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Agronomical evaluation of the Aula Dei barley collection *

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ABSTRACT

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258 barley cultivars from the Aula Dei collection have been agronomically evaluated under drought conditions. Based on higher drought tolerance, 50 cultivars were selected for a second evaluation.

Wide variability was detected among cultivars for most of the evaluated traits. The selected cultivars showed higher yield levels than the check. Yield was significantly correlated with early flowering, as an escape mechanism for late drought, and with visual biomass estimations.

Information and seed samples are made available.

INTRODUCTION

The importance of barley in Spain increases continuously and 4.2 million ha are actually devoted to this crop, with an average yield close to 2.0 tons per ha (Anuario Estadística Agraria, 1985). Of the total acreage, 2.2 million ha are cultivated with 6-row varieties.

Fifty per cent of this area is cultivated with only one 6-row variety, named Albacete (Prieto, 1985), selected 31 years ago at the Estación Experimental de Aula Dei. Since then the feed barley breeding efforts in Spain have not resulted in a competi-

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tive substitute variety.

One reason of this failure seems to be the narrow genetic basis that has been used. Most of the germplasm incorporated into the breeding programs has been European commercial varieties, poorly adapted to the dry areas of southern Europe, with yields below 2.0 t/ha (Grando et al., 1987).

This narrow genetic basis was confirmed by Persson (1984), who reported that only 2% of the available genetic variability in barley is presently being used in the breeding programs.

This lack of variability could be overcome through evaluation of germplasm resources and development of "elite germplasms" based on those accessions found to carry specific characters or specific adaptability (Moseman and Craddock, 1975).

The value of germplasm collections is emphasized by Lehmann et al. (1975), who indicate that recent barley breeding in Central Europe is based on material collected 40-50 years ago. At the same time, they pointed out that materials from the Gatersleben collection were used in the breeding of Trumpf and Nadja, two of the most successful spring barley varieties from GDR.

In 1984 we started a barley breeding programme for dry areas, based on a Male Sterile Facilitated Recurrent Selection scheme, trying to recombine local adapted germplasms (Lasa et al., 1987).

The first step is the evaluation under dry conditions of the local germplasm collections (Ceccarelli, 1987) to identify the most appropriate genotypes to be recombined.

The barley collection from our Institute was previously described with respect to morphological characters (Villena, 1956). The objective of this work is to complement that information with the agronomic evaluation under drought conditions.

MATERIALS AND METHODS

The materials used in the experiments were 258 accessions from the barley collection of Aula Dei, most of which consists of old 6-row local cultivars from Spain.

The first year's evaluation took place at Aula Dei in the 1984-85 season, with the use of an "Augmented Design" (Petersen, 1985) for preliminary yield test, and with the commercial varieties Albacete and Soledad as checks. The experiment consisted of blocks with 24 old cultivars and two duplicated checks per block. The plots, each of two rows, 0.2 m apart and 1.2 m long, were sown 0.4 m apart with pathways 1.0 m wide between blocks. 120 seeds were sown per plot. The evaluated traits were days to flowering, plant height, biomass visual score, yield and 100 kernel weight.

The 50 entries selected after the first evaluation were sown at Aula Dei in a randomized block experiment with four replications, and using as checks the varieties Albacete and Barberousse, well adapted to dry and semi-dry conditions, respectively. The plot was the same size as in the first year.

Cultivar evaluation was based on different vegetative traits

and yield components (Table 1). Biomass was visually scored at the stem elongation stage (9=highest). Plant height, was measured just after ripening and included awns.

Table 1.- Traits used in the evaluation.

Trait	Units	Code
Days to 50 % Flowering	days	FD
Days to 50 % Maturity	days	MD
Grain Filling (MD-FD)	days	GF
Biomass reading	1-9	BM
Lodging	1-9	LG
Mature Plant Height	cm	PH
Grain Yield	g m ⁻²	GY
Test Weight	g dm ⁻³	TW
Total Spike Weight	g	TSW
Seed Spike Weight	g	SSW
Kernels per Spike	—	KPS
Kernel Weight	g	KW
Nodes per Spike	—	NS
Spike Fertility (=KPS/NS*3)	%	SF
Spike Length	cm	SL
Ear Length (without awns)	cm	EL

The trials were harvested with a plot combine. In the second year 15 randomly selected spikes from one replication were collected before harvest and used for the spike determinations. Harvest was on June 20-21 in 1985 and on June 24-25 in 1986.

Statistical analyses were performed with the use of an SPSS/PC+ package (Norusis, 1986).

RESULTS AND DISCUSSION

In Figure 1 are presented the histogrammes of frequencies for the traits evaluated in the first year. 1984-85 season was characterized by drought from tillering to harvesting, and plant heights were very low. Yield and kernel weight results reflected the very wide variability present in the collection with respect to drought tolerance.

Based on the biomass estimation as an indicator of drought tolerance, flowering date to match the phenological characteristics of the adapted cultivar, and the yield characters, 50 entries were selected to undergo a second year of evaluation. Mean values for the 258 entries, the 50 selected ones and the check Albacete, are presented in Table 2.

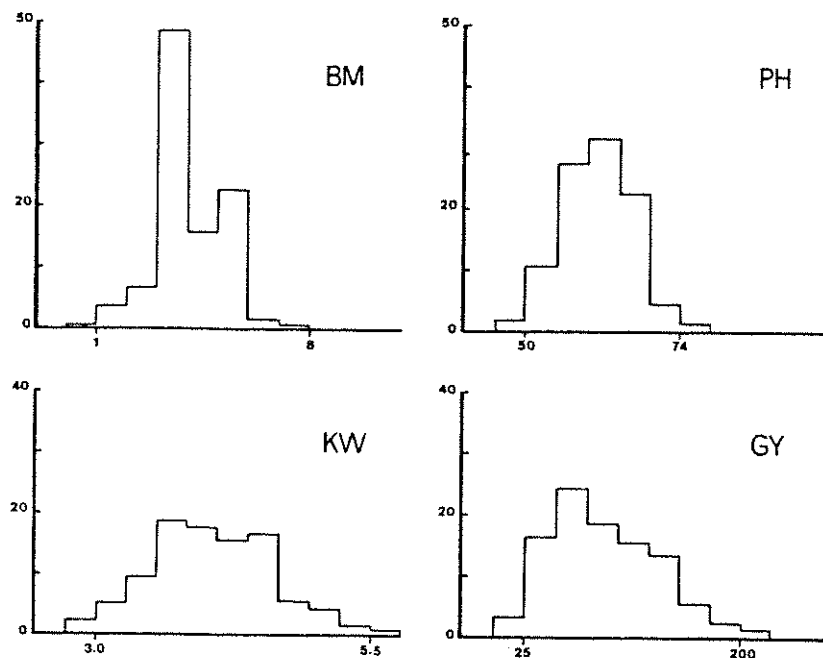


Figure 1.- Biomass (BM), plant height (PH), kernel weight (KW) and grain yield (GY) distributions of 258 Aula Dei cultivars.

Table 2.- Mean values of the 258 cultivars, the selected 50, and the check Albacete in 1984-85 season.

	258 c.	50 sc.	Check
FD	172	170	168
BM	4.55	5.68	6.00
PH	61	65	68
GY	90.9	154.7	162.8
KW	4.20	4.61	3.67

Results from the evaluation in 1985-86 are presented in Tables 3 and 4. The 50 cultivars are compared with the check variety Albacete, and the results are in percentage of the check, with the exception of phenological data, which are presented in days difference, and biomass readings which are in absolute values.

Phenological characteristics show a very wide variability among cultivars with differences in flowering from -8 to +7 days, and differences in grain filling period from -5 to +4. The differences in grain filling duration was largely due to differences in anthesis, rather than maturity date (Metzger et al., 1984). This was due to the high temperatures that affected the crop at ripening, and which produced a very quick maturity.

Table 3.- Means and LSD (.05) of phenological and yield traits, for 50 selected Aula Dei cultivars. Data presented as percentages of the check. (*) days difference, (**) absolute values.

NUM	ORIGIN	FD*	BF*	BM**	LG	PH	GY	TW	KW
4056	OPAL 30/74	3	-1	3.5	100	103.7	127.9	96.2	145.7
4087	CHEVALIER II	-2	0	2.5	67	86.4	111.0	96.7	111.3
4091	GULKORN x BRAGE 27-279	-2	3	2.5	100	109.9	106.5	93.6	95.5
4094	MAJA x (SEGERxOPAL) 34/2	3	1	3.0	67	96.3	100.6	101.0	120.2
4162	HORDEUM HEXASTICHUM L.	6	-1	3.0	67	87.7	95.6	104.5	127.1
4164	SEL. 15 AULA DEI	6	-1	3.0	67	86.4	110.5	100.7	116.1
4198	LINEA B3 VAR. 1007	4	-1	4.0	133	100.0	109.1	97.0	129.9
4209	LINEA 127 VAR. TENKOW	5	-5	3.0	33	91.4	109.4	98.2	104.8
4230	GRANJA 15	7	-1	3.0	33	81.5	88.3	100.3	129.5
4236	LA ALMUNIA 1	6	-1	3.0	133	96.3	110.7	102.6	115.1
4238	LA ALMUNIA 3	2	-2	3.0	167	97.5	142.8	95.9	116.8
4259	BURGUETE (b)	5	0	3.0	100	113.6	94.5	94.2	121.6
4302	PRECOZ DE ERRO (a)	4	0	3.0	67	92.6	96.7	96.4	127.8
4325	CADIZ	1	1	4.0	100	97.5	127.0	92.9	136.7
4326	RUSO 5 (2)	4	-1	2.5	133	86.4	93.2	93.6	119.2
4378	BALAZOTE 4	3	0	3.0	67	96.3	91.2	94.5	115.8
4392	TAMMISTOS LENTIKORN	-4	1	3.0	133	98.8	118.6	97.2	119.9
4393	BALAZOTE 3	7	-2	3.0	100	98.8	97.8	98.2	116.8
4441	PLUMAGE ARCHER	-4	2	3.5	100	101.2	106.4	98.5	121.9
4468	VANLINGT SKANST SEXRADS	0	1	2.5	33	81.5	117.1	98.8	111.3
4481	SV. PRIMUS x ASPLUNDS	7	-2	2.5	33	74.1	94.0	102.0	116.1
4585	AURORE	6	-1	2.5	100	88.9	83.3	97.9	125.4
4611	10 KRASNODAR	4	-1	3.0	167	111.1	104.3	95.0	128.1
4626	CERVECERA x PRECOZ 7	7	-2	2.5	67	88.9	72.5	96.9	119.9
4642	SEL. PRECOZ 22	-4	3	3.0	100	109.9	122.4	96.7	123.3
4644	VILLARDBLEDO 4	-6	3	4.0	133	108.6	155.2	95.7	128.8
4653	SEL. DEL PAIS	2	-3	3.0	67	93.8	113.6	94.4	132.9
4675	AULA DEI 17	-4	1	3.5	133	101.2	126.6	97.4	114.7
4691	BALAZOTE 8	1	1	3.0	67	97.5	104.9	98.5	109.6
4695	CERVECERA x PRECOZ 1	-8	4	3.0	133	101.2	138.5	96.4	139.1
4698	SEL. DEL PAIS	-3	1	3.0	67	96.3	115.1	97.9	127.1
4699	BALAZOTE 9	1	-3	2.5	33	84.0	107.6	90.7	94.8
4701	MARZAL 14	0	-1	3.5	100	106.2	144.6	94.5	119.5
4703	COGOTONA 7	5	1	3.0	100	103.7	116.1	97.9	136.0
4710	AULA DEI 4	3	-1	3.0	67	93.8	103.3	94.2	124.4
4717	BARLUENGA	0	0	4.5	100	104.9	141.3	92.9	123.0
4720	SELGUA 3	7	-2	2.5	100	98.8	92.8	98.8	136.4
4721	SELGUA 4	5	0	3.0	100	92.6	88.3	103.5	135.0
4725	CASTARLENAS GRAUS 3	5	-1	3.0	67	85.2	95.2	101.0	114.7
4726	CASTARLENAS GRAUS 4	3	-4	3.0	100	91.4	106.2	98.8	110.3
4735	SEL. LAS ALMUNIAS 2	5	0	2.5	67	93.8	80.9	102.0	122.6
4741	ALBAY 2	7	-2	3.5	67	93.8	116.0	95.7	154.9
4745	CASTEJON DE SOS 1	6	-1	3.0	33	79.0	99.0	98.3	126.1
4751	SANTOSENS	7	-2	3.0	133	93.8	103.1	95.2	126.4
4759	RIDDENA 2	4	-2	3.5	133	103.7	114.8	101.3	126.1
4835	RADIGUERO 3	2	-2	3.5	100	100.0	68.6	96.4	158.7
4845	CUARTE 1	6	-2	3.0	67	91.4	99.2	98.3	112.3
4848	FANLO	2	2	3.5	67	100.0	118.7	98.3	126.8
4873	PAMULA DE BORREDA	5	-2	2.5	100	96.3	112.1	93.1	74.9
4877	SAN PEDRO DE RIBAS	4	0	2.5	133	100.0	98.9	95.2	126.8
	BARBEROUSSE	-6	2	2.0	33	80.2	101.9	101.2	96.2
CHECK	ALBACETE = 100 %	28/IV	19	2.0	3.0	81.0	176.1	60.5	2.9
LSD (.05)		3.2	3.7	0.8	79.3	--	32.0	5.5	17.4

Table 4.- Means and LSD (.05) of spike traits, for 50 selected Aula Dei cultivars. Data presented as percentages of the check.

NUM	DRIGIN	TSW	SSW	KPS	NS	SF	SL	EL
4056	OPAL 30/74	114.2	115.6	78.4	81.8	96.1	111.6	87.1
4087	CHEVALIER II	83.4	82.3	74.5	81.8	90.9	98.0	97.1
4091	BULKORN x BRAGE 27-279	88.8	87.8	86.3	90.9	94.8	100.0	97.1
4094	MAJA x (SEGERxDPAL) 34/2	92.9	91.8	68.6	86.4	79.2	92.5	82.9
4162	HORDEUM HEXASTICHUM L.	98.2	99.3	74.5	77.3	97.4	106.8	90.0
4164	SEL. 15 AULA DEI	85.2	81.6	68.6	81.8	84.4	106.1	87.1
4198	LINEA 83 VAR. 1007	104.7	104.8	78.4	95.5	81.8	105.4	91.4
4209	LINEA 127 VAR. TENKOW	101.2	101.4	86.3	104.5	83.1	102.0	105.7
4230	GRANJA 15	102.4	97.3	74.5	95.5	77.9	108.8	105.7
4236	LA ALMUNIA 1	117.2	119.7	92.2	90.9	101.3	102.7	71.4
4238	LA ALMUNIA 3	110.6	112.9	98.0	100.0	98.7	89.8	70.0
4259	BURGUETE (b)	120.7	124.5	86.3	100.0	87.0	93.2	111.4
4302	PRECOZ DE ERRO (a)	104.7	107.5	76.5	90.9	84.4	102.7	92.9
4325	CADIZ	93.5	93.2	64.7	81.8	79.2	91.8	85.7
4326	RUSO 5 (2)	88.2	86.4	72.5	77.3	94.8	101.4	75.7
4378	BALAZOTE 4	110.1	106.8	82.4	90.9	90.9	117.0	97.1
4392	TAMMISTOS LENTIKORN	95.3	94.6	72.5	90.9	80.5	94.6	91.4
4393	BALAZOTE 3	94.1	89.8	72.5	90.9	80.5	107.5	107.1
4441	PLUMAGE ARCHER	109.5	107.5	84.3	86.4	97.4	106.8	105.7
4468	VANLINGT SKANST SEXRADS	87.0	85.0	76.5	81.8	93.5	104.1	97.1
4481	SV. PRIMUS x ASPLUNDS	102.4	101.4	78.4	86.4	90.9	106.1	95.7
4585	AURORE	81.1	78.2	60.8	77.3	79.2	101.4	82.9
4611	10 KRASNODAR	95.3	96.6	70.6	81.8	87.0	117.7	91.4
4626	CERVECERA x PRECOZ 7	87.0	87.8	66.7	72.7	92.2	100.0	91.4
4642	SEL. PRECOZ 22	104.1	101.4	74.5	90.9	81.8	95.9	81.4
4644	VILLAROBLEDD 4	128.4	129.9	84.3	81.8	103.9	114.3	82.9
4653	SEL. DEL PAIS	116.6	110.2	72.5	90.9	80.5	112.9	98.6
4675	AULA DEI 17	103.0	99.3	72.5	86.4	84.4	98.6	92.9
4691	BALAZOTE 8	78.1	78.9	66.7	77.3	87.0	94.6	85.7
4695	CERVECERA x PRECOZ 1	95.9	95.2	64.7	72.7	89.6	99.3	77.1
4698	SEL. DEL PAIS	91.1	89.1	70.6	77.3	92.2	105.4	90.0
4699	BALAZOTE 9	103.6	99.3	100.0	100.0	100.0	103.4	105.7
4701	MARZAL 14	117.2	119.7	92.2	95.5	97.4	104.8	101.4
4703	COGOTONA 7	110.1	108.8	72.5	77.3	94.8	103.4	60.0
4710	AULA DEI 4	85.8	80.9	72.5	86.4	84.4	113.6	102.9
4717	BARLUENGA	98.8	102.7	86.3	81.8	105.2	102.0	91.4
4720	SELGUA 3	115.4	112.2	74.5	86.4	87.0	119.7	100.0
4721	SELGUA 4	98.2	96.6	70.6	86.4	81.8	102.0	90.0
4725	CASTARLENAS GRAUS 3	80.5	80.9	68.6	77.3	89.6	95.2	82.9
4726	CASTARLENAS GRAUS 4	85.2	83.7	76.5	86.4	88.3	86.4	61.4
4735	SEL. LAS ALMUNIAS 2	79.3	78.2	60.8	72.7	84.4	101.4	82.9
4741	ALBAY 2	81.7	77.5	66.7	81.8	81.8	96.6	90.0
4745	CASTEJON DE SOS 1	106.5	103.4	80.4	90.9	89.3	106.8	105.7
4751	SANTORENS	98.8	97.2	72.5	81.8	89.6	110.2	101.4
4759	RIDDENA 2	150.3	149.0	98.0	104.5	93.5	114.3	105.7
4835	RADIGUERO 3	116.0	113.6	88.2	90.9	97.4	115.6	104.3
4845	CUARTE 1	117.2	119.0	90.2	86.4	105.2	102.0	101.4
4848	FANLO	134.9	135.4	92.2	95.5	97.4	108.8	105.7
4873	PAMULA DE BORREDA	117.2	117.0	113.7	113.6	100.0	112.9	118.6
4877	SAN PEDRO DE RIBAS	110.1	110.9	86.3	95.5	90.9	114.3	102.9
	BARBEROUSSE	97.0	94.6	103.9	109.1	96.1	107.5	105.7
CHECK	ALBACETE = 100 %	1.69	1.47	51.0	22.0	77.0	14.7	7.0
LSD (.05)		28.8	29.8	21.2	13.6	14.8	12.4	15.0

Grain yield of this selected group has been quite high compared with the check, with an average value of 107 %. On the other hand the test weight has been lower (97 %), with narrow variability.

With respect to spike characters, Albacete has given the highest values in almost all the traits, with the exception of spike length and kernel weight.

Analysis of the correlation between traits in this particular set of materials, showed a significant correlation between yield and early flowering (.58**), caused by the partial degree of drought escape through early flowering (Fisher and Maurer, 1978). Biomass reading is also highly correlated with yield (.51**) offering a good possibility for visual selection. Finally, no significant correlation was found between yield and any of the spike traits.

Evaluation results and seed samples of this barley collection are available upon request from the Estación Experimental de Aula Dei, P.O.Box 202, 50080 Zaragoza, Spain.

RESUMEN

Se ha realizado la evaluación agronómica bajo condiciones de sequía de 258 cultivares de la colección de cebadas de la Estación Experimental de Aula Dei. Por su mayor tolerancia a sequía se seleccionaron 50 cultivares que fueron sometidos a una segunda evaluación.

Se ha detectado una gran variabilidad para la mayor parte de los caracteres estudiados. Los cultivares seleccionados presentan niveles de producción superiores al testigo, y correlacionados significativamente con la floración temprana, como forma de escape a la sequía terminal, y con las estimaciones visuales de biomasa.

Se pone a disposición de los mejoradores información y semilla de los cultivares estudiados.

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