RESEARCH PAPER

Seedling vigor variation among 80 recombinant chromosome substitution lines (RCSL) of barley (*Hordeum vulgare*)

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Abstract

L. Inostroza, C. Quezada, W. Inostroza, I. Matus, M. Tapia, and A. del Pozo. 2011. Seedling vigor of 80 recombinant chromosome substitution lines (RCSL) of barley (*Hordeum vulgare*). Cien. Inv. Agr. 38 (1): 137-147. The seedling vigor of 80 barley recombinant chromosome substitution lines (RCSLs) was measured for selecting high seedling vigor genotypes. The RCSLs were derived from a cross between *H. vulgare* subsp. *spontaneum* and *H. vulgare* subsp. *vulgare* 'Harrington'. The work was carried out under greenhouse conditions during the summer of 2008. The experimental design was an alpha lattice with 3 replicates. In each replicate, 40 plants were established, distributed in eight polyethylene pots containing sand as substrate, which were fertilized an irrigated. The emergence of seedlings, number of leaves and shoots, dry matter of leaves, shoots and roots and leaf area of fully expanded leaves were measured. In addition, growth indices were calculated: emergence rate, leaf appearance rate, relative leaf expansion rate, relative growth rate (RGR), net assimilation rate (NAR), leaf area ratio (LAR) and the allometric coefficient (K) between root and shoot dry matter. All calculated indices varied significantly among genotypes (P≤0.05) and some RCSLs showed better early vigor associated traits than 'Harrington'. The dry matter accumulation 30 DAS (when the experiment ended) was significant and positively correlated with the RGR (r=0.61; P≤ 0.05) and NAR (r=0.41; P≤0.05). The K coefficient was negatively correlated with NAR (r=-0.40, P≤0.05). The genotypes with the greatest seminal vigor were the RCSLs 45, 92, 112 and 'Harrington', whereas the RCSLs 5, 19, 47 and 121 presented the lowest seminal vigor.

Key words: Plant growth analysis, relative growth rate, net assimilation rate, allometric coefficient.

Introduction

In environments with Mediterranean climates, such as the central area of Chile, southern Australia, and the Mediterranean

basin, temperate climate cereals that are cultivated under dry conditions are planted in autumn and harvested at the beginning of summer. In these environments, rainfall is concentrated during the winter when temperate crops do not yet completely cover the ground and decreases towards spring when crops are in the reproductive phase, which often leads to a condition of terminal drought that affects

the grain filling period (Richards and Lukacs, 2002; Richards, *et al*., 2002).

When water availability is the factor that limits crop production, grain yield (GY) can be expressed through the following expression (Passioura, 1977; Richards *et al*., 2002; Araus *et al*., 2002): $GY = T \times WUE \times H$; where T is transpired water; WUE is water use efficiency or biomass production per unit of transpired water and HI is the harvest index, or the fraction of total biomass that is commercial biomass. If it is assumed that each of these factors acts independently, it is possible to achieve increases in GY through an increase in any of them (Richards *et al*., 2002). Nevertheless, wheat and barley may have reached their maximum HI (Calderini *et al*., 1997; Abeledo *et al*., 2002) and consequently future increases in GY should be achieved through increases in biomass production and/or an improvement in water use efficiency.

At crop level, WUE is expressed as the coefficient between GY and the quantity of evapotranspirated water (ET= ES+T). The term ET corresponds to evaporated water from the soil surface (ES) and transpired by the plant (T). In Mediterranean environments, temperate cereals are cropping when ES, as proportion of T, is large (Richards et al., 2002). In these environments, it has been established that a reduction in ES causes an increase of WUE (Richards and Lukacs, 2002; Richards, et al., 2002). Reducing ES is a challenge that presents great potential for advances, given that it has been estimated that evaporation ranges between 35 and 60% of the total water used in wheat and barley crops (Cooper, 1983; Gregory, 1991; French and Schultz, 1984).

In cereals, higher yields are obtained when the foliar biomass of the plants covers the soil surface early on, which reduces ES and increases the available water for use by the plant (López-Castañeda *et al*., 1996; Richards *et al.,* 2002). Seedling vigor of a genotype describes the fast development of leaf area or aboveground biomass and soil cover. Greater seedling vigor increases the competitive level of the crops, allowing for a reduction in the number of seeds used in planting or the quantity herbicides re-

quired (Richards *et al*., 2002). For these reasons, increasing seedling vigor offers a way to increase crop yields in environments with water restrictions, particularly in regions with Mediterranean climates.

Many morpho-physiological traits can influence the seedling vigor of a genotype. For example, at the moment of emergence, barley has twice the foliar area of wheat, which has been associated with the larger size of the embryo and greater specific leaf area (Richards and Lukacs, 2002). Other factors that can influence seedling vigor are the enzymatic activities of the seed (total amylase and α-amylase), root oxidative activity, the rate of germination and emergence, coleoptile length, leaf and tiller appearance rate, width of the first two leaves and the relative growth rate in the first developmental states (López-Castañeda *et al*., 1995; 1996; Cui *et al*., 2002; Richards and Lukacs, 2002; Richards, *et al*., 2002).

Barley is a model species for physiological and genetic studies given that it is of great economic importance, especially in regions with Mediterranean climates. It exhibits a wide range of physiological, morphological and genetic diversity within the species and is a diploid (2n = 14), with only seven pairs of small chromosomes, which has resulted in the development of well-defined genetic maps (Forster *et al*., 2000).

In search of genetic variability in barley, Matus *et al*. (2003) developed a population of 80 recombinant chromosome substitution lines (RCSLs), from crosses between *Hordeum vulgare* subsp. *spontaneum* (accession Caesarea 26-24, originally from Israel) and *H. vulgare* subsp. *vulgare* (cultivar Harrington of US origin and apt for malting). *H. spontaneum* was the donor parent and *H. vulgare* 'Harrington', the recurrent parent. *H. spontaneum* was collected in an arid and saline environment in Israel, which suggests that the introgression of segments of the Caesarea 26-24 genome on 'Harrington' could have effects on characters that confer adaptability or tolerance to abiotic stress.

In previous works, the RCSLs have been phenotypically characterized by Matus *et al*.

(2003), who evaluated agronomic and malting quality traits. They were also characterized by Inostroza *et al.* (2007; 2009), who studied the drought tolerance of these genotypes. Both works concluded that RCSLs are highly useful as a source of genetic diversity, available for searches of genotypes adapted to be developed and produced under abiotic stress conditions.

The objective of this work was to characterize the seedling vigor of 80 barley RCSLs to identify and select genotypes with high seedling vigor.

Materials and methods

Growing environment

The experiment was conducted under greenhouse conditions in the summer of 2008 at the Quilamapu Regional Research Center of the Instituto de Investigaciones Agropecuarias, Chillán-Chile (36º03'S, 72º07'W). Temperature and relative humidity were regulated with a forced air refrigeration system. These variables were registered every 15-minute intervals throughout the experimental period with an automatic sensor (Hobo pro series, Onset, USA). The greenhouse was covered with a white mesh to reduce incident radiation (40% shade). Average registered temperature and relative humidity in the evaluation period were 25.2 ºC (± 5 ºC) and 62.5% (± 15%), respectively. Seeds of a homogenous size were selected through sieving (1.8 x 12.7 mm) to avoid the effect of the seed size on the seedling vigor of the 80 RCSLs. Eight seeds per pot at a depth of three cm were sowed on substrate of fine sand. Eight days after sowing (DAS), seedlings were thinned to leave five per pot. An experimental alpha-lattice design was used with three replicates and nine incomplete blocks (IB) per replicate, with each IB containing nine RCSLs. In each replication, eight pots were established for each RCSLs in order to program eight samplings (9 IB × 9 RCSLs × 8 replicate pots^{-1} = 648 replicate pots^{-1}). The recurrent parent 'Harrington' was used as control.

Evaluations

Seedling emergence was monitored from seeding to six DAS, recording the number of emerged seedlings daily. Plant samples were taken eight times during the assay: at 7, 10, 12, 13, 14, 18, 22 and 30 DAS. Plants were separated from the substrate by rinsing them under running water. Following this, the plants were stored in plastic bags at 4 ºC in darkness. The samples were divided in leaves, shoots and roots, and the number of leaves and shoots was registered. Leaf area was measured in fully expanded leaves beginning at 10 DAS; one leaf per plant was evaluated at 12 DAS, two leaves at 13 and 14 DAS, and three leaves between18 and 30 DAS. Leaf area was measured with a leaf area meter (Delta-T Devices; MK2; Cambridge, England). Subsequently, the samples were dried in a forced air oven at 65 ºC for 48 h. Finally, the dry matter weight of leaves, stems and roots was recorded and the shoot dry matter (shoot DM = leaves + stems) was calculated.

Calculation of growth indices

All the indices were calculated according to Hunt (1982). Thermal time (TT), expressed in Celsius degree-days (ºCd) accumulated from sowing until each date of the samplings, was calculated with the following equation:

$$T = \sum_{i=1}^{n} (Tm - Tb)$$

where Tm, is the mean daily temperature of the environment and Tb is the base temperature for the beginning of barley growth from seedling. Base temperature used in this study was 0ºC as in previous reports (López-Castañeda *et al.*, 1996). The seedling emergence rate (R_{EMG}) was estimated as the slope of the relationship between the percentage of seedling emergence and accumulated TT from seeding until six DAS (R_{EMG} = %seedlings ºCd^{-1}). Through lineal regression, the straight line equation for each genotype was obtained and the TT required for 95% of seedling emergence was estimated (TT_{95}); the leaf appearance rate (R_{leaf}; Nº leaves

ºCd⁻¹) was calculated by means of the quotient between the number of leaves and TT accumulated from seeding to 30 DAS; the relative leaf expansion rate (RLER) was calculated for the experimental period as the slope of the relationship between the natural logarithm of the leaf area of each sampling and the number of days after seeding accumulated in each sampling (RLER= $m^2 m^{-2} d^{-1}$); the relative growth rate (RGR= $kg kg^{-1} d^{-1}$) was calculated for the entire experimental period through the slope of the relationship between the natural logarithm of shoot DM in each sampling and the number of days after seeding accumulated for each sampling; the net assimilation rate (NAR; $kg m^{-2} °Cd^{-1}$) of the experimental period was calculated using the following equation:

$$NAR = \frac{DM_2 - DM_1}{TT_2 - TT_1} \times \frac{\ln LA_2 - \ln LA_1}{LA_2 - LA_1}$$

where DM_2 and DM_1 are accumulated shoot dry matter in the thermal times TT_2 and TT_1, respectively, while LA_2 and LA_1 are the leaf area evaluated at the thermal times TT_2 and TT_1, respectively.

The leaf area ratio (LAR) was calculated in each sample as the product between the specific leaf area (SLA=$m^2 kg^{-1}$) and the leaf weight ratio (LWR=DM leaves shoot DM^{-1}). The LAR for the experimental period was calculated as the average of all the samplings; the allometric coefficient (K) was derived from paired measurements of the production of root DM and shoot DM in each sampling, through lineal regression in the following manner:

$$K = \frac{(\log rootDM - \log b)}{\log shootDM}$$

where b is a constant (Hunt, 1982).

Statistical analysis

The data obtained was analyzed through analysis of variance using PROC MIXED procedure in SAS (SAS Inst., 1999). Each line was considered as a fixed effect and the block and incomplete blocks of each replicate as random

effects. The Least Square Means were estimated for each RCSL and the significance of the difference from the recurring parental cultivar (Harrington) was obtained with the command *diff* in SAS. The relationship between the studied variables and their effects on seedling vigor was analyzed for each genotype, by means of a principal components analysis using XLSTAT software.

Results and discussion

Emergence of seedlings and sensitivity to temperature

As mentioned, barley has greater seedling vigor than wheat, triticale and oats, which has been attributed to its early germination (López-Castañeda *et al*., 1996). In this study, the seedling emergence rate (R_{EMG}) varied significantly among genotypes (P≤0.05) in a range that fluctuated between 0.54 (RCSL-1) and 1.10% ºCd⁻¹ (RCSL-19) (Figure 1a). Furthermore, 45 RCSLs significantly surpassed the R_{EMG} of 'Harrington' (0.71% ºCd⁻¹).

Temperature affects diverse growth processes such as germination, emergence, leaf expansion, net assimilation rate, leaf appearance rate and the relative growth rate. It also influences development processes such as primordial leaf initiation, leaf initiation, formation of the terminal spikelet in wheat, the maximum number of primordials in barley, anthesis and physiological maturity (Slafer and Rawson, 1995). In this work, the 80 RCSLs presented a wide range of responses to temperature, given that the thermal time required to reach 95% of emergence of seedlings (TT_{95}) varied significantly among genotypes (P ≤ 0.05), in a range between 161.5 (RCSL-19) and 268.1 ºCd (RCSL-1) (Figure 1b). 'Harrington' showed a TT_{95} value of 212.2 ºCd and at least five RCSLs showed a significantly lower value of TT_{95}.

All the indices and phenotypic characters associated with germination and emergence are strongly influenced by seed size (Cui *et al*., 2002; Ahmad *et al*., 2004; Soltania *et al*., 2006). In this study, the seeds had a similar size. Nevertheless, R_{EMG} and TT_{95} varied significantly
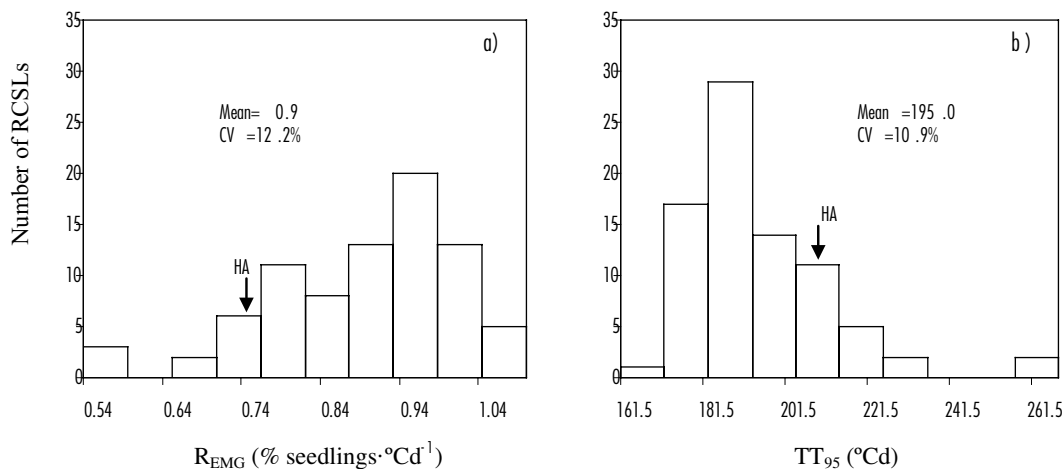
Figure 1. Frequency distributions for: a) seedling emergence rate (R_{EMG}) and b) thermal time for 95% of seedling emergence (TT_{95}) of 80 recombinant chromosome substitution lines of barley. The arrows indicate the values for 'Harrington' (HA).

among the genotypes. Cui *et al*. (2002) evaluated some physiological traits associated with seedling vigor in rice and found that small seed size genotypes achieved equal and even greater seedling vigor than large seed size genotypes. This was attributed to greater enzymatic activity (total amylase and α-amylase) of the genotypes with smaller sized seeds, which obtained a more efficient transformation of seed reserves in autotrophies tissue.

Plant growth analysis

RLER, R_{leaf}, LAR, RGR, NAR and the production of shoot DM in the last sampling varied significantly among genotypes ($P \leq 0.05$). Only RGR and NAR correlated significantly with shoot DM production (Table 1), which means that leaf growth and development did not contribute to seedling vigor of the RCSLs. Similar results were reported by López-Castañeda *et al*. (1996) in genotypes of barley, wheat, triticale and oats.

RLER varied between 0.03 (RCSL-10) and 0.11 m² m⁻² d⁻¹ (RCSL-76). 'Harrington' registered a value of 0.07 m² m⁻² d⁻¹ (Figure 2a); R_{leaf} fluctuated between 0.028 (RCSL-45) and 0.038 (RCSL-50) leaves ºCd⁻¹ (Figure 2b); LAR varied

between 1.9 (RCSL-99) and 3.2 m² kg⁻¹ (RCSL-30). 13 RCSLs showed significantly higher LAR values than 'Harrington', which obtained a LAR value of 2.0 m² kg⁻¹ (Figure 2c). RGR varied between 0.072 (RCSL-6) and 0.116 kg kg⁻¹ d⁻¹ (RCSL-112); 'Harrington' registered a value of 0.099 kg kg⁻¹ d⁻¹ (Figure 3a). For this index, 18 RCSLs showed RGR value similar to 'Harrington', but none were significantly higher. NAR varied between 0.0019 kg m⁻² ºCd⁻¹ (RCSL-6) and 0.0061 kg m⁻² ºCd⁻¹ (RCSL-92) (Figure 3b). For this index, only two genotypes (RCSL-64 and RCSL-92) were significantly higher than 'Harrington', which registered a NAR value of 0.0031 kg m⁻² ºCd⁻¹. Shoot DM production at the last sampling varied between 0.30 (RCSL-6) and 1.0 g pot⁻¹ (RCSL-112). Only RCSL-112 achieved a shoot DM production statistically similar to 'Harrington'. It should be noted that the RCSLs that presented the lower and higher RGR were those that achieved the lower and higher shoot DM accumulation, respectively.

The results of this study can only be compared to those reported by López-Castañeda *et al*. (1995; 1996), due to methodological aspects. Comparing the RCSLs to the barley genotypes in the aforementioned studies, it can be observed that the RCSLs present a lower RLER

(0.08 vs. 0.21 m^2 m^{-2} d^{-1}), NAR (0.003 vs. 0.08 kg m^{-2} °Cd^{-1}) and RGR (0.09 vs. 0.18 kg kg^{-1} d^{-1}), but a higher R_{leaf} (0.030 vs. 0.015 leaves °Cd^{-1}) and similar LAR (2.3 vs. 2.1 m^2 kg^{-1}). Consequently, the genotypes studied by López-Castañeda *et al*. (1995; 1996) showed higher seedling vigor than the RCSLs, which allows for duplicating the shoot DM production of the RCSLs in a similar time period and under similar environmental conditions (López-Castañeda *et al*., 1995).

Dry matter partitioning

Hunt (1982) proposed that the distribution of carbohydrates between the aboveground and belowground organs of a plant depends on an allometric ratio between these organs. In accordance with this sentence, the size of the root DM: shoot DM ratio depends on a power function specific for each genotype. The exponent, called the "allometric coefficient" (K), determines how the root DM: shoot DM ratio changes with the plant size. Additionally, Körner (1991) proposes that the root DM: shoot DM ratio, or the proportion between heterotrophic/autotrophic tissue, is one of the most important factors determining plant growth. Under ideal growth conditions, plants with a high root DM: shoot DM ratio have a high respiration cost. However, under restrictive growth conditions, a higher root DM: shoot DM ratio is considered a characteristic that confers adaptability, given that it allows for more exploration of the soil to capture resources. In this work, the allometric coefficient between root and shoot DM production (K) varied significantly among the 80 RCSLs and fluctuated between 0.29 (RCSL-32) and 0.78 (RCSL-47). 'Harrington' showed a K value of 0.57 (Figure 4). López-Castañeda *et al.* (1996), reported that the root DM: shoot DM ratio of barley in an early stage of development (2 leaves) is similar to that of wheat and oats. Nevertheless, their results show significant differences among the studied genotypes of barley, which coincides with the results of this study. Furthermore, the K value correlated negatively with TT_{95}, NAR and SLA (Table 1).

Table 1. Phenotypic correlations (r) among eleven traits related to seedling vigor of 80 recombinant chromosome substitutions lines of barley.

	TT_{95}	R_{EMG}	RLER	Shoot DM	RGR	NAR	K	SLA	LWR	LAR	R_{leaf}
TT_{95}	1.00										
R_{EMG}	-0.89***	1.00									
RLER	Ns	ns	1.00								
Shoot DM	Ns	ns	ns	1.00							
RGR	Ns	ns	ns	0.61***	1.00						
NAR	Ns	ns	ns	0.39***	0.41***	1.00					
K	-0.25*	ns	ns	ns	ns	-0.39***	1.00				
SLA	ns	ns	ns	ns	ns	ns	-0.28**	1.00			
LWR	ns	ns	0.38***	ns	ns	ns	ns	ns	1.00		
LAR	ns	ns	ns	ns	ns	ns	ns	0.93***	0.23*	1.00	
R_{leaf}	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	1.00

*P≤0.05; **P≤0.01; ***P≤0.001; the variables are: thermal time for 95% of seedling emergence (TT_{95}), seedling emergence rate (R_{EMG}), relative leaf elongation rate (RLER), shoot dry matter production at the last sampling (Shoot DM), relative growth rate (RGR), net assimilation rate (NAR), allometric coefficient (K), specific leaf area (SLA), leaf weight ratio (LWR), leaf area ratio (LAR) and leaf appearance rate (R_{leaf}).
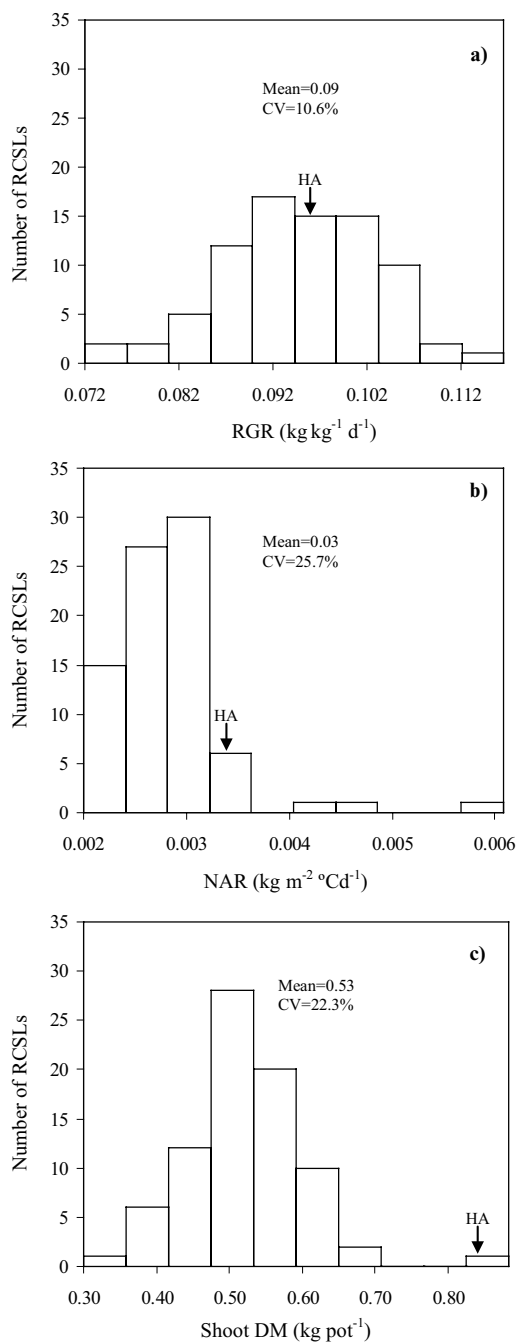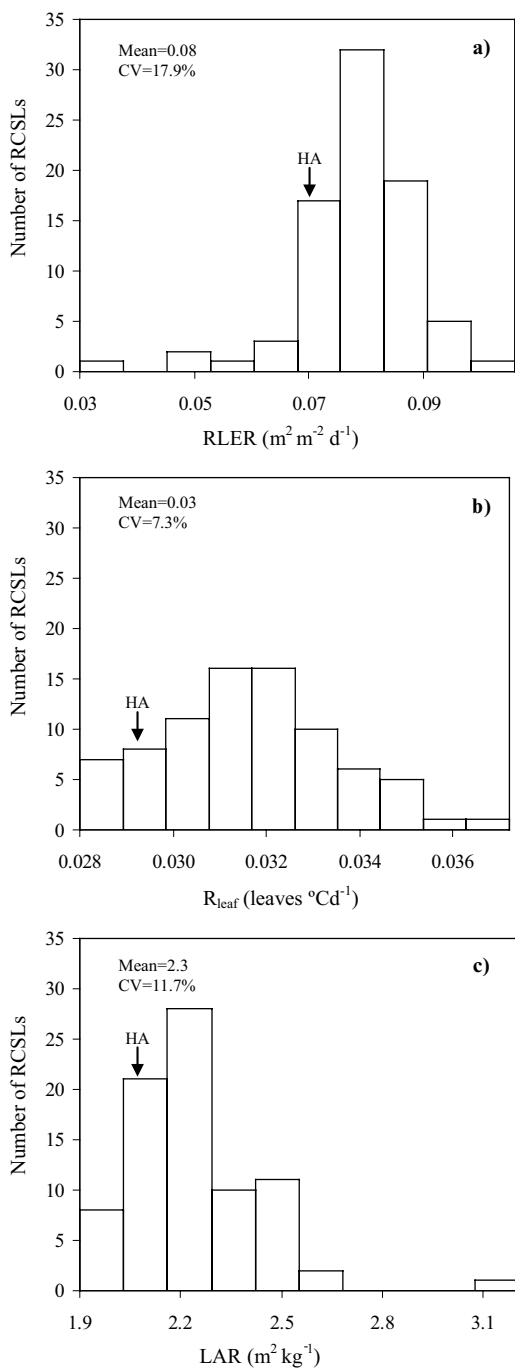
Figure 2. Frequency distributions for: a) relative leaf expansion rate (RLER); b) leaves appearances rate (Rleaf); c) leaf area ratio (LAR) of 80 recombinant chromosome substitution lines of barley. The arrows indicate the values for 'Harrington' (HA).

Figure 3. Frequency distributions for: a) relative growth rate (RGR); b) net assimilation rate (NAR); c) shoot dry matter production at the last sampling (Shoot DM) of 80 recombinant chromosome substitution lines of barley. The arrows indicate the values for 'Harrington' (HA).
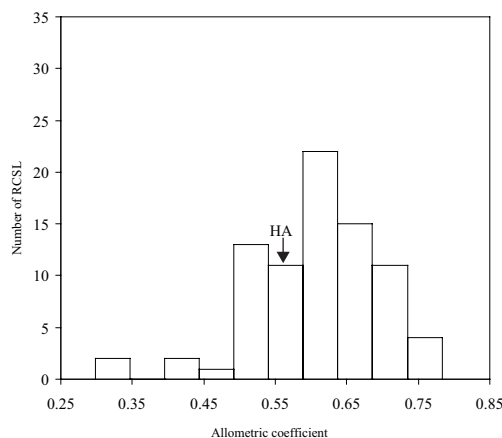
Figure 4. Frequency distribution for the allometric coefficient (K) between root and shoot dry matter, calculated for 80 recombinant chromosome substitution lines of barley. The arrow indicates the values for 'Harrington' (HA).

Figure 5. Biplot of the first two principal components (PC1 and PC2) for the principal component analysis of five traits evaluated in 80 recombinant chromosome substitution lines (RCSLs) of barley. The traits are: allometric coefficient between root and shoot dry matter (K), shoot dry matter at 30 days after sowing (Shoot DM), relative growth rate (RGR), net assimilation rate (NAR), leaf area ratio (LAR). Some RCSLs and 'Harrington' (HA) are labeled.

Selection of genotypes with high seedling vigor

To select genotypes that have a greater quantity of traits that contribute to seedling vigor, the relationship between the calculated indices and the genotypes was studied through a principal components analysis (PCA). The variables RGR, NAR, LAR, K and shoot DM production in the last sampling were considered for this purpose. The variables RLER, R_{leaf}, TT_{95} and R_{EMG} were not included, given that they were not correlated with the shoot DM production at the last sampling. The result of the PCA revealed that 66 % of the variation in seedling vigor is explained by the first two principal components (PC). The PC1 explained 42 %, while the PC2 explained 24 % of the variability. Figure 5 shows a biplot of the studied variables and the values of PC_1 and PC_2 for each RCSL. Each variable is represented by a vector and the angle that is formed between them, which shows the correlation between the assessed traits. Angles lower than 90º indicate a positive correlation, angles higher than 90º indicate a negative correlation, and orthogonal angles indicate that the variables are independent.

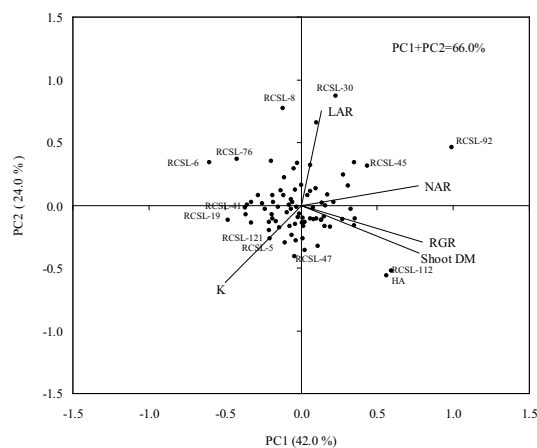The shoot DM production in an initial state of development of the RCSLs (30 DAS), RGR and NAR correlated positively and significantly among themselves; the K value correlated negatively with NAR (Table 1; Figure 5). On the other hand, the variables that contribute most to PC1 are RGR (30%), NAR (28%) and shoot DM (29 %), and to PC2, LAR (47%) and K (32%). With this information, it is possible to interpret the behavior of each RCSL. For example, the RCSLs that presented high values of PC1 and PC2 (RCSL-45 and 92) are characterized by high RGR, NAR, shoot DM production and LAR, but by a low K value. RCSL-30 had the highest value of PC2, with a medium value of PC1, which means that this line invested the major part of its photo-assimilates in the leaves production (high LAR and low K) and achieved medium values, in comparison to the other genotypes for RGR, NAR and shoot DM production. 'Harrington' and RCSL-112 presented a high value of PC1 but a low value of PC2, which indicates that these genotypes achieve a high shoot DM production with a high dry matter investment in roots production (high K and low LAR). RCSLs 5, 19, 47 and 121 presented the lowest values of PC1 and PC2 (Figure 5), which means that they are the lines with less seedling vigor owing to low RGR, NAR and consequently a low shoot DM production. Also, these genotypes invest a great quantity of resources in the formation of heterotrophic organs (roots).

Inostroza *et al*. (2007) evaluated the agronomic performance of the 80 RCSLs in two Mediterranean environments of Chile. Through this evaluation, contrasting genotypes for drought tolerance were selected (tolerant and sensitive to drought). The RCSLs 8 and 41 were selected as drought tolerant genotypes. However, these genotypes showed low seedling vigor in this study (Figure 5). RCSL-8 presented low NAR, RGR, K and shoot DM production, but a high value of LAR. RCSL-41 also showed low values of NAR, RGR, K and shoot DM production but one of the highest values of K. It should be noted that seedling vigor is a character related to plant water use efficiency and a genotype with high WUE is not always the most drought tolerant (Araus *et al*., 2002). RCSL-45 was also selected as tolerant to drought by Inostroza *et al*. (2007) and proved to be a genotype with high seedling vigor in this study (Figure 5). This shows that different genotypes can achieve a high level of drought tolerance through different combinations of traits (Ceccarelli *et al.*, 1991).

H. spontaneum is widely considered as a potential donor of genes that grants adaptability to different types of abiotic and biotic stresses (Ivandic *et al*., 2000; Backes *et al*., 2003; Baum *et al*., 2003; Ivandic *et al*., 2003; Matus *et al*., 2003; Pillen *et al*., 2003; Talamè *et al*., 2004; Grando and Ceccarelli, 2007; Inostroza *et al*., 2009). The results of this study confirm the value of *H. spontaneum* given that all the RCSLs have chromosomal regions of this wild ancestor. In addition, all the characters associated with seedling vigor varied significantly among genotypes and several RCSLs showed a more favorable expression of traits than 'Harrington'.

Finally, the 80 recombinant chromosome substitution lines differed widely in terms of their seedling vigor, given that the evaluated characters (TT$_{95}$, REMG, RLER, RGR, NAR K and MSa) varied significantly among genotypes. The most discriminating variables for seedling vigor were the relative growth rate, the net assimilation rate and allometric coefficient between root and shoot dry matter production. The genotypes that presented the greatest seedling vigor were RCSLs 45, 92, 112 and 'Harrington', while the RCSLs 5, 19, 47 and 121 showed the least seedling vigor**.**

Resumen

L. Inostroza, C. Quezada, W. Inostroza, I. Matus, M. Tapia y A. del Pozo. 2011. Vigor seminal de 80 líneas recombinantes con sustitución de cromosomas (RCSL) de cebada (*Hordeum vulgare*). Cien. Inv. Agr. 38 (1): 137-147. Se estudió el vigor seminal de 80 líneas recombinantes con sustitución de cromosomas (RCSLs), derivadas de la cruza entre H. vulgare subsp. spontaneum y H. vulgare subsp. vulgare 'Harrington'. El trabajo se realizó bajo invernadero durante el verano del 2008. Se usó un diseño experimental de alpha lattice con tres repeticiones. En cada repetición, 40 plantas de cada línea se establecieron en 8 macetas que contenían arena como sustrato. Se realizó 8 muestreos, en los que se evaluó emergencia de plántulas, número de hojas y tallos, materia seca de hojas, tallos y raíces y área foliar de hojas plenamente expandidas. Además, se calculó índices de crecimiento como tasa de emergencia, tasa de aparición de hojas, tasa relativa de expansión foliar, tasa de crecimiento relativo (TCR), tasa de asimilación neta (TAN), proporción de área foliar (PAF) y el coeficiente alométrico de la relación entre materia seca radical y aérea (K). Todos los parámetros variaron significativamente entre genotipos (P ≤ 0,05) y algunas RCSLs fueron superiores a Harrington. La acumulación de materia seca en el último muestreo se correlacionó significativa y positivamente con la TCR (r =0,613; P ≤ 0,05) y la TAN (r=0,414; P ≤ 0,05). El K se correlacionó negativa y significativamente con la TAN (r=-0,393; P ≤ 0,05). Los genotipos con mayor vigor seminal fueron las RCSLs 45, 92, 112 y Harrington; mientras que los con menor vigor seminal fueron las RCSLs 5, 19, 47 y 121.

Palabras clave: Análisis del crecimiento de plantas, tasa de crecimiento relativa, tasa de asimilación neta, coeficiente alométrico**.**

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