

Maximizing Grain Yield by Optimizing Root and Shoot Biomass in Bread Wheat

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INTRODUCTION

Grain yield in spring bread wheat (*Triticum aestivum* L.) is influenced by:

- 1- Shoot characteristics such as plant height and number of tillers.
- 2- Phenological periods such as time to anthesis and maturity.
- 3- Root characteristics such as shallow and deep roots and root biomass.

Information on the relationship between **grain yield**, **root biomass**, and **shoot biomass** is scarce in wheat. Our main objectives were:

To determine optimum root and shoot biomass to maximize grain yield.

MATERIALS and METHODS

A set of **16 genotypes** was used:

12 F8 recombinant inbred lines (RILs), derived from a cross **Iran #49** × **Yecora Rojo**, chosen for similar days to maturity and plant height, but showing significant variation for root biomass and grain yield per plant, plus **2 parents** and **2 standard Californian wheat cultivars**, namely 'Blanca Fuerte' and 'Joaquin'.

Genotype Iran #49 is a tall late landrace with a large root system. Yecora Rojo is a CIMMYT-derived two-gene dwarf cultivar with a small root system (Fig. 1 a, b)

Grains were germinated in Petri dishes on January 13, 2012. Seven days later, seedlings were transplanted in polyethylene tubing bags sleeved into polyvinyl chloride (PVC) tubes, 150 cm long and 10 cm in diameter (Fig. 2 a, b).

Plants were grown under well watered conditions.

Phenological periods and shoot traits including grain yield was measured.

Sand columns in plastic bags were taken off of PVC tubes (Fig. 3) and the root system was washed without damage (Fig. 4 a, b).

Root system separated into shallow roots including all roots less than 30 cm and deep roots including all roots greater than 30 cm. Root biomass was calculated as the sum of the two parts.

Data were subjected to ANOVA for each trait and simple correlation coefficients between pairs of traits were computed.

The experiment was repeated a second year using a slightly different set of RILs.

RESULTS and DISCUSSION

Significant differences were found among the genotypes for all the traits measured (Table 1).

Simple correlation coefficients:

	DM	GY	PH	RB
GY	0.33			
PH	0.16	0.22		
RB	0.71**	0.78**	0.48⁺	
SBEG	0.71**	0.75***	0.50*	0.99***

These correlations indicate that grain yield was not confounded by DM and PH.



Fig. 1 a – Parental lines

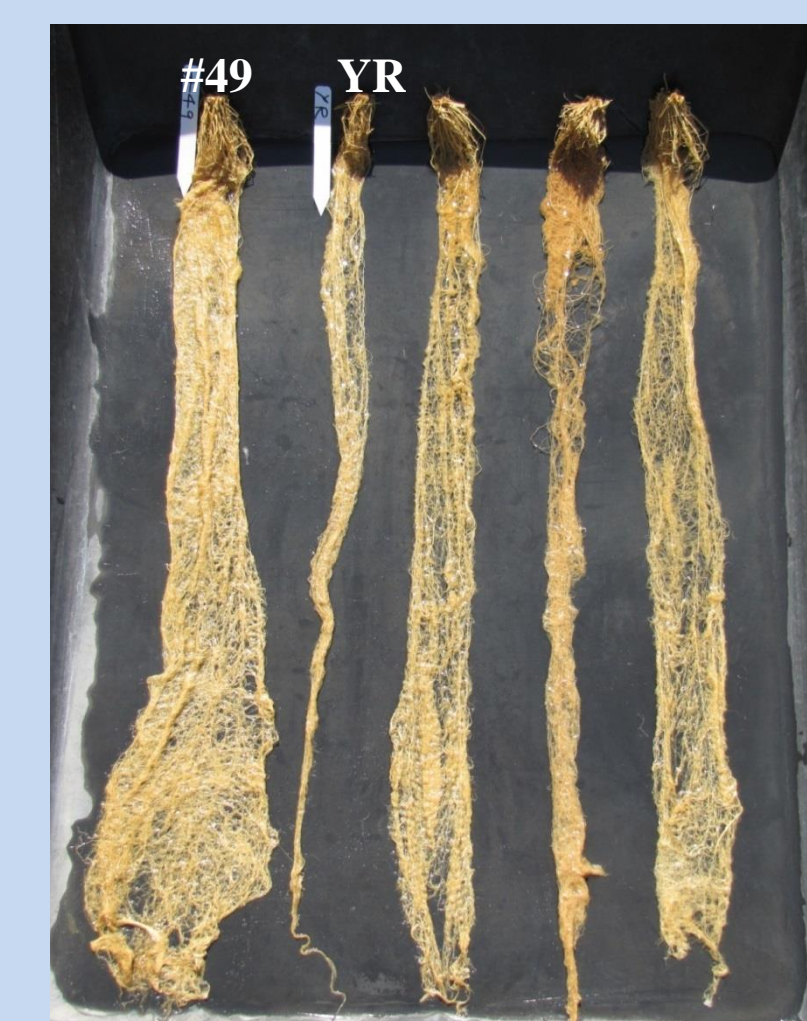


Fig. 1 b – Genotypic variation in root systems.



Fig. 2 a – Parental lines.



Fig. 2 b – Genotypic variation in root systems.



Fig. 2a

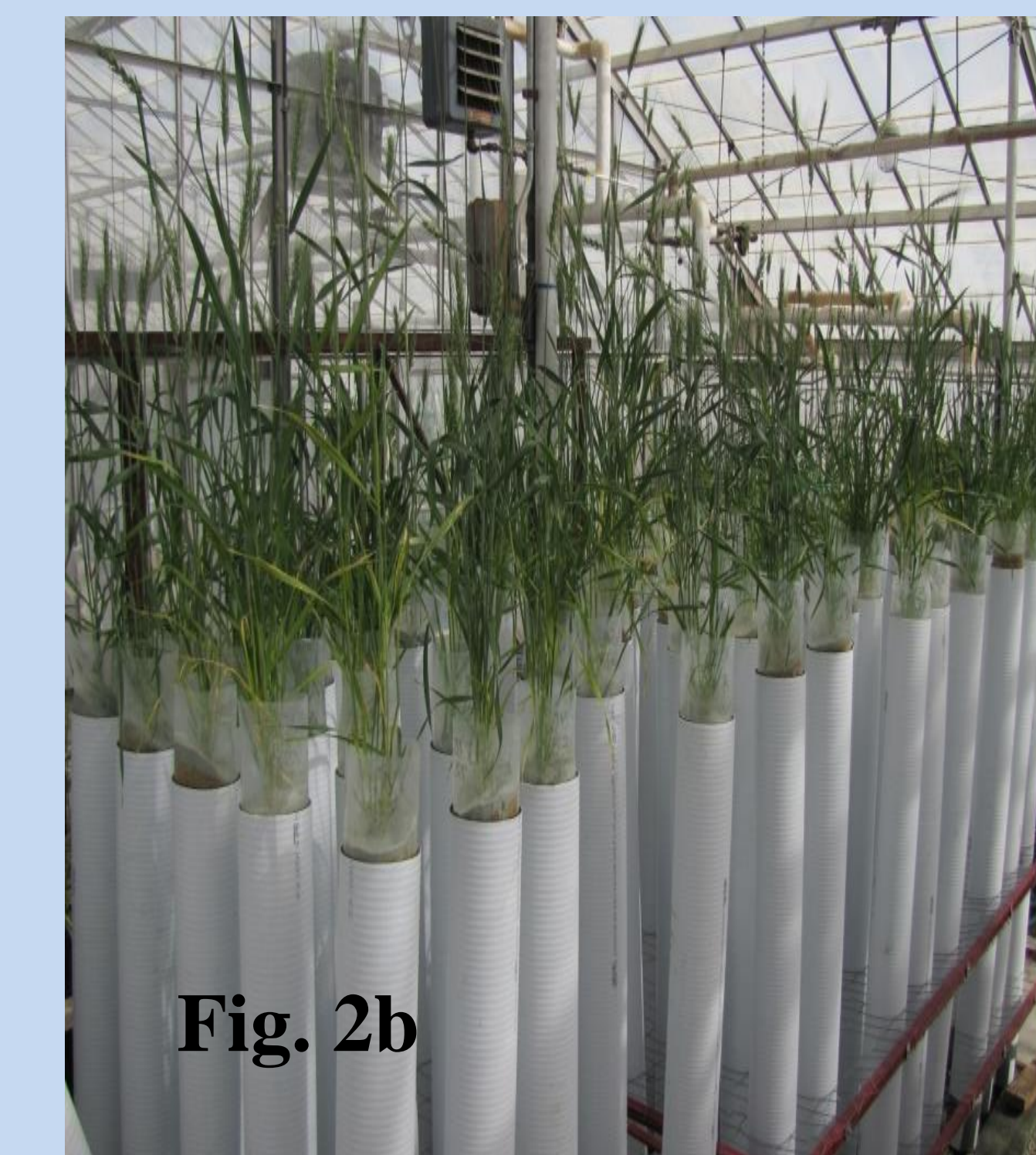


Fig. 2b



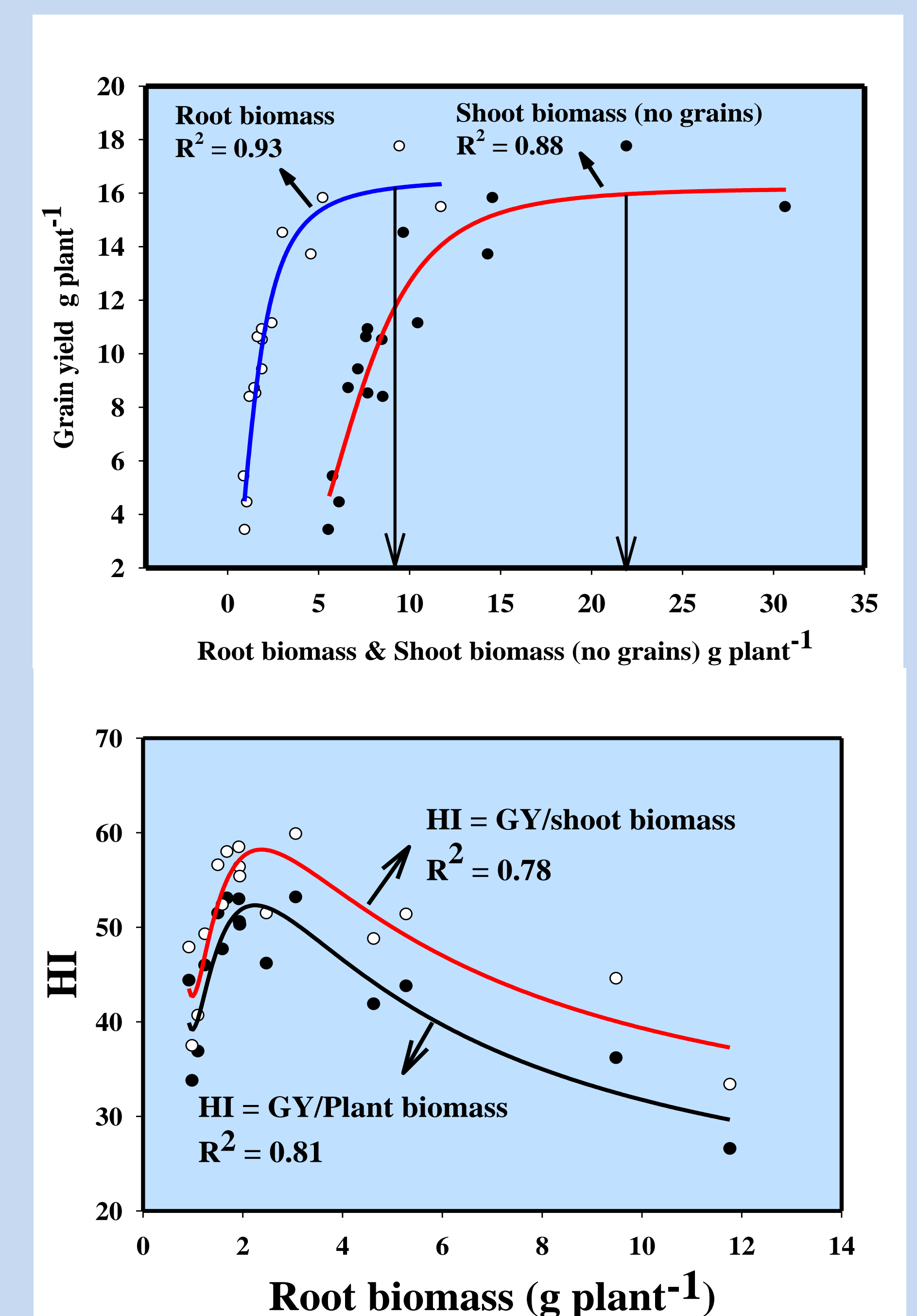
Fig. 3 – Sand cores in polyethylene tubing bags.



Fig. 4a - Washed roots.

Table 1. Plant height (PH), days to maturity (DM), shallow root weight (SRW), deep root weight (DRW), root biomass (RB), shoot biomass excluding grains (SBEG), grain yield (GY), shoot biomass (SB), and harvest index (HI, GY/plant biomass) for bread wheat genotypes grown under well-watered conditions in 1.5 m sand-tube experiment in glasshouse in 2012.

	PH	DM	SRW	DRW	RB	SBEG	GY	SB	HI
Genotype	cm	no.	g/p	g/p	g/p	g/p	g/p	g/p	%
Blanca Fuerte	62	118	1.97	1.09	3.06	9.7	14.5	24.2	53.2
Joaquin	62	114	1.17	0.76	1.93	7.2	9.4	16.6	50.6
Iran #49	117	131	5.32	4.16	9.48	22.0	17.7	39.7	36.2
Yecora Rojo	57	117	1.20	0.72	1.92	7.7	10.9	18.6	53.0
L 8	71	114	0.96	0.54	1.50	6.7	8.7	15.4	51.5
L 9	102	114	1.32	1.15	2.47	10.9	11.1	21.6	46.2
L19	96	117	0.76	0.48	1.24	8.6	8.4	16.9	46.0
L21	94	118	0.74	0.37	1.10	6.2	4.4	10.6	36.9
L22	78	122	1.06	0.53	1.59	7.7	8.5	16.3	47.7
L23	78	122	0.53	0.45	0.98	5.6	3.4	8.9	33.8
L27	94	141	7.47	4.29	11.76	30.7	15.5	46.1	26.6
L28	63	121	1.19	0.75	1.94	8.5	10.5	19.1	50.3
L31	60	129	3.28	1.99	5.27	14.6	15.8	30.4	43.8
L34	99	119	3.02	1.60	4.62	14.3	13.7	28.0	41.9
L49	59	133	0.46	0.46	0.92	5.8	5.4	11.2	44.4
L51	55	118	0.93	0.75	1.68	7.7	10.6	18.2	53.1



CONCLUSIONS

- 1- In these materials, grain yield was not confounded with days to maturity and plant height.
- 2- Maximum grain yield was produced when root biomass and shoot biomass (excluding grains) reached 9 and 22 g per plant.
- 3- Root biomass in Blanca Fuerte was greater than Joaquin. **Under rainfed field conditions** Blanca Fuerte produced 10% more grain yield than Joaquin (APR, UC Davis, 2011, No. 304).
- 4- There was a negative correlation between root biomass and HI.
- 5- Two RILs had greater grain yield and root biomass than Blanca Fuerte.
- 6- In the second year, grain yield was maximized when root biomass reached 7.5 g per plant.