribución Relativa de Granos de Diferentes Posiciones

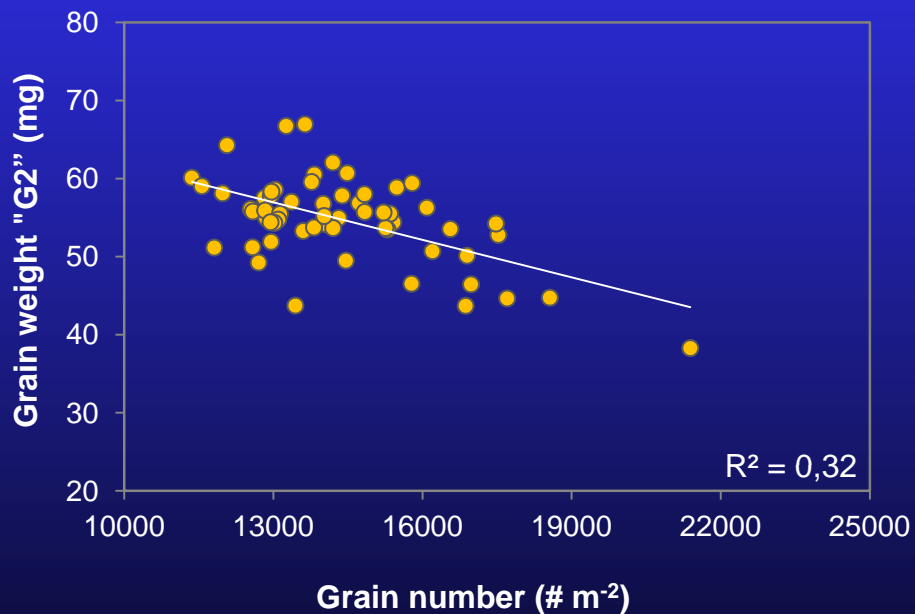


Acreche & Slafer (2006)
Field Crops Res.

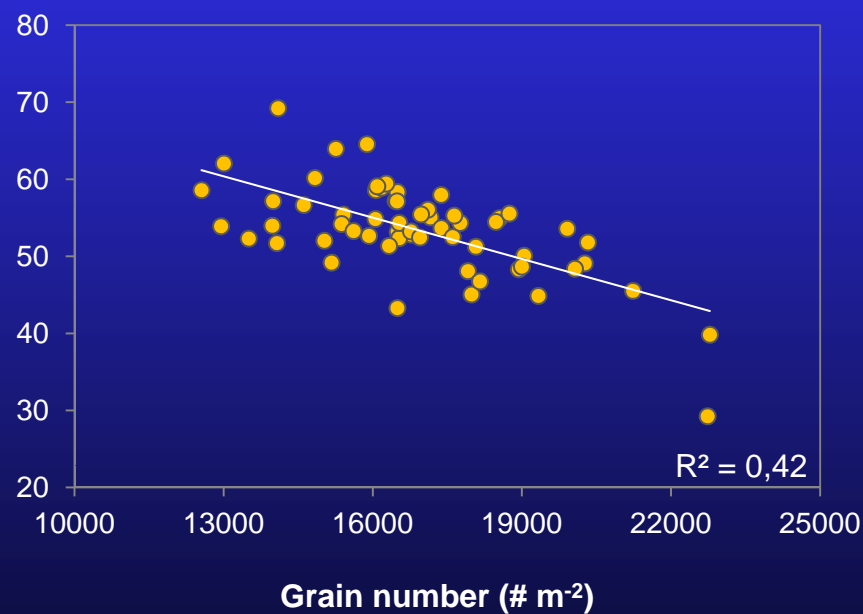
Trade off between grain weight of G2 and GN



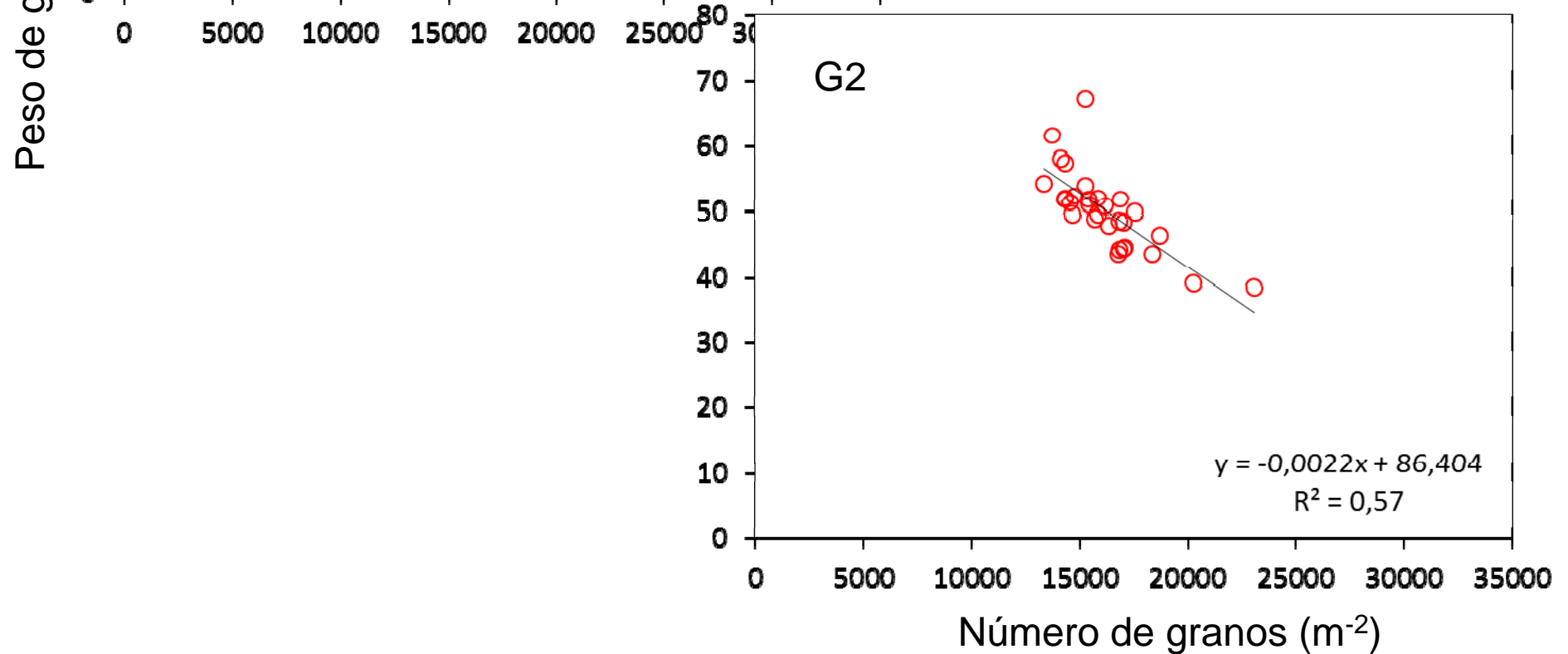
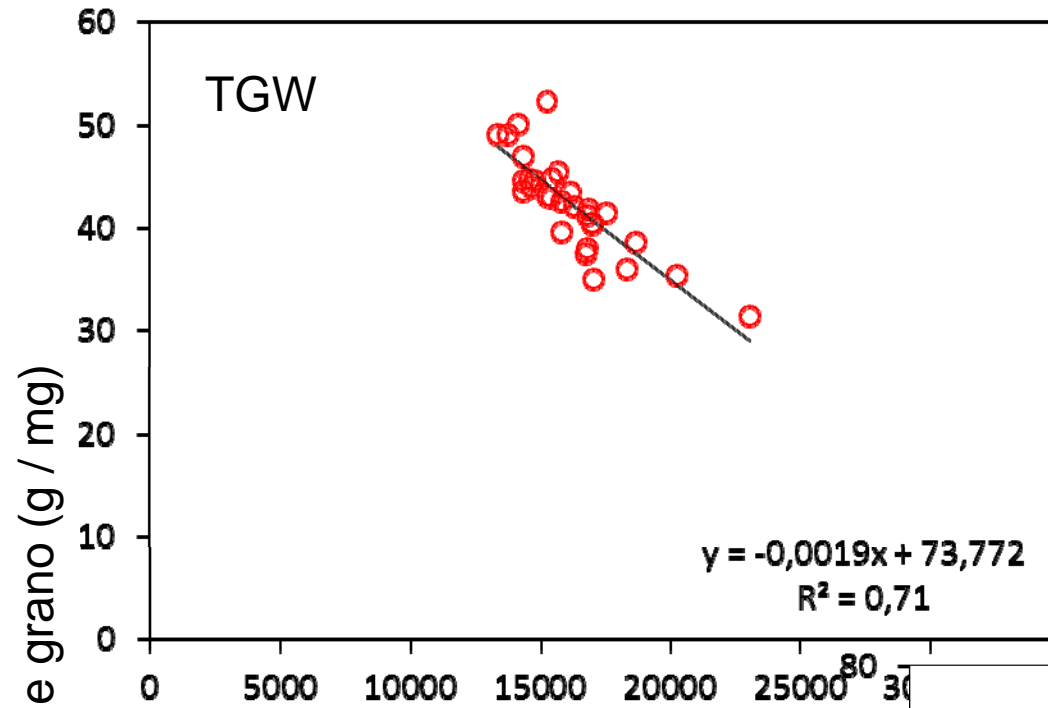
BEDS



FLATS

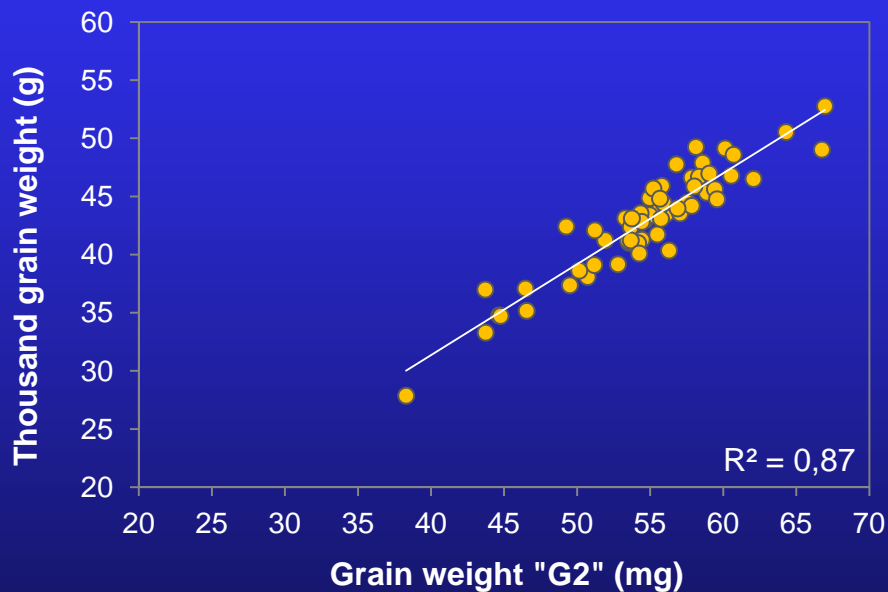


Genotipos CIMCOG

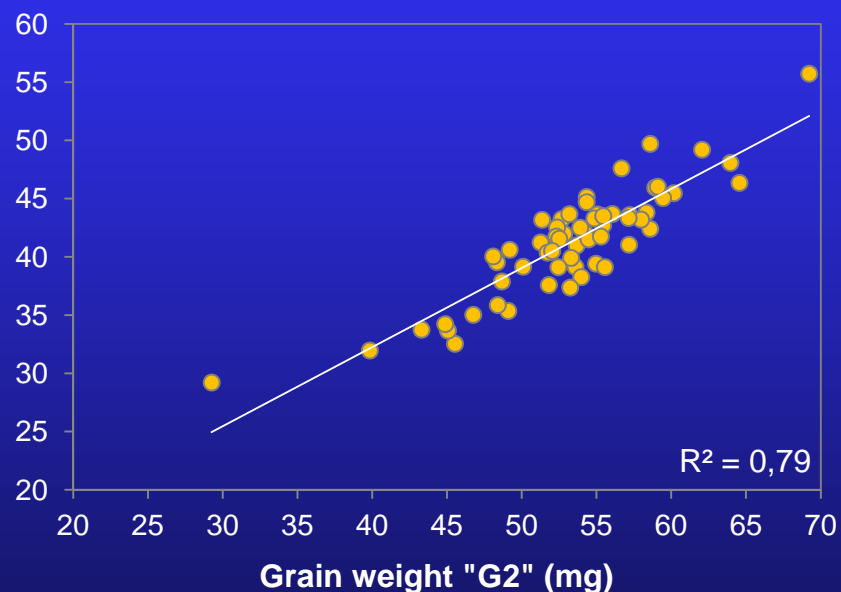


Positive associations were found between TGW and both grain weight of G2 and average grain weight G1-G4

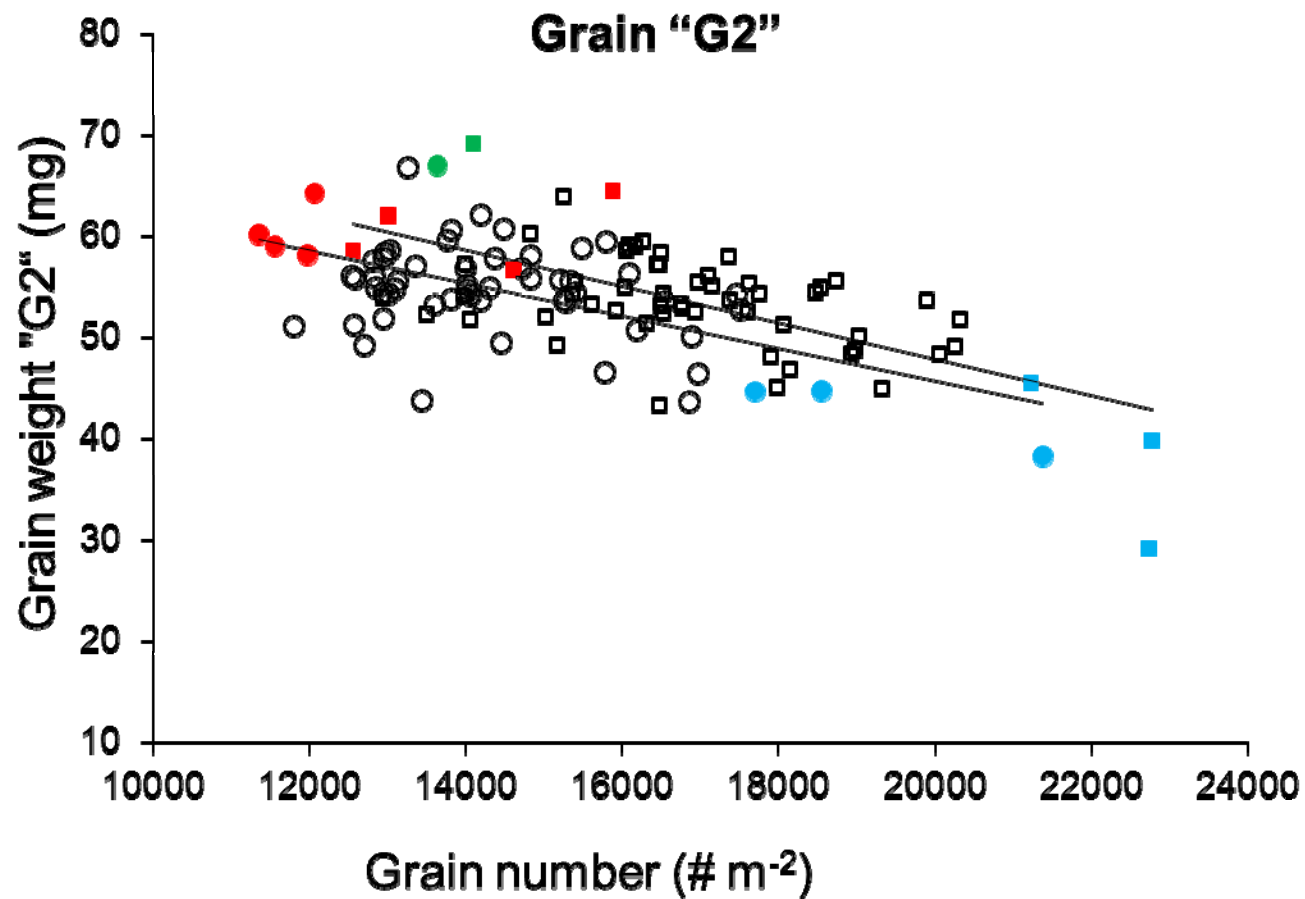
BEDS



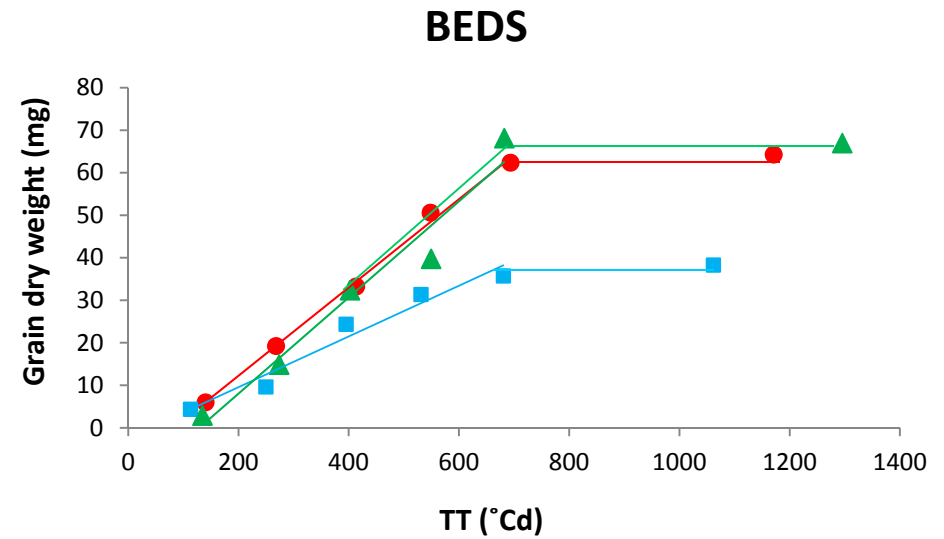
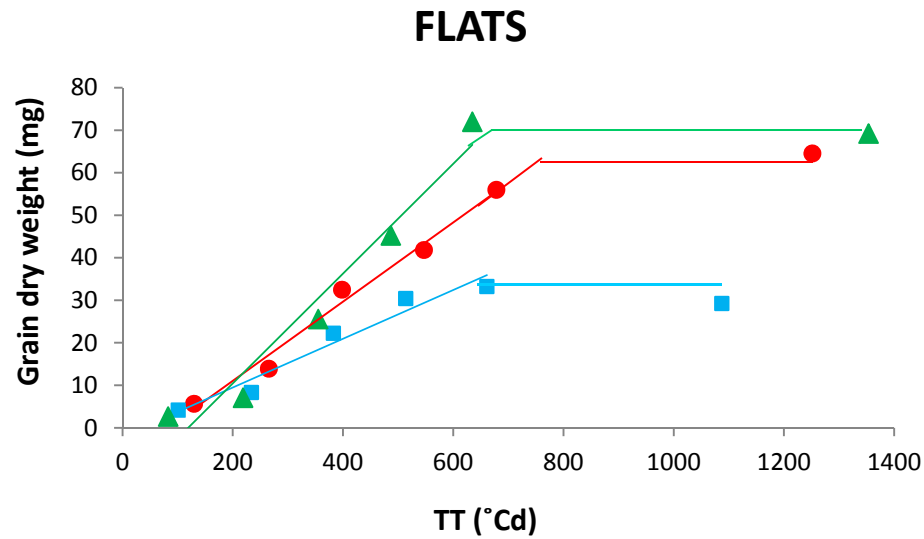
FLATS



8 contrasting genotypes were chosen for more detailed assessments

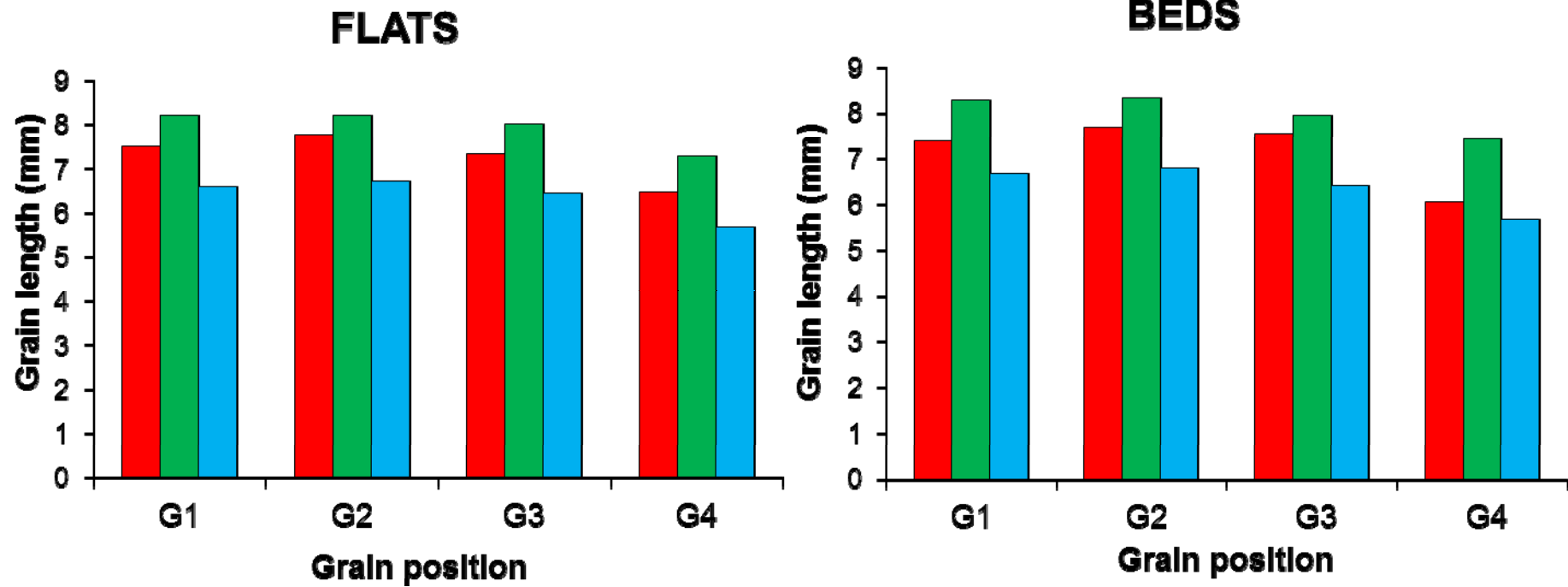


Grain weight dynamics in contrasting genotypes (6, 20 and 9)



Genotype	BEDS		FLATS	
	GFR	R ²	GFR	R ²
6	0.104	0.99	0.093	0.99
20	0.113	0.96	0.123	0.96
9	0.060	0.96	0.057	0.95

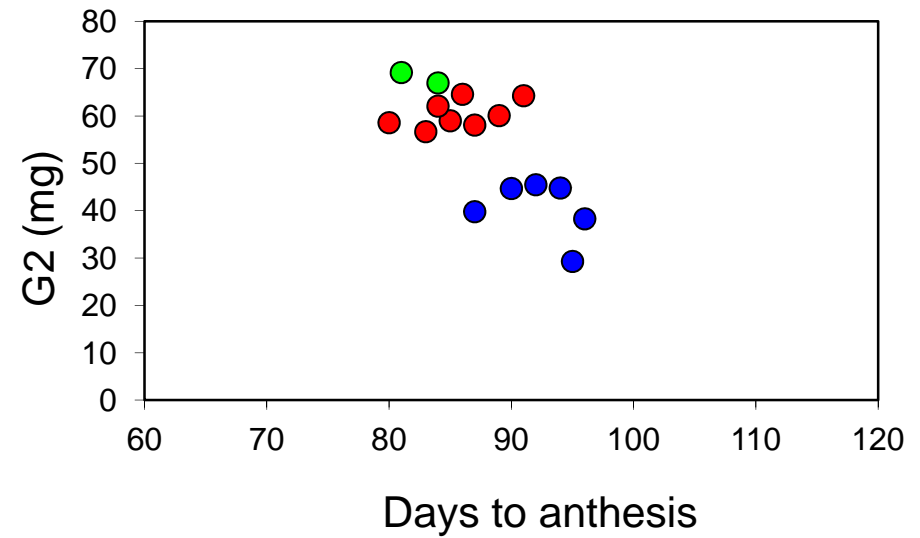
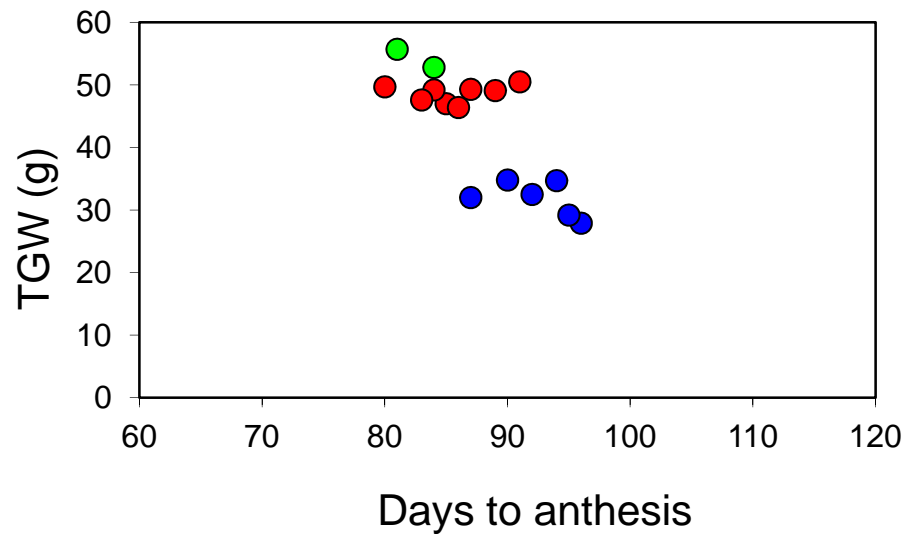
Grain length in contrasting genotypes (6, 20 and 9)



Genotypes	Days to Anthesis	
	Beds (days)	Flats (days)
6	91	86
28	89	84
29	87	83
54	85	80
20	84	81
7	90	87
9	96	95
26	94	92

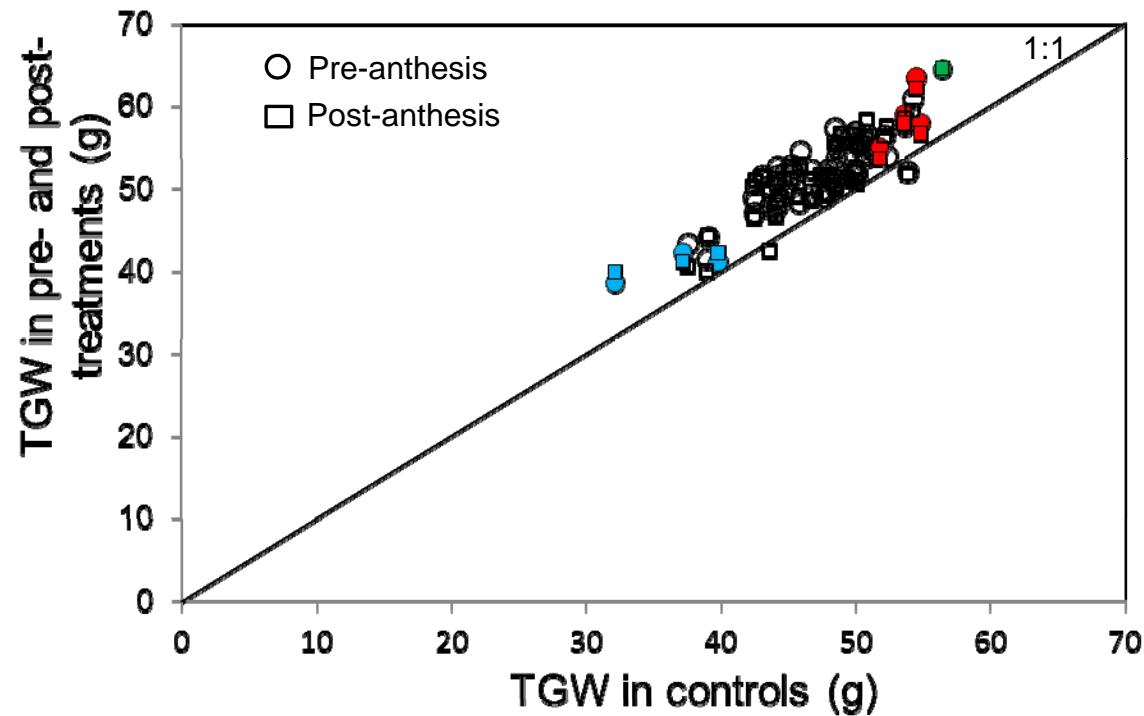
Grain weight and time to anthesis in high and low GW genotypes

(6, 28, 29, 54, 20, 7, 9 and 26)



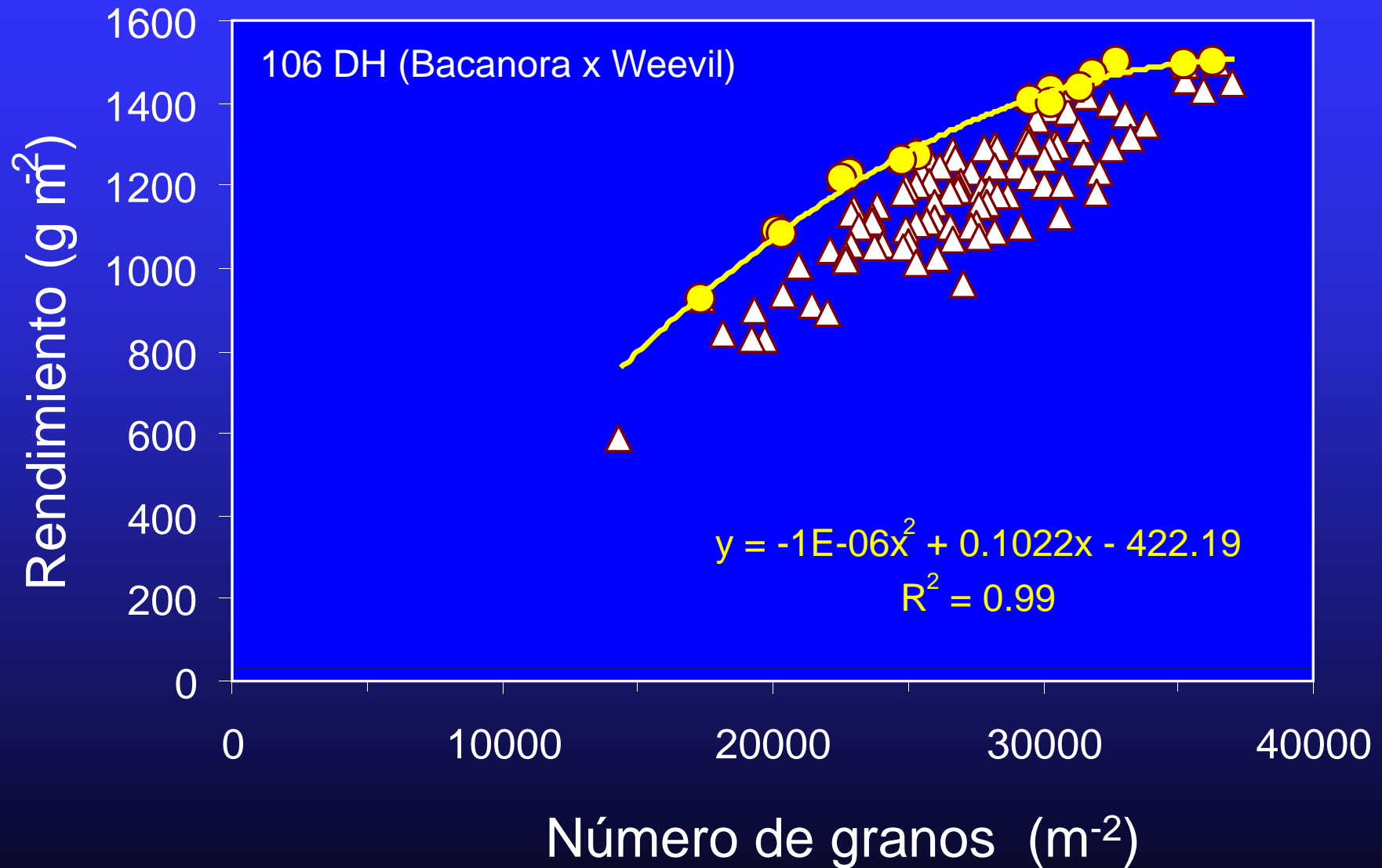
Grain weight response to source-sink manipulation at pre- and post-anthesis

(6, 28, 29, 54, 20, 7, 9 and 26)

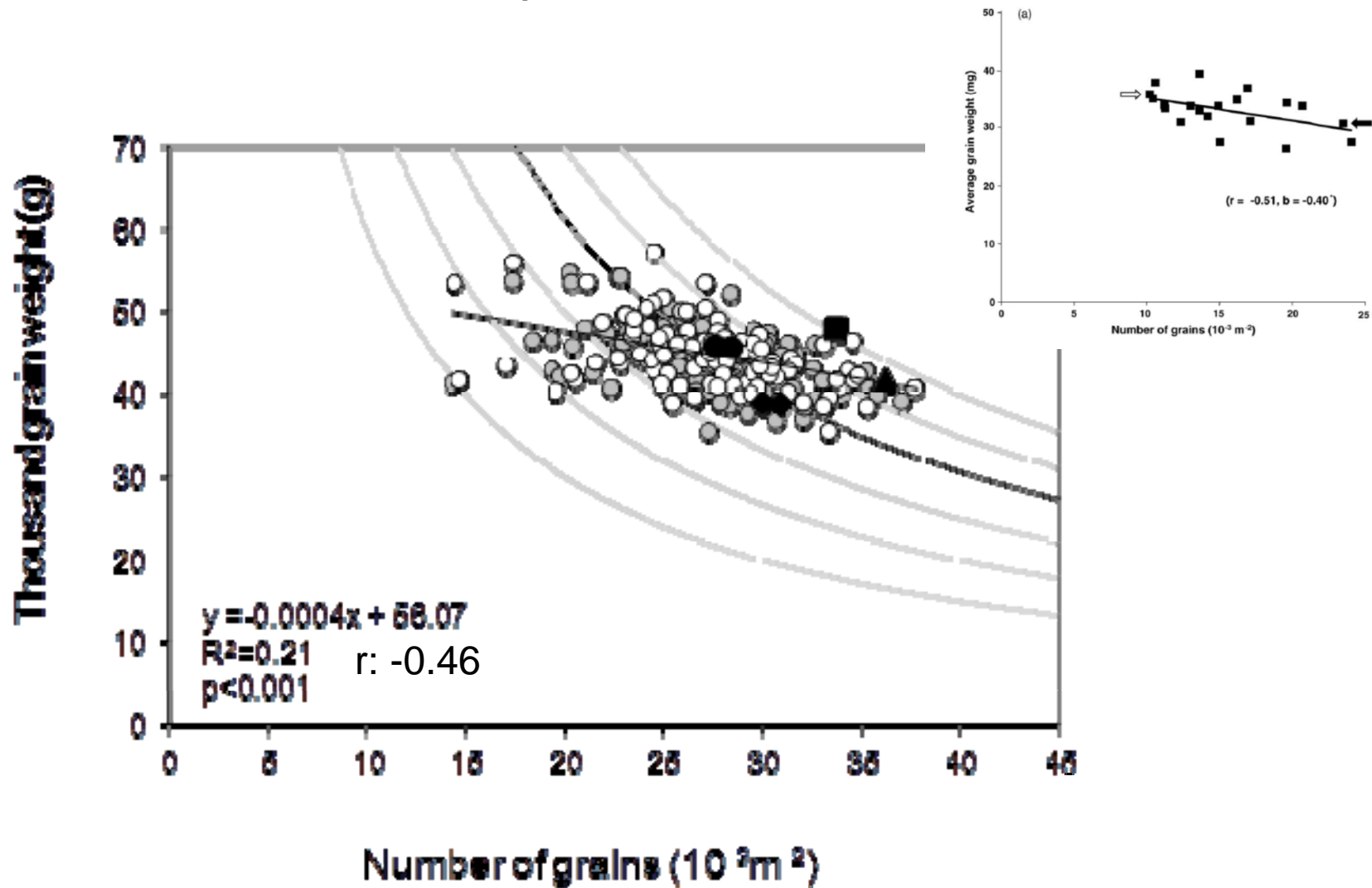


Líneas doble haploide derivadas de alto peso x alto número de granos como estrategia para disminuir la interacción negativa entre ambos componentes del rendimiento

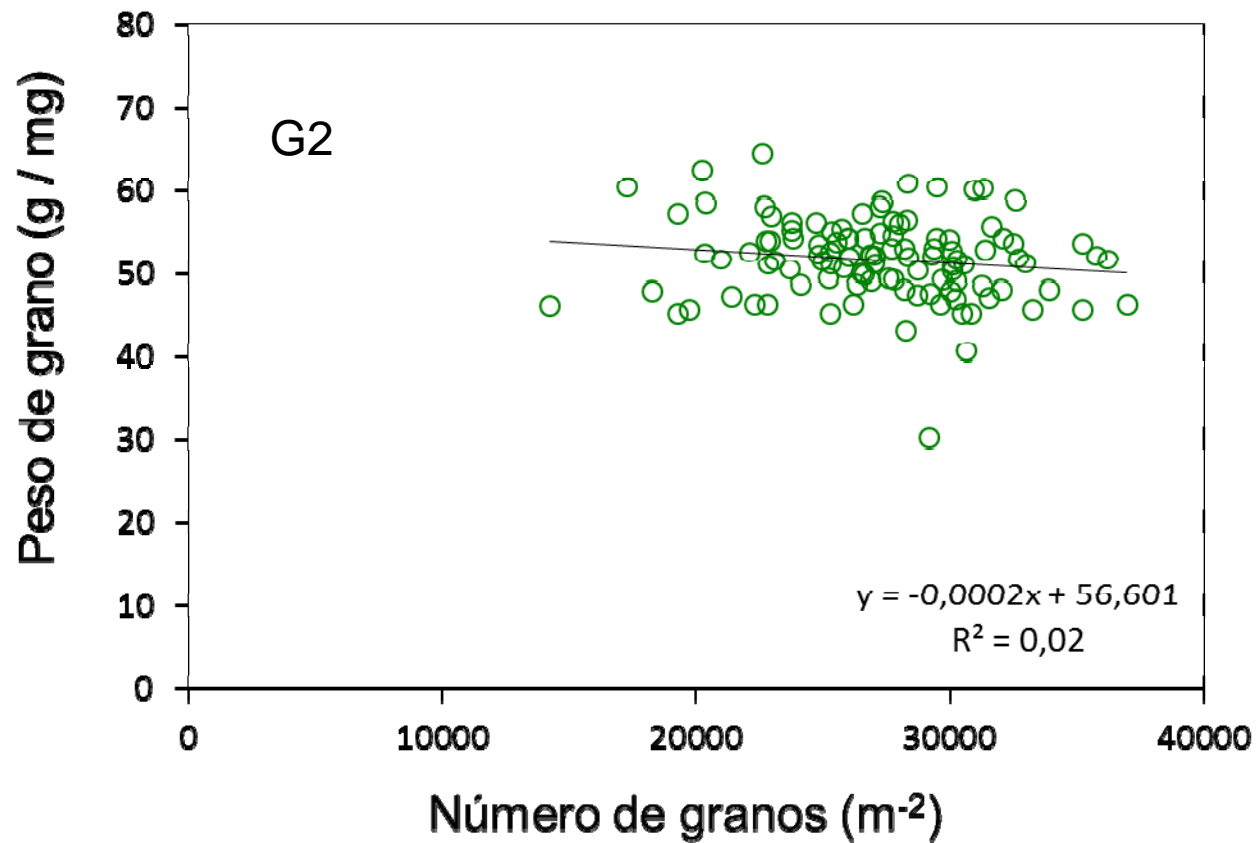
La necesidad de incrementar el peso de grano



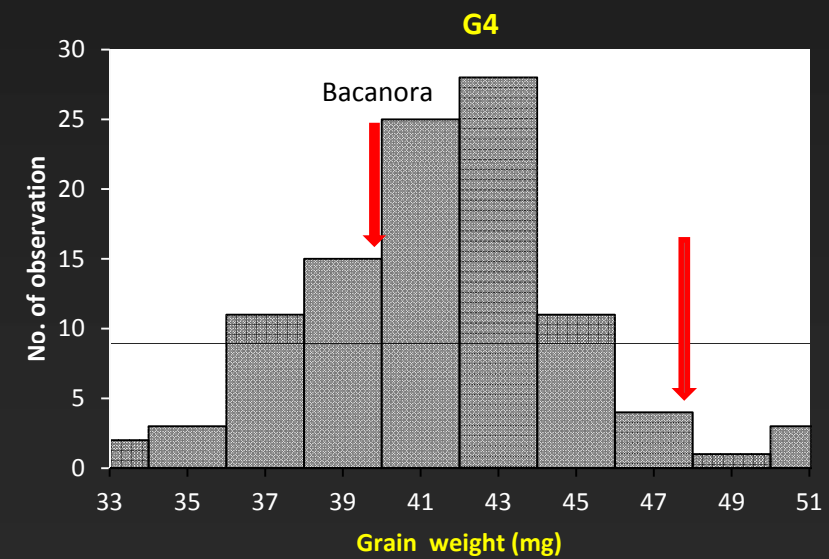
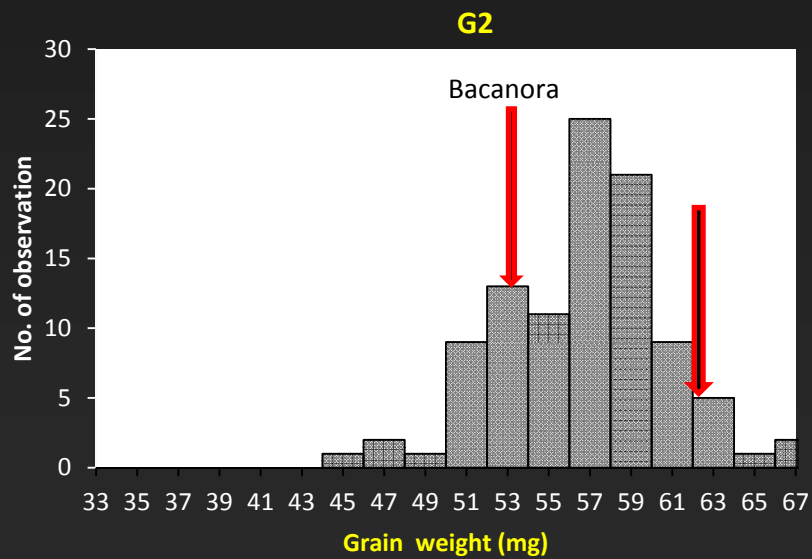
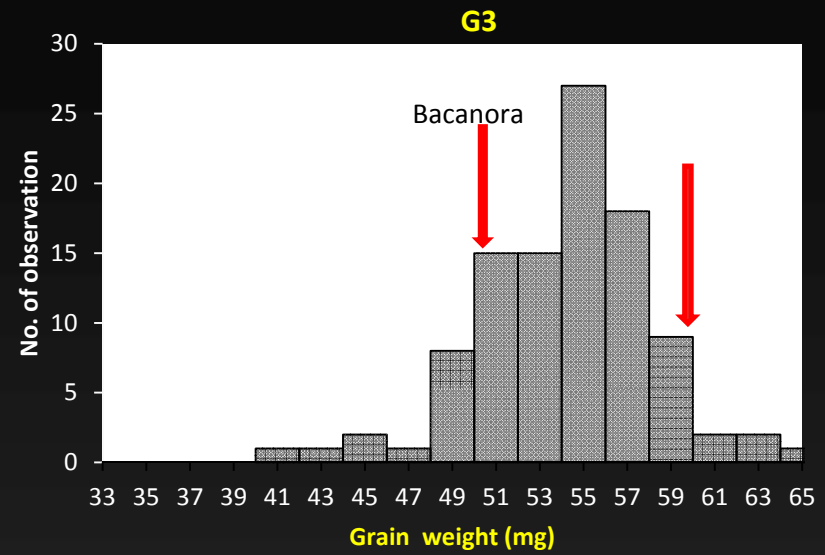
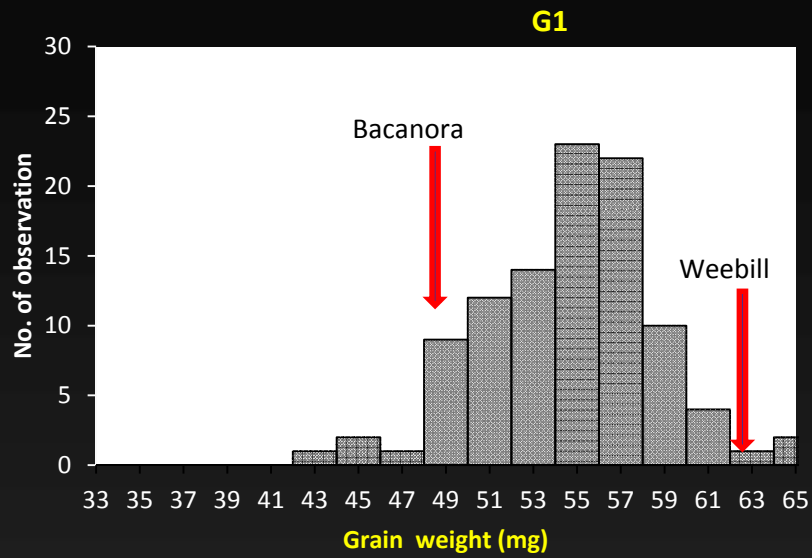
Relación entre el Peso y Número de Granos en Trigo en líneas doble haploides Bacanora x Weebil



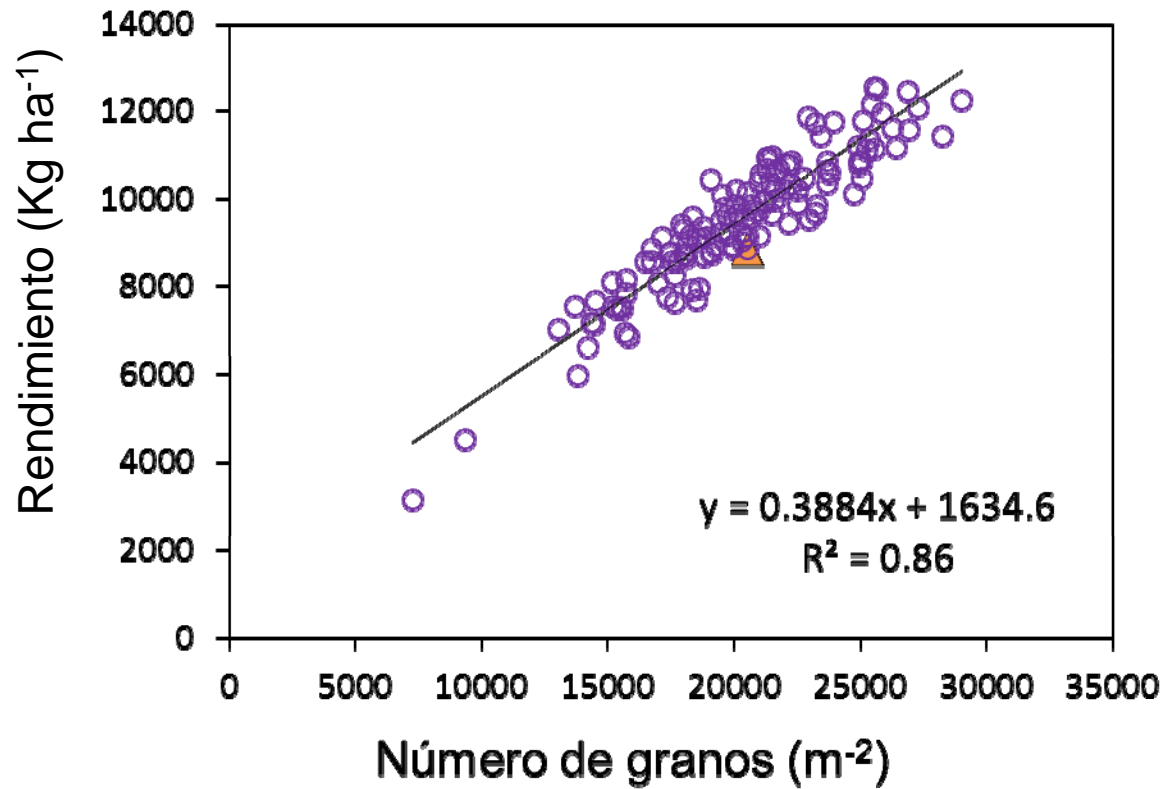
Línea Doble Haploide Bacanora x Weebil



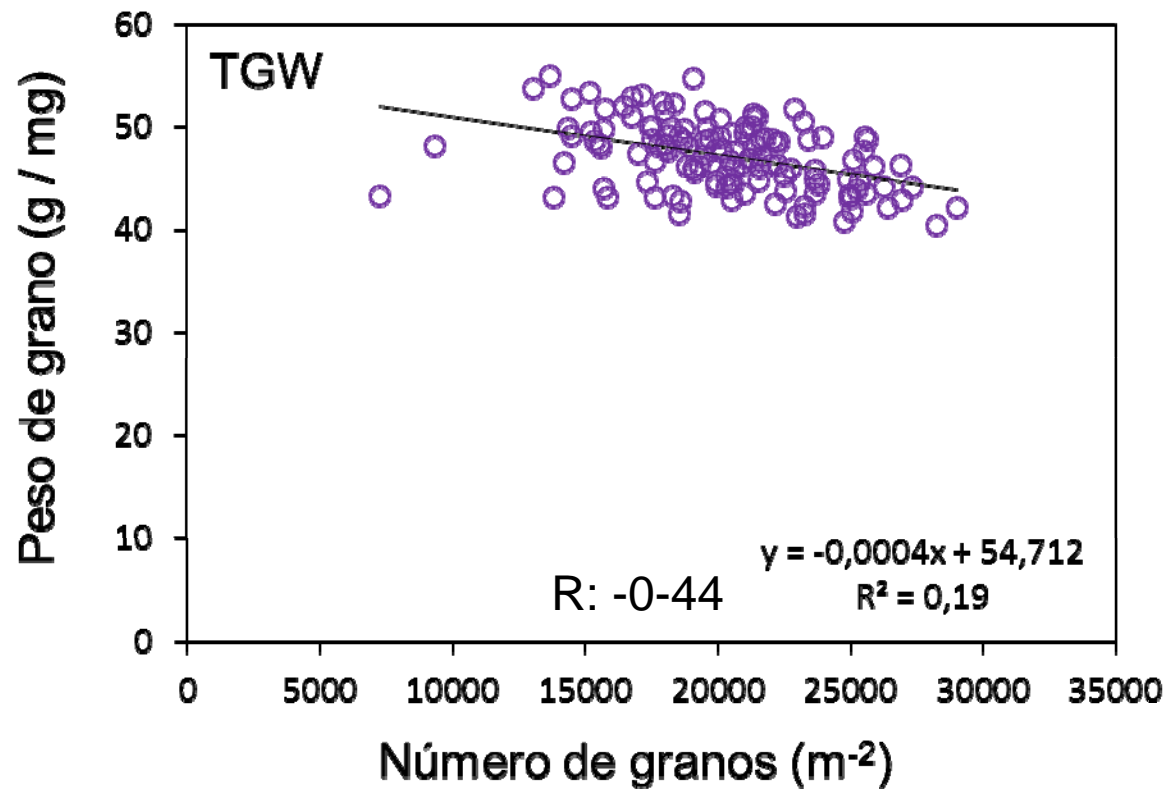
Histogram patterns of the triats



Líneas Doble Haploide Kambara x Bacanora

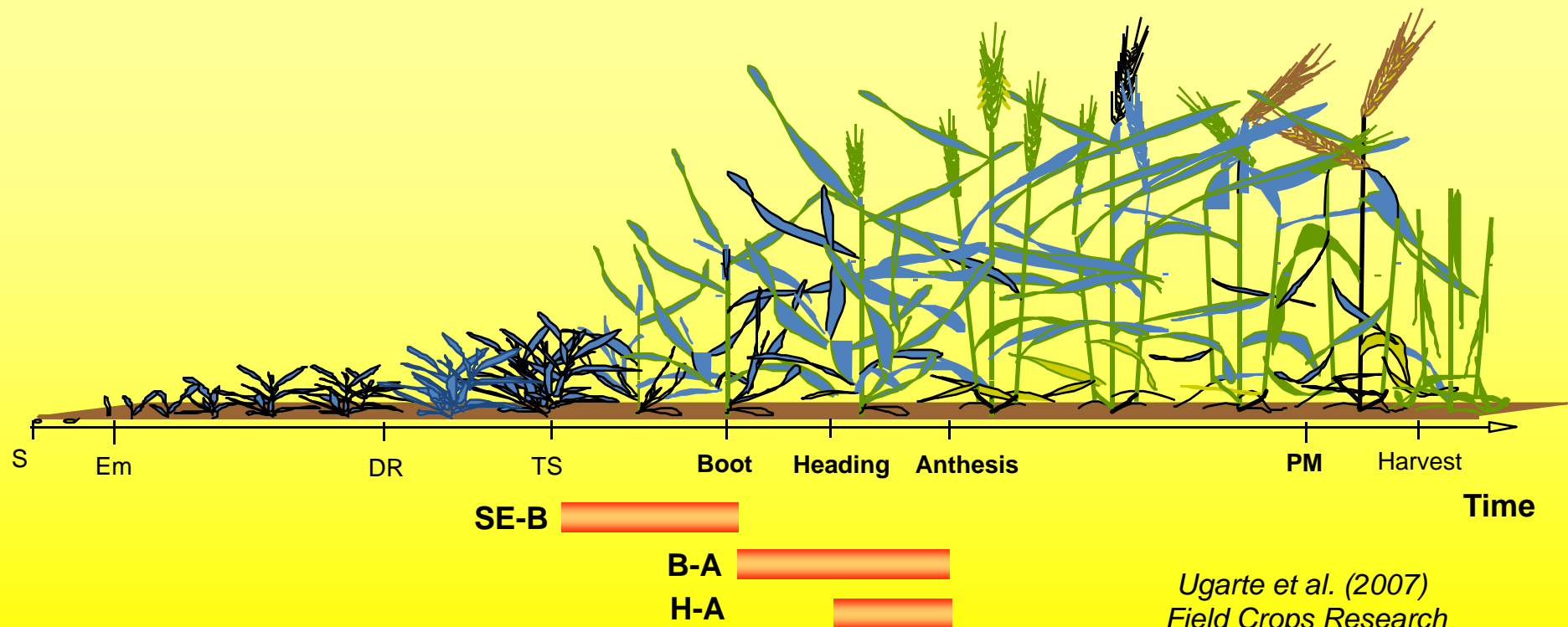


Líneas Doble Haploide Kambara x Bacanora



Effect of temperature before anthesis on grain weight

Temperature was increased (5.5°C) at different developmental phases in wheat, barley and triticale



Respuesta del Número y Peso de Grano a la Temperatura Pre-Antesis

Grain number and grain weight of treatments and their relative changes (%) respect to the control (between brackets) in wheat, barley and triticale during three experimental years

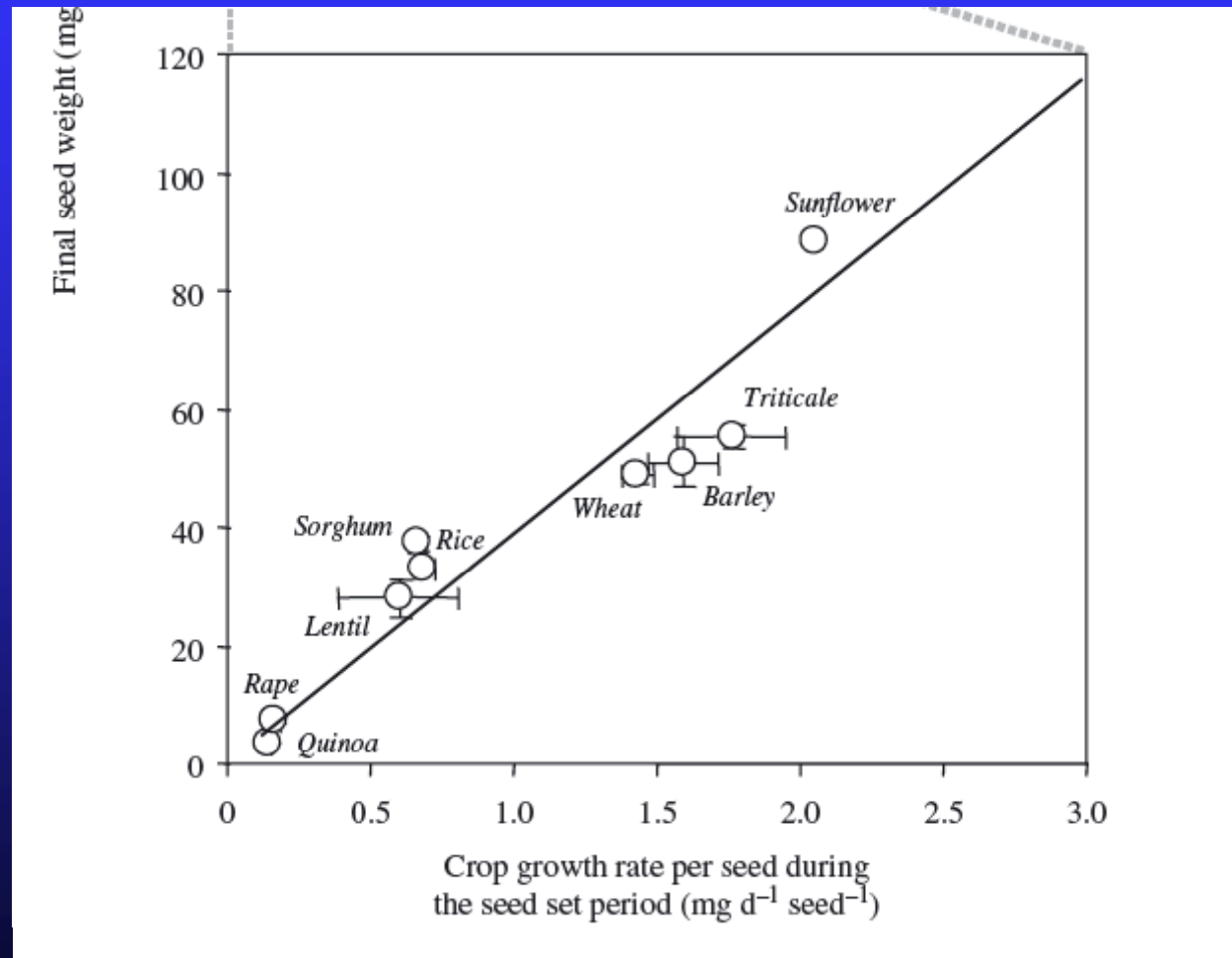
Crop	Thermal treatment ^a	Grain number (no. m ⁻²)			Grain weight (g)		
		2000	2001	2002	2000	2001	2002
Wheat	Control	28,201	16,771	23,742	36.72	36.07	38.14
	Hd-At	28,601 (+1.4)	13,915 (-17.0)		33.51 (-8.7)	34.21 (-5.2)	
	Bo-At	25,457 (-9.7)	13,417 (-20.0)	20,590 (-13.3)	31.63 (-13.9)	33.35 (-7.5)	30.80 (-19.2)
	SE-Bo			14,132 (-40.5)			35.46 (-7.0)
Barley	Control	15,812	15,563	14,526	41.14	36.06	42.04
	Hd-At	16,303 (+3.1)	12,772 (-17.9)		37.74 (-8.3)	34.66 (-3.9)	
	Bo-At	16,460 (+4.1)	11,380 (-26.9)	13,289 (-8.5)	35.62 (-13.4)	32.98 (-8.5)	33.01 (-21.5)
	SE-Bo			9241 (-36.4)			38.69 (-8.0)
Triticale	Control	17,621	23,220	19,865	44.99	41.32	44.61
	Hd-At	17,232 (-2.2)	20,720 (-10.8)		38.19 (-15.1)	39.81 (-3.6)	
	Bo-At	14,883 (-15.5)	17,149 (-26.1)	16,633 (-16.3)	38.40 (-14.6)	36.99 (-10.5)	34.40 (-22.9)
	SE-Bo			10,271 (-48.3)			41.94 (-6.0)
S.E.M. ^b	563	1145	1076	1.57	0.80	1.33	

^a SE, Bo, Hd, and At stand for the onset of stem elongation, booting, heading and anthesis, respectively.

^b S.E.M. stands for the standard error of the means.

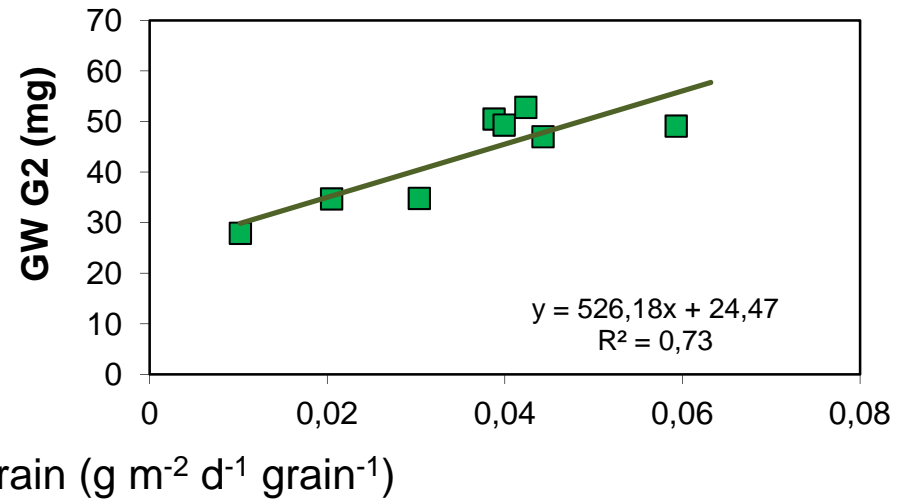
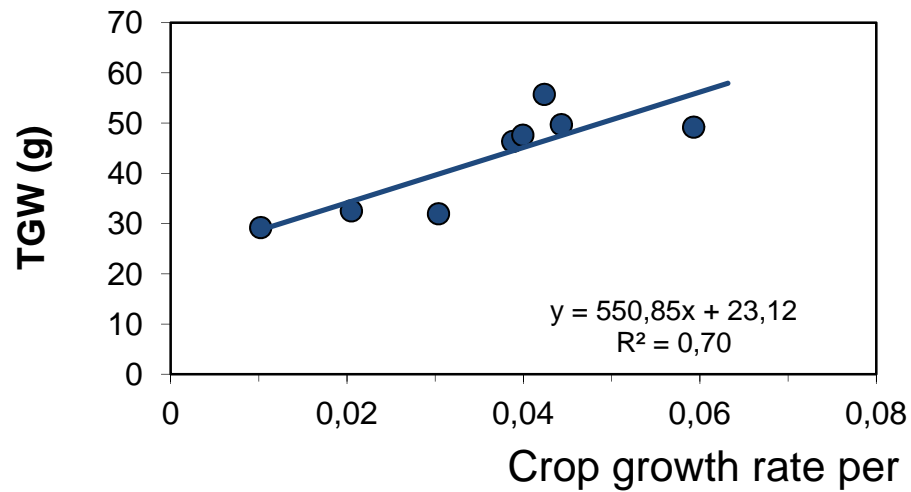
Ugarte et al. (2007)
Field Crops Res.

Relationship between grain weight and crop growth rate in different crops



Gambín & Borrás (2010)
Annals of Applied Biology

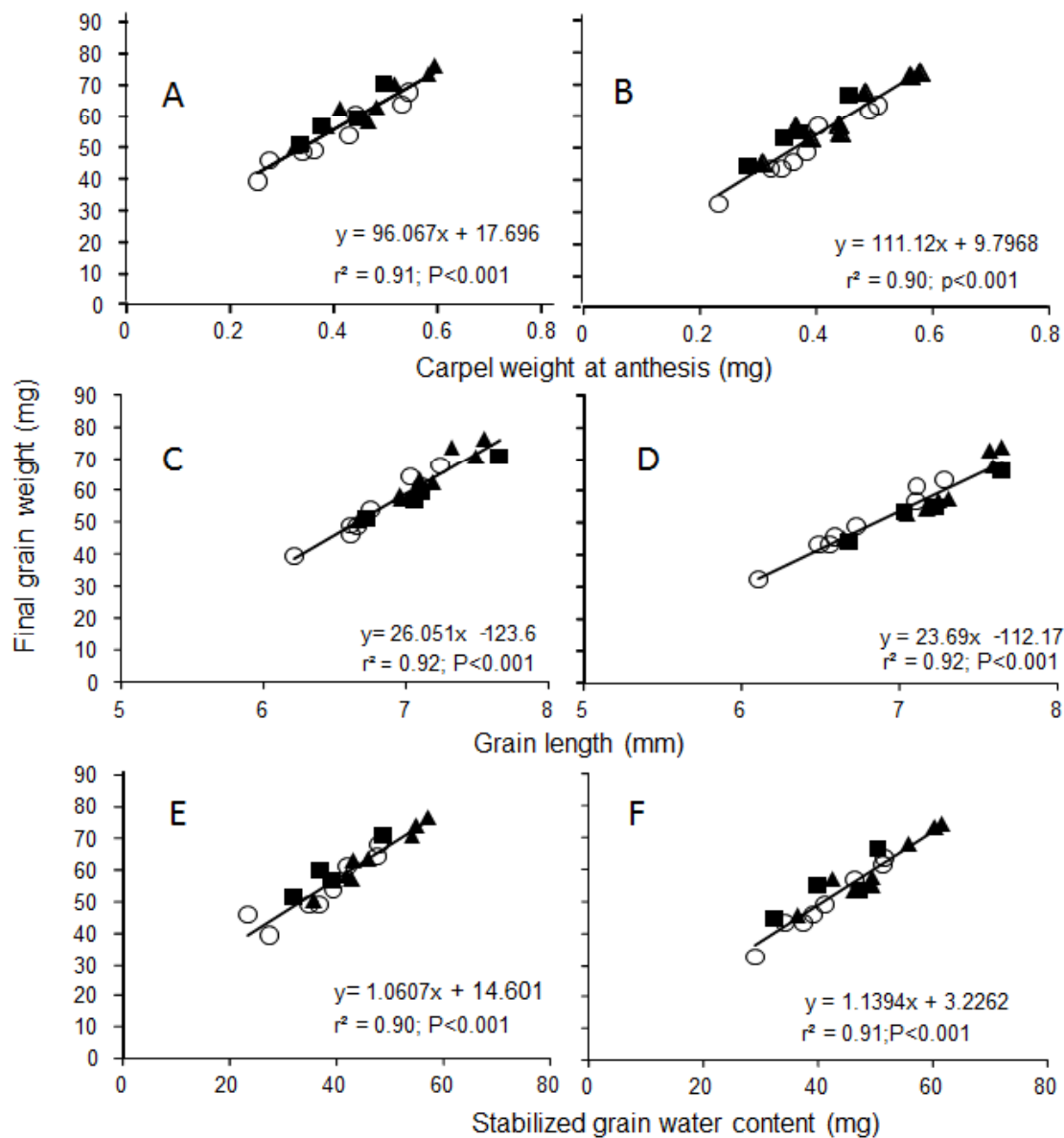
Relationship between grain weight and crop growth rate bracketing anthesis CIMCOG



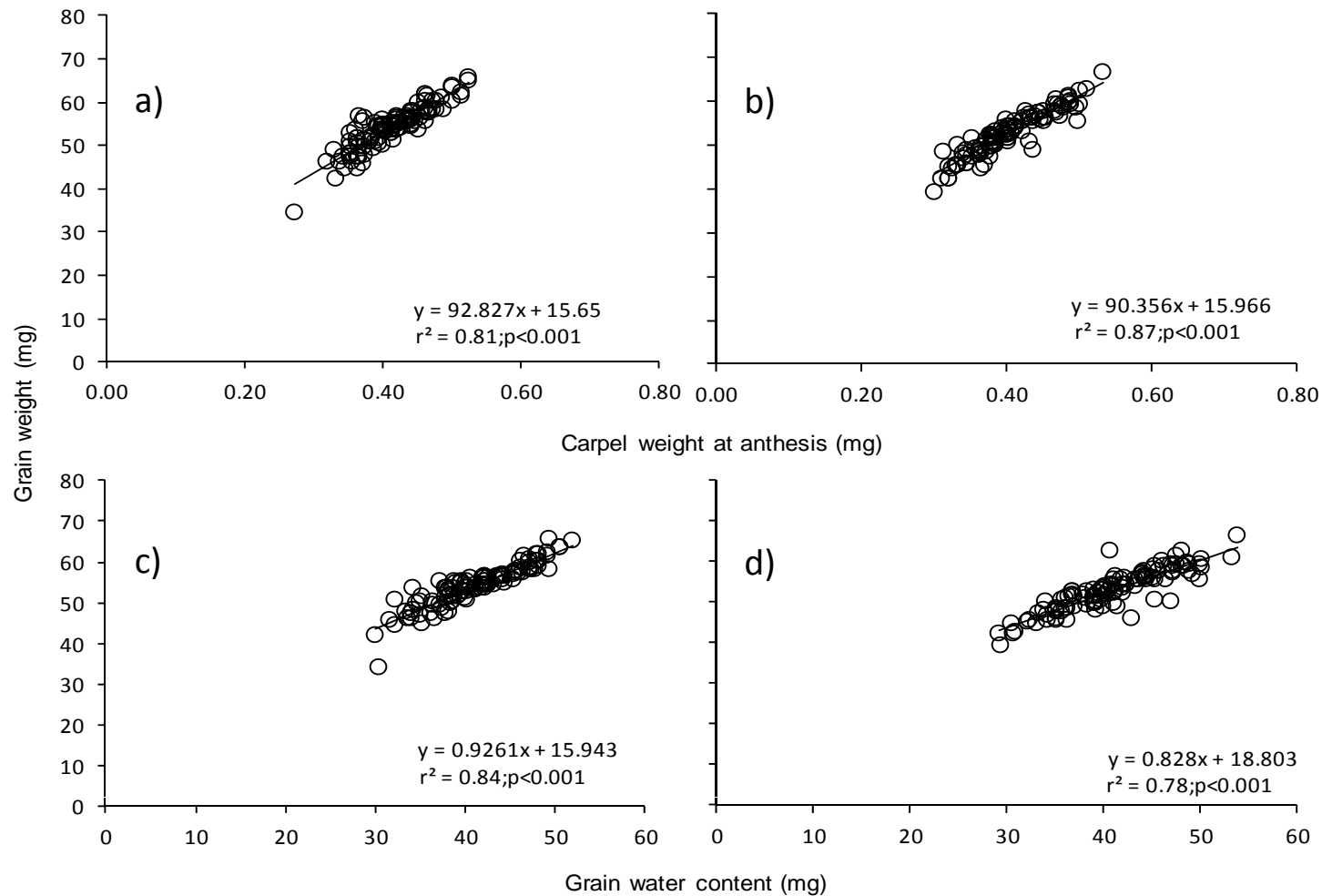
Indicadores de crecimiento en líneas doble haploide Bacanora x Weebil

Genotype	Crop growth rate (g day ⁻¹)	IPARa (MJ)	RUE (g MJ ⁻¹)	RUE _{post} (g MJ ⁻¹)	Spikes m ⁻²	Grains spike ⁻¹	Grains spike DM ⁻¹
DH2	37.9 a	915.5 a	4.0 a	4.7 a	702 a	56 a	129 a
DH1	31.1 a	831.8 b	3.6 b	4.0 a	560 b	60 a	136 a
Pandora-INIA	26.9 c	886.5 ab	3.1 c	1.9 b	587 ab	40 b	86 b
Invento-Baer	28.9 bc	932.1 a	2.8 c	2.1 b	591 ab	35 b	90 b
	***	ns	*	**	*	***	**
S.E.M.	1.3	15	0.2	0.5	22	3	8

Asociación entre el peso de grano y peso de carpelos, largo y contenido hídrico de los granos en Bacanora y Kambara



Asociación entre el peso de grano en líneas DH Bacanora x Weebil y el peso de carpelos y contenido hídrico



Conclusiones

- Es necesario incrementar el rendimiento de trigo para enfrentar los desafíos de crecimiento poblacional y cambio climático
- Los genotipos elite muestran compensaciones entre peso y número de granos que afectan el continuar incrementando el rendimiento del cultivo
- La relación negativa entre peso y número de granos se observa aún en posiciones (e.g. G2)

Conclusiones

- Líneas DH derivadas del cruzamiento entre padres de alto peso y número de granos resultan promisorias para disminuir la compensación entre los componentes
- Una mayor tasa de crecimiento durante la etapa crítica (bota-antesis) se postula como hipótesis del mejor comportamiento de las líneas DH

¡MUCHAS GRACIAS!