

10.1071/CP17306_AC

© CSIRO 2018

Supplementary Material: *Crop & Pasture Science*, 2018, **69**, 335–346.

Grain mineral density of bread and durum wheat landraces from geochemically diverse native soils

José Francisco Vázquez^A, Efraín Antonio Chacón^A, José María Carrillo^A and Elena Benavente^{A,B}

^ADepartment of Biotechnology and Plant Biology, School of Agricultural, Food and Biosystems Engineering, UPM – Universidad Politécnica de Madrid, Ciudad Universitaria s/n, 28040-Madrid, Spain.

^BCorresponding author. Email: e.benavente@upm.es

Supplementary Table S1. Detailed results on grain Zn concentration (GZn), grain iron concentration (GFe), grain protein content (GPC) and grain yield of the BREAD WHEAT landraces (203) and commercial varieties (22) evaluated in the PRELIMINARY TRIAL

For local materials, the reference in the Spanish Centre of Genetic Resources CRF-INIA (BGE code) is showed in the variety column. Summary results are given in Table 1 of the main text. The varieties selected for multi-location trials are highlighted.

Variety code/name	GZn (mg/kg)	GFe (mg/kg)	GPC (%)	Yield (t/ha)
BGE000142	47	21	10.1	3.2
BGE001982	49	16	11.2	1.3
BGE001983	57	28	10.7	1.2
BGE002010	52	32	11.3	2.7
BGE002011	57	32	11.0	1.7
BGE002834	48	16	11.7	1.8
BGE002836	58	36	11.3	1.4
BGE002838	62	16	10.8	2.0
BGE002849	49	55	10.8	3.2
BGE003540	53	59	10.8	2.5
BGE003610	50	22	10.8	2.2
BGE003612	58	31	10.1	2.9
BGE004788	58	34	11.6	1.7
BGE004789	53	25	10.6	1.9
BGE005443	45	15	9.7	3.0
BGE008213	52	20	10.7	1.9
BGE008707	50	24	12.8	3.1
BGE010003	43	21	10.2	3.3
BGE010015	62	20	10.4	2.5
BGE011826	39	26	9.8	3.1
BGE011829	54	48	9.3	3.1
BGE011869	58	26	11.0	1.2
BGE011870	43	35	9.7	3.1
BGE011872	47	23	10.6	2.0
BGE011874	52	28	11.2	2.9
BGE011879	54	36	10.6	0.5
BGE011880	65	28	11.2	3.2
BGE011881	43	21	9.7	3.1
BGE011887	51	41	11.6	3.1
BGE011888	59	25	10.3	2.2
BGE011932	61	26	11.7	2.6
BGE011935	60	18	11.4	3.2
BGE011947	40	14	9.5	3.2
BGE011950	48	24	10.1	3.1

Variety code/name	GZn (mg/kg)	GFe (mg/kg)	GPC (%)	Yield (t/ha)
BGE011955	47	37	9.9	2.5
BGE011959	41	33	10.9	2.9
BGE011985	54	25	10.6	2.7
BGE011995	48	18	10.4	1.9
BGE011998	46	23	10.6	3.0
BGE011999	45	29	10.7	1.9
BGE012011	56	27	11.8	2.0
BGE012012	50	24	10.9	2.8
BGE012019	43	27	10.6	2.8
BGE012025	51	35	11.2	3.1
BGE012039	46	15	11.1	1.5
BGE012048	50	36	11.0	1.9
BGE012056	48	23	11.0	3.3
BGE012061	50	34	11.7	3.2
BGE012067	40	27	10.6	3.2
BGE012083	55	30	11.7	3.0
BGE012091	52	28	12.0	1.9
BGE012092	45	39	9.9	2.0
BGE012110	54	26	11.4	3.1
BGE012112	57	32	10.8	1.6
BGE012113	56	28	10.7	3.2
BGE012114	54	26	11.4	3.1
BGE012122	46	26	10.5	3.3
BGE012124	45	26	12.5	3.2
BGE012125	42	25	10.5	3.0
BGE012127	50	27	10.5	3.2
BGE012128	58	27	12.2	2.8
BGE012129	54	15	11.0	2.1
BGE012130	64	24	12.6	1.8
BGE012193	47	36	11.1	3.2
BGE012194	46	32	10.2	2.8
BGE012201	45	24	10.5	3.1
BGE012203	53	19	11.5	3.3
BGE012205	48	22	10.6	2.0
BGE012206	48	27	10.7	3.3
BGE012207	48	34	11.6	2.7
BGE012210	43	25	9.1	3.1
BGE012211	42	20	10.1	3.2
BGE012212	59	30	12.2	1.3
BGE012214	49	29	10.7	3.3
BGE012238	48	26	10.7	3.1
BGE012239	62	18	11.4	2.7
BGE012575	63	22	11.7	1.8
BGE012576	45	24	10.1	3.3

Variety code/name	GZn (mg/kg)	GFe (mg/kg)	GPC (%)	Yield (t/ha)
BGE012577	52	22	10.7	3.2
BGE012580	47	27	11.8	2.1
BGE012582	44	45	9.8	3.1
BGE012586	52	24	9.8	2.6
BGE012591	52	35	11.5	3.2
BGE012594	54	24	11.3	2.7
BGE012595	53	34	11.3	3.2
BGE012596	49	28	10.3	2.8
BGE012602	50	25	11.7	3.2
BGE012603	56	27	10.8	3.2
BGE012615	53	17	9.9	3.1
BGE012744	46	21	10.7	2.7
BGE012746	58	24	10.4	3.3
BGE012752	59	21	10.4	2.9
BGE012761	48	40	11.6	3.3
BGE012785	43	22	9.6	3.1
BGE012861	44	23	11.5	2.9
BGE012867	54	28	10.8	3.0
BGE012873	58	28	10.5	3.1
BGE012875	47	26	10.6	2.5
BGE012888	67	29	11.6	1.6
BGE012889	46	21	10.8	3.3
BGE012893	49	39	11.4	3.1
BGE012894	70	46	12.7	0.8
BGE012896	59	19	9.3	2.9
BGE013123	52	25	11.8	2.5
BGE013125	51	19	9.9	2.9
BGE013128	52	26	9.7	3.2
BGE013131	52	28	9.7	2.7
BGE013132	55	30	9.4	3.2
BGE013133	56	27	10.2	2.2
BGE013134	52	36	9.6	3.2
BGE013135	49	30	11.2	3.1
BGE013136	52	26	11.0	3.2
BGE013137	55	27	11.4	1.8
BGE013149	57	22	10.3	2.4
BGE013151	50	28	10.8	3.1
BGE013152	71	22	11.7	3.0
BGE013153	48	20	10.2	3.4
BGE013155	41	23	8.4	3.4
BGE013158	46	24	9.7	1.6
BGE013162	68	14	11.3	2.1
BGE013164	59	30	10.8	3.0
BGE013166	64	27	11.6	3.1

Variety code/name	GZn (mg/kg)	GFe (mg/kg)	GPC (%)	Yield (t/ha)
BGE013171	47	19	10.1	3.3
BGE013174	45	22	9.7	3.0
BGE013181	46	22	10.2	3.3
BGE013182	49	33	10.8	3.2
BGE013183	58	26	10.6	3.4
BGE013184	51	19	12.0	3.3
BGE013185	52	24	11.1	3.2
BGE013186	72	38	11.3	1.7
BGE013187	64	24	11.9	2.1
BGE013190	64	26	11.3	2.0
BGE013192	44	27	10.2	2.7
BGE013194	55	26	10.9	2.3
BGE013195	60	35	10.4	2.5
BGE013197	55	25	11.0	2.9
BGE013198	52	16	9.1	3.2
BGE013199	52	27	10.6	2.9
BGE013202	63	36	12.5	2.6
BGE013203	48	29	11.4	2.5
BGE013213	44	48	8.9	2.8
BGE013215	46	23	10.4	3.2
BGE013216	69	45	10.9	3.1
BGE013218	80	34	12.5	1.4
BGE013760	53	30	10.3	3.2
BGE013762	36	31	9.2	1.8
BGE013764	50	17	10.6	2.1
BGE013767	62	23	12.4	1.8
BGE013769	65	29	10.8	1.9
BGE013771	52	21	10.4	3.1
BGE013776	90	62	12.7	0.3
BGE013795	65	29	10.7	0.3
BGE013798	57	18	10.8	0.8
BGE013800	54	27	10.9	1.6
BGE013802	62	34	11.9	2.0
BGE013811	54	32	12.9	1.2
BGE014258	47	37	10.6	2.7
BGE014261	52	35	9.6	1.9
BGE014281	54	20	10.6	2.9
BGE014285	51	24	10.3	2.1
BGE015396	45	18	11.0	2.6
BGE015404	49	43	10.9	3.1
BGE018196	50	31	11.1	3.0
BGE018200	53	37	9.1	3.0
BGE018202	42	22	8.5	3.1
BGE018203	59	25	10.3	3.3

Variety code/name	GZn (mg/kg)	GFe (mg/kg)	GPC (%)	Yield (t/ha)
BGE018207	47	42	8.3	3.4
BGE018208	55	24	12.0	2.1
BGE018210	47	31	9.7	2.4
BGE018211	46	25	11.3	2.1
BGE018212	53	27	11.7	3.0
BGE018213	66	27	10.9	2.0
BGE018214	60	27	11.1	2.9
BGE018215	54	29	9.1	3.0
BGE018217	59	21	11.0	2.1
BGE018219	55	21	9.5	3.0
BGE018222	58	42	10.1	2.4
BGE018225	61	29	10.4	2.4
BGE018226	59	27	10.2	3.0
BGE018227	50	22	10.3	3.5
BGE018228	55	10	11.4	1.1
BGE018229	67	34	11.4	1.8
BGE018230	49	13	11.4	1.1
BGE018231	45	21	11.0	2.0
BGE018233	63	27	10.3	3.2
BGE018234	49	27	11.4	3.1
BGE018239	48	35	11.0	3.1
BGE018242	48	20	12.6	3.3
BGE018244	51	25	10.8	3.3
BGE018248	51	23	12.5	3.2
BGE018249	48	19	10.9	2.4
BGE018253	54	60	11.5	3.1
BGE018254	67	28	11.4	3.1
BGE018258	75	42	11.5	1.6
BGE018355	60	14	9.7	3.2
BGE018671	60	46	12.0	2.2
BGE018922	47	33	11.4	3.0
BGE019314	44	22	10.5	3.2
BGE019317	47	22	10.2	3.1
BGE019324	62	24	10.4	3.2
BGE019329	44	17	9.7	2.0
BGE026408	59	52	10.7	3.2
BGE038604	55	37	10.8	1.4
Amarok	39	21	9.6	
Anza	46	42	8.9	
Astral	36	18	9.2	
Bancal	47	27	11.1	
Berdún	46	17	10.4	
Cajeme	67	32	11.7	
Capitole	37	19	11.2	

Variety code/name	GZn (mg/kg)	GFe (mg/kg)	GPC (%)	Yield (t/ha)
Cartaya	61	36	10.6	
Cezanne	46	26	9.2	
Cortex	60	39	11.3	
Etecho	52	26	9.9	
Fiuza	42	30	9.5	
Galera	49	29	9.3	
Greina	44	28	9.2	
Manero	48	25	10.5	
Marius	42	22	8.1	
Pané-247	46	36	9.6	
Rinconada	55	33	12.7	
Soissons	49	31	10.8	
Tigre	47	38	9.5	
Trapío	58	38	11.5	
Yécora	66	32	12.6	

Supplementary Table S2. Detailed results for grain Zn concentration (GZn), grain iron concentration (GFe) and grain protein content (GPC) of the DURUM WHEAT landraces (222) and commercial varieties (13) evaluated in the PRELIMINARY TRIAL

For local materials, the reference in the Spanish Centre of Genetic Resources CRF-INIA (i. e., BGE code) is showed in the variety column. Summary results are given in Table 1 of the main text. The varieties selected for multi-location trials are highlighted.

Variety code/name	GZn (mg/kg)	GFe (mg/kg)	GPC (%)
BGE000110	56	36	12.7
BGE000122	52	33	11.9
BGE000125	58	33	12.5
BGE002870	67	39	13.2
BGE002879	65	38	13.9
BGE002884	62	34	13.5
BGE002892	61	39	12.4
BGE008247	55	30	11.9
BGE008248	63	40	12.2
BGE008251	63	32	12.4
BGE008253	57	36	12.5
BGE008254	56	36	12.7
BGE008257	53	33	12.6
BGE008261	58	31	11.1
BGE008262	65	33	12.7
BGE008263	80	33	12.4
BGE008264	61	36	13.5
BGE008269	59	37	11.8
BGE012334	58	35	13.4
BGE012345	64	36	12.7
BGE012347	53	37	13.3
BGE012357	68	37	12.4
BGE012359	50	33	11.2
BGE012381	57	34	12.7
BGE012382	56	26	13.4
BGE012384	59	28	12.3
BGE012392	59	32	12.5
BGE012534	66	34	12.1
BGE012557	56	33	12.4
BGE013040	50	30	12.6
BGE013043	53	33	13.5
BGE013044	53	36	12.9
BGE013045	58	34	14.0
BGE013046	56	34	10.6

Variety code/name	GZn (mg/kg)	GFe (mg/kg)	GPC (%)
BGE013047	58	37	12.5
BGE013051	64	27	14.1
BGE013052	56	37	11.7
BGE013053	58	40	12.8
BGE013054	72	35	13.4
BGE013057	57	31	11.7
BGE013063	61	35	12.7
BGE013064	68	33	12.1
BGE013069	59	25	12.6
BGE013070	54	34	12.9
BGE013071	66	36	13.2
BGE013072	62	31	12.9
BGE013073	58	31	13.3
BGE013074	57	32	13.6
BGE013075	70	31	13.5
BGE013081	55	36	11.9
BGE013083	57	33	11.5
BGE013084	63	33	14.2
BGE013085	57	30	11.5
BGE013088	71	33	14.5
BGE013094	79	36	14.1
BGE013095	58	35	12.9
BGE013096	57	33	9.8
BGE013098	60	39	10.7
BGE013099	71	38	12.2
BGE013101	91	37	14.6
BGE013104	61	29	12.3
BGE013583	61	32	12.6
BGE013584	65	36	11.9
BGE013585	69	37	13.6
BGE013587	63	29	11.9
BGE013589	62	36	13.3
BGE013592	60	37	11.4
BGE013593	57	33	12.0
BGE013594	58	28	11.4
BGE013595	60	31	12.2
BGE013596	66	36	12.8
BGE013600	72	35	12.7
BGE013601	58	36	11.7
BGE013604	63	38	11.6
BGE013606	55	30	11.5
BGE013607	58	33	12.7
BGE013611	53	32	10.8
BGE013614	52	32	11.6

Variety code/name	GZn (mg/kg)	GFe (mg/kg)	GPC (%)
BGE013652	56	38	11.8
BGE013654	52	35	11.2
BGE013655	60	38	12.0
BGE013656	61	39	12.6
BGE013663	55	31	11.3
BGE013668	58	32	12.8
BGE013669	60	26	12.1
BGE013672	64	35	13.9
BGE013684	64	31	12.5
BGE013685	53	31	12.3
BGE013687	52	25	11.3
BGE013695	76	36	13.9
BGE013696	64	32	14.0
BGE013697	55	33	11.9
BGE013698	58	30	12.2
BGE013702	59	32	11.6
BGE013703	52	35	13.3
BGE013704	57	33	13.0
BGE013713	51	24	11.2
BGE013717	54	29	12.2
BGE013718	57	34	11.2
BGE013719	63	40	14.2
BGE013722	71	38	12.7
BGE013724	65	39	13.4
BGE013726	62	31	12.4
BGE013729	57	32	13.0
BGE013730	82	38	13.4
BGE013731	54	30	12.1
BGE013733	56	41	11.3
BGE013735	64	33	14.3
BGE014237	57	31	12.8
BGE014247	61	36	13.2
BGE015016	63	39	12.7
BGE015017	63	37	13.7
BGE015021	54	29	13.8
BGE015386	56	32	12.7
BGE015388	60	28	12.1
BGE015389	54	32	13.0
BGE018260	60	41	12.6
BGE018269	54	28	11.9
BGE018270	60	33	12.5
BGE018272	54	34	14.0
BGE018273	56	34	12.0
BGE018274	56	39	12.6

Variety code/name	GZn (mg/kg)	GFe (mg/kg)	GPC (%)
BGE018276	52	41	12.4
BGE018281	58	40	13.7
BGE018282	58	36	13.1
BGE018283	56	35	12.0
BGE018284	47	33	11.3
BGE018285	55	29	12.1
BGE018287	58	32	12.4
BGE018288	59	47	11.4
BGE018290	54	35	11.9
BGE018291	50	42	12.9
BGE018295	63	43	11.7
BGE018296	68	47	13.2
BGE018303	58	38	13.6
BGE018305	60	34	13.3
BGE018309	50	28	12.1
BGE018311	57	34	13.1
BGE018313	56	33	12.1
BGE018314	56	25	11.9
BGE018315	57	31	11.4
BGE018319	66	37	13.6
BGE018323	76	36	13.0
BGE018326	71	38	13.0
BGE018333	73	36	13.1
BGE018337	54	37	12.7
BGE018339	63	32	13.2
BGE018341	69	38	12.9
BGE018345	58	34	11.9
BGE018347	62	43	12.9
BGE018348	64	39	12.9
BGE018349	60	32	13.5
BGE018597	58	35	12.6
BGE018600	55	45	13.6
BGE018604	57	41	11.4
BGE018611	57	37	12.8
BGE018614	56	33	13.2
BGE018616	62	31	12.9
BGE018618	58	35	12.5
BGE018620	74	37	13.4
BGE018621	67	38	12.3
BGE018625	74	45	13.1
BGE018626	78	41	13.2
BGE018627	56	32	12.4
BGE018628	53	38	12.0
BGE018639	57	36	11.8

Variety code/name	GZn (mg/kg)	GFe (mg/kg)	GPC (%)
BGE018641	74	38	14.1
BGE018642	74	37	13.5
BGE018643	63	34	13.0
BGE018644	70	34	14.6
BGE018645	56	31	11.7
BGE018647	66	47	13.4
BGE018649	63	41	13.1
BGE018650	46	26	11.5
BGE018652	53	29	11.4
BGE018655	73	42	14.7
BGE018657	64	30	13.7
BGE018658	68	36	14.6
BGE018659	55	38	11.8
BGE018676	59	31	12.2
BGE018677	58	34	11.8
BGE018678	64	33	13.0
BGE019251	60	46	12.4
BGE019252	51	35	11.6
BGE019253	53	30	12.9
BGE019254	67	36	12.9
BGE019260	66	32	12.5
BGE019280	62	36	13.6
BGE019281	60	41	12.4
BGE019283	79	38	14.2
BGE019285	71	39	14.1
BGE019287	59	35	13.0
BGE019289	63	40	13.1
BGE019290	67	33	11.7
BGE019301	62	37	13.0
BGE019306	69	23	13.4
BGE019307	50	26	10.3
BGE019308	62	26	12.3
BGE020464	55	30	10.4
BGE021765	60	29	13.1
BGE021769	67	46	14.3
BGE021773	54	27	11.9
BGE021780	57	38	11.3
BGE021782	59	40	12.7
BGE021785	59	33	12.3
BGE021786	56	32	12.0
BGE026411	59	33	13.1
BGE026950	57	33	10.0
BGE026952	47	33	9.3
BGE026955	58	33	13.0

Variety code/name	GZn (mg/kg)	GFe (mg/kg)	GPC (%)
BGE026956	50	32	10.6
BGE026958	48	31	9.6
BGE026959	56	39	13.4
BGE026961	56	30	10.8
BGE028567	56	30	11.1
BGE029097	54	28	10.8
BGE030921	54	32	9.9
BGE030922	53	24	12.4
BGE030924	63	27	12.4
BGE030926	63	28	13.4
BGE030927	65	30	13.5
BGE030928	63	31	13.7
Ariesol	50	38	10.9
Astrodur	55	36	11.8
Becuarentaicinco	58	40	10.6
Ciccio	54	35	11.4
Don Juan	49	34	9.9
Mellaria	47	34	11.2
Polaris	48	40	10.1
Requeño	49	39	9.8
Cocorit	51	38	10.0
Concadoro	62	41	10.5
Jiloca	49	31	10.7
Pedrisco	56	29	10.0
Valnova	54	38	11.7

Supplementary Table S3

PASSPORT INFORMATION at the CRF webpage on the collecting sites of the Spanish landraces selected for multi-location trials. SOIL CHARACTERISTICS of their native locations according to the geochemical studies referenced in the main text are also indicated.

Landrace	BGE code	Local name	Province ^a	Locality	Latitude	Longitude	Altitude (m)	Soil pH	Soil content ^b	Zn Soil content ^c	Fe
<i>Bread wheat landraces</i>											
BwL01	BGE012896	Alcaraz negro	Albacete	Alcaraz	384011N	022934W	945	8.0 - 8.5	2		2
BwL02	BGE013195	Barbilla de Carbajales de Zamora Alba	Zamora	Carbajales Alba	de 413917N	055948W	740	5.0 - 6.0	3		5
BwL03	BGE010015	Barbilla rojiza de Huelva	Huelva *	n. a.				6.0 - 7.0	3		2
BwL04	BGE013171	Blanco de Cerrato	Palencia	Cerrato	415248N	042144W	819	8.0 - 8.5	2		3
BwL05	BGE012582	Blanquillo de Toledo	Toledo *	n. a.				7.5 - 8.0	2		2 - 4
BwL06	BGE018671	Blat mort	Baleares	Manacor	393412N	031238E	80	8.0 - 8.5	4		4
BwL07	BGE013134	Candeal de Aranda	Burgos	Aranda	414018N	034112W	804	7.5 - 8.0	2		3
BwL08	BGE013131	Candeal de Salamanca	Salamanca *	n. a.				5.0 - 6.0	2		4 - 5
BwL09	BGE013152	Canet	Girona	Canet d'Adri	420222N	024409E	241	7.0 - 7.5	4		5
BwL10	BGE005443	Cascon	Palencia	Capillas	420053N	045322W	764	8.0 - 8.5	3		3
BwL11	BGE012761	Catalan de monte	Zaragoza *	n. a.				8.0 - 8.5	3		1 - 2
BwL12	BGE012128	Chamorro de Humanes	Guadalajara	Humanes	404942N	030909W	746	7.0 - 7.5	2		3
BwL13	BGE011955	Chamorro de Viveros	Albacete	Viveros	384629N	023429W	1010	8.0 - 8.5	2		2
BwL14	BGE013184	Corriente de Jaca	Huesca	Jaca	423420N	003301W	825	8.0 - 8.5	3		5
BwL15	BGE013213	Coruche negro	Caceres	n. a.				5.0 - 6.0	3		4
BwL16	BGE013162	Grandal	Lugo	n. a.				5.0 - 6.0	4		4

Landrace	BGE code	Local name	Province ^a	Locality	Latitude	Longitude	Altitude (m)	Soil pH	Soil content ^b	Zn Soil content ^c	Fe
BwL17	BGE013760	Isla de Fuerteventura	Las Palmas	n. a.				8.5 - 9.0	3	5	
BwL18	BGE015396	Jeja colorada	Cuenca	Zafrilla	401145N	013658W	1417	8.0 - 8.5	2	2	
BwL19	BGE018222	Jeja de Cieza	Murcia	Cieza	381421N	012508W	190	8.0 - 8.5	2	2	
BwL20	BGE012061	Negrete de Priego	Cuenca	Priego	402655N	021853W	862	8.0 - 8.5	2	2	
BwL21	BGE012083	Negrete de Huelves	Cuenca	Huelves	400241N	025257W	817	8.0 - 8.5	2	2	
BwL22	BGE012752	Negro	Madrid *	n. a.				7.0 - 7.5	2	3	
BwL23	BGE012092	Negro de Salas	Asturias	Salas	432435N	061538W	243	5.0 - 6.0	5	5	
BwL24	BGE012124	Richela blanca	Lleida *	n. a.				7.5 - 8.0	4	3 - 4	
BwL25	BGE018355	Ruso	Avila	Arenas de Pedro	401236N	050523W	510	5.0 - 6.0	3	3	
BwL26	BGE013216	Santa Marta	Badajoz	Santa Marta	383658N	063734W	340	7.5 - 8.0	2	4	
BwL27	BGE012207	Toseta de Jaca	Huesca	Jaca	423420N	003301W	825	8.0 - 8.5	3	5	
BwL28	BGE013155	Tremesino	Caceres *	n. a.				5.0 - 6.0	3	4	
BwL29	BGE003540	Trigo de campo del pais	Lugo	Villalba	431607N	074005W	470	5.0 - 6.0	3	4	
BwL30	BGE012893	Trigo de riego	Pontevedra *	n. a.				5.0 - 6.0	4	4	
BwL31	BGE013190	Trujillo	Caceres	Trujillo	392749N	055253W	564	5.0 - 6.0	3	4	
BwL32	BGE018242	Xeixa	Lleida *	n. a.				7.5 - 8.0	4	3 - 4	

Durum wheat landraces

DwL01	BGE013043	Amoros blanco	Alicante	Monforte del Cid	382245N	004345W	224	8.0 - 8.5	3	2	
DwL02	BGE018296	Arisnegro	Cordoba	Villa del Rio	375901N	041723W	165	7.5 - 8.0	3	3	
DwL03	BGE013713	Arisnegro velloso grano	Canarias*	n. a.				7.5 - 8.0	4	5	

Landrace	BGE code	Local name	Province ^a	Locality	Latitude	Longitude	Altitude (m)	Soil pH	Soil content ^b	Zn Soil content ^c	Fe
		rojo									
DwL04	BGE013687	Basto duro	Alava *	n. a.				7.5 - 8.0	2	3	
DwL05	BGE019307	Baza	Granada	Baza	372927N	024628W	845	8.0 - 8.5	2	4	
DwL06	BGE013094	Blanco vellosa de Vegadeo	Asturias	Vegadeo	432753N	070304W	4	5.0 - 6.0	4	4	
DwL07	BGE013600	Blat obeia	Barcelona *	n. a.				8.0 - 8.5	4	3 - 4	
DwL08	BGE026952	Candeal	Almeria	Ohanes	370340N	024331W	1090	8.0 - 8.5	4	4	
DwL09	BGE018295	Don Benito	Badajoz	Don Benito	385715N	055142W	279	6.0 - 7.0	2	4	
DwL10	BGE002879	Las Palmas 7	Las Palmas*	n. a.				7.0 - 7.5	4	5	
DwL11	BGE018625	Mazachon de Balazote	Albacete	Balazote	385303N	020903W	775	8.0 - 8.5	2	2	
DwL12	BGE013051	Negro	Cordoba *	n. a.				7.5 - 8.0	3	3 - 4	
DwL13	BGE018314	Recio cañihueco	Toledo *	n. a.				7.5 - 8.0	2	2 - 4	
DwL14	BGE012359	Recio cañimacizo	Cordoba	Cañete de Torres	375203N	041908W	321	8.0 - 8.5	3	3	
DwL15	BGE019285	Recio de Ronda	Malaga	Ronda	364431N	050959W	720	8.0 - 8.5	4	3	
DwL16	BGE019283	Rubio de Montijo	Badajoz	Montijo	385436N	063702W	202	7.0 - 7.5	2	4	
DwL17	BGE013685	Ruso	Lleida *	n. a.				7.5 - 8.0	4	3 - 4	
DwL18	BGE008263	Trigo	Almeria *	n. a.				8.0 - 8.5	3	4 - 5	
DwL19	BGE013695	Valencia grano rojo	Baleares*	n. a.				8.0 - 8.5	3	3 - 4	
DwL20	BGE018291	Valencina	Sevilla	Valencina	372458N	060437W	151	8.0 - 8.5	3	3	

^a (*) Local varieties for which only province of collecting was available at CRF database

^b 1: < 25 ppm; 2: 25-50 ppm; 3: 50-75 ppm; 4: 75-100 ppm; 5: > 100 ppm

^c 1: < 0.78%; 2: 0.78 to 1.48%; 3: 1.48 - 2.48%; 4: 2.48 - 3.49%; 5: > 3.49%

n. a. : not available.

Supplementary Table S4. Detailed results by genotype and by environment (location-year combination) of FIELD TRIALS conducted on BREAD WHEAT landraces

The values for commercial varieties are also showed. For GZn, GFe and GPC, means with a common letter are not significantly different after SNK test with $p = 0.05$. *N1*: number of environments where grain Zn, Fe and protein concentration was analyzed; *N2*: number of environments where grain yield was evaluated. *N3*: number of BwL varieties analyzed for grain mineral and protein composition; *N4*: number of BwL varieties analyzed for yield.

VARIETY	<i>N1</i>	GZn (mg/kg)					GFe (mg/kg)					GPC (%)					<i>N2</i>	Yield (t/ha)				
		Mean	SNK	S.E.	Min	Max	Mean	SNK	S.E.	Min	Max	Mean	SNK	S.E.	Min	Max		Mean	S.E.	Min	Max	
BwL01	10	42	b-g	4.7	26	71	41	a-c	3.8	19	64	10.8	e-f	0.5	9.0	13.7	4	2.2	0.4	1.4	3.1	
BwL02	10	42	b-g	3.3	31	60	44	a-c	2.5	28	52	11.6	b-f	0.6	9.9	15.3	5	2.5	0.2	2.0	3.0	
BwL03	10	43	b-e	3.7	27	62	45	a-c	4.4	20	62	11.6	a-f	0.6	9.5	14.9	5	2.9	0.1	2.7	3.2	
BwL04	10	36	f-g	2.3	24	47	38	b-c	2.9	19	49	11.4	b-f	0.5	9.6	14.1	5	2.3	0.2	1.6	2.9	
BwL05	10	37	e-g	2.0	26	44	41	a-c	2.3	27	51	11.4	b-f	0.5	9.3	14.6	5	2.2	0.3	1.5	3.1	
BwL06	10	42	b-g	3.3	26	60	48	a	2.4	36	61	12.3	a-c	0.6	8.8	15.0	5	2.7	0.2	2.0	3.5	
BwL07	10	41	b-g	2.7	28	55	45	a-c	3.1	32	58	11.7	a-e	0.6	9.6	14.4	4	2.7	0.4	1.7	3.8	
BwL08	10	38	d-g	2.6	26	52	41	a-c	2.6	28	53	11.5	b-f	0.6	8.5	14.5	5	2.5	0.5	1.2	4.0	
BwL09	10	44	b-d	4.1	26	71	42	a-c	3.7	22	59	12.0	a-e	0.4	10.6	14.7	5	2.6	0.2	1.8	3.1	
BwL10	10	35	g	2.8	22	48	37	c	3.3	15	50	11.1	d-f	0.6	9.1	14.6	5	3.9	0.4	3.0	5.2	
BwL11	10	37	e-g	3.0	26	53	45	a-c	4.6	30	81	12.0	a-d	0.6	10.2	15.5	5	3.1	0.3	2.3	3.8	
BwL12	10	45	b	2.9	32	58	47	a-b	3.3	27	64	12.1	a-d	0.5	10.2	15.1	5	2.2	0.2	1.5	2.8	
BwL13	10	38	c-g	2.1	26	47	43	a-c	2.9	27	55	11.1	d-f	0.5	9.3	13.8	4	2.8	0.3	1.9	3.4	
BwL14	10	40	b-g	2.6	24	51	43	a-c	4.0	19	59	11.9	a-e	0.4	10.2	15.1	5	2.7	0.3	1.7	3.4	
BwL15	10	39	b-g	2.9	25	53	46	a-c	3.0	25	59	11.7	a-f	0.6	8.9	15.6	5	2.9	0.2	2.6	3.3	
BwL16	10	49	a	4.2	33	70	46	a-c	5.1	14	65	12.3	a-c	0.4	10.7	15.1	5	2.8	0.3	2.0	3.8	
BwL17	10	39	b-g	2.7	29	53	43	a-c	3.2	23	58	11.3	c-f	0.7	8.8	15.7	4	2.9	0.4	1.9	3.7	
BwL18	10	38	d-g	2.1	27	46	40	a-c	3.7	18	56	11.4	b-f	0.6	8.7	14.8	5	2.6	0.2	2.2	3.2	
BwL19	10	41	b-g	3.1	29	58	47	a-b	3.2	35	66	11.9	a-e	0.5	10.1	15.4	4	2.6	0.3	1.7	3.3	
BwL20	10	42	b-f	2.9	29	55	40	a-c	2.9	30	54	11.5	b-f	0.5	10.0	14.0	5	2.5	0.2	1.6	3.0	
BwL21	10	43	b-f	2.4	31	55	42	a-c	3.3	29	62	11.6	b-f	0.6	9.3	14.6	5	2.3	0.3	1.6	3.2	

VARIETY	N1	GZn (mg/kg)					GFe (mg/kg)					GPC (%)					N2	Yield (t/ha)			
		Mean	SNK	S.E.	Min	Max	Mean	SNK	S.E.	Min	Max	Mean	SNK	S.E.	Min	Max		Mean	S.E.	Min	Max
BwL22	10	41	b-g	3.5	26	59	41	a-c	3.3	21	54	11.9	a-e	0.6	9.8	15.6	5	3.1	0.2	2.5	3.4
BwL23	10	38	d-g	2.5	25	48	41	a-c	2.7	28	52	11.3	b-f	0.7	8.3	15.0	5	2.5	0.3	1.5	3.0
BwL24	10	40	b-g	2.4	25	47	42	a-c	3.6	26	59	11.8	a-e	0.6	9.3	14.6	5	2.8	0.3	2.0	3.6
BwL25	10	39	b-g	4.1	24	60	39	a-c	3.9	14	59	11.3	b-f	0.5	9.4	13.7	5	2.8	0.3	2.1	3.7
BwL26	10	44	b-d	4.2	26	69	49	a	3.0	29	63	11.9	a-e	0.5	10.3	15.1	5	3.0	0.1	2.6	3.4
BwL27	10	43	b-f	2.5	31	53	43	a-c	3.1	28	60	11.9	a-e	0.5	10.6	14.9	5	2.1	0.4	1.2	3.1
BwL28	10	36	f-g	2.4	25	51	39	b-c	3.3	23	53	10.6	f	0.6	8.3	14.7	4	3.4	0.5	2.3	4.3
BwL29	10	38	c-g	2.7	27	53	47	a-b	3.6	30	64	11.7	a-f	0.6	9.0	15.0	5	3.0	0.3	2.4	3.9
BwL30	10	36	e-g	2.6	27	49	42	a-c	3.2	27	56	12.1	a-d	0.6	9.8	16.2	5	2.8	0.3	2.1	3.7
BwL31	10	45	b-c	4.3	27	64	44	a-c	3.0	26	57	12.4	a-b	0.5	11.0	15.4	5	2.9	0.4	2.0	3.8
BwL32	10	38	d-g	2.6	26	49	41	a-c	3.6	20	55	12.7	a	0.6	10.6	16.3	5	3.3	0.3	2.3	3.8
Califa	8	33		3.2	25	45	42		2.7	28	52	11.2		0.7	9.4	14.4	3	2.7	0.8	1.2	3.9
Cartaya	5	31		4.2	21	44	36		2.7	26	42	12.3		1.0	9.7	15.1	2	4.3	0.5	3.9	4.8
Soissons	3	42		10.0	26	61	46		5.1	36	52	9.4		0.6	8.5	10.6	1	7.7	0.0	7.7	7.7

ENVIRONMENT	N3	GZn (mg/kg)				GFe (mg/kg)				GPC (%)				N4	Yield (t/ha)					
		Mean	S.E.	Min	Max	Mean	S.E.	Min	Max	Mean	S.E.	Min	Max		Mean	S.E.	Min	Max		
Madrid-10	32	54	1.4	41	71	30	2.0	14	59	10.7	0.2	8.4	12.6		n. d.					
Madrid-11	32	45	1.0	36	58	36	0.8	28	46	10.2	0.2	8.3	13.7		n. d.					
Madrid-12	32	52	1.2	43	71	39	0.6	32	45	14.1	0.1	12.6	15.3		n. d.					
Madrid-13	32	45	0.9	36	60	30	0.7	23	40	12.1	0.2	10.4	13.5		n. d.					
Carmona-11	32	39	0.8	30	48	50	1.1	34	63	10.7	0.1	9.3	11.8	32	2.2	0.1	1.2	3.9		
Carmona-12	32	39	0.7	30	49	45	1.4	33	81	11.1	0.1	10.1	12.4	32	3.0	0.1	2.1	4.1		
Carmona-13	32	30	0.6	22	38	55	1.0	45	66	10.1	0.1	8.9	11.6	32	2.8	0.1	1.7	3.9		
Elorz-11	32	41	0.8	33	50	55	0.9	45	64	11.3	0.2	9.6	12.4	32	3.0	0.1	2.0	4.3		
Elorz-12	32	28	0.5	24	34	44	0.8	32	53	14.9	0.1	12.7	16.3		n. d.					
Elorz-13 ^a	32	31	0.6	23	39	45	1.0	36	56	11.7	0.1	8.8	13.4	26	2.6	0.2	1.5	5.2		

^a The climatic conditions in the north of Spain during 2013 provoked severe lodging of six landraces (BwL01, 07, 13, 17, 19 and 28) whose grain

yield could not be determined.

Supplementary Table S5. Detailed results, by genotype and by environment (location-year combination), of FIELD TRIALS conducted on DURUM WHEAT landraces

The values for commercial varieties are also showed. For GZn, GFe and GPC, means with a common letter are not significantly different after SNK test with $p = 0.05$. *N1-3*: number of environments where evaluation of grain Zn and Fe concentration, protein content and yield was conducted.

N4-6: number of DwL varieties analyzed for grain mineral concentration, protein content and yield

VARIETY	GZn (mg/kg)						GFe (mg/kg)					GPC (%)						Yield (t/ha)				
	<i>N1</i>	Mean	SNK	S.E.	Min	Max	Mean	SNK	S.E.	Min	Max	<i>N2</i>	Mean	SNK	S.E.	Min	Max	<i>N3</i>	Mean	S.E.	Min	Max
DwL01	8	46	c-g	3	34	62	37	a-d	3	25	50	5	13.8	a-b	0.4	12.8	14.9	4	2.4	0.5	1.6	4.0
DwL02	8	52	a-d	5	38	70	40	a-b	3	25	53	5	13.9	a-b	0.4	13.2	15.3	3	2.5	0.3	1.9	3.0
DwL03	8	45	d-g	2	34	53	35	b-d	4	20	46	5	13.4	a-b	0.6	11.2	14.5	4	2.4	0.3	1.8	3.1
DwL04	8	43	e-g	4	30	61	31	c-d	2	23	40	5	13.2	a-b	0.6	11.3	14.5	4	2.9	0.4	2.3	3.9
DwL05	8	47	c-f	3	32	62	34	b-d	3	26	47	5	12.8	a-b	0.7	10.3	14.3	3	3.0	0.3	2.5	3.4
DwL06	8	55	a-b	5	41	79	38	a-d	3	26	48	5	14	a-b	0.3	13.1	15	3	2.2	0.5	1.5	3.1
DwL07	8	52	a-d	5	40	72	38	a-d	4	27	56	5	13.7	a-b	0.7	12.3	16	4	2.7	0.7	1.5	4.8
DwL08	8	39	g	2	31	47	31	c-d	2	22	43	5	11.5	c	0.7	9.3	13	4	4.2	1.1	2.4	7.4
DwL09	8	48	a-f	4	34	65	41	a-b	2	29	53	5	13.2	a-b	0.6	11.7	14.8	4	2.3	0.2	2.0	2.7
DwL10	8	50	a-e	3	42	65	36	a-d	3	23	49	5	13.9	a-b	0.3	13.2	14.8	4	2.4	0.4	1.6	3.4
DwL11	8	53	a-c	4	45	74	39	a-c	3	26	52	5	13.6	a-b	0.3	13.1	14.6	3	2.0	0.5	1.5	2.9
DwL12	8	50	a-e	5	35	72	38	a-d	3	27	50	5	13.8	a-b	0.5	12.3	14.9	4	2.4	0.6	1.1	3.9
DwL13	8	47	c-f	4	28	60	30	d	3	21	49	5	13.2	a-b	0.4	11.9	14	4	2.3	0.5	1.6	3.9
DwL14	8	41	f-g	2	33	51	35	b-d	3	24	49	5	12.4	b	0.7	11	14.6	4	3.0	0.4	1.9	3.6
DwL15	8	52	a-d	5	31	73	37	a-d	2	27	47	5	14.3	a	0.5	13.3	15.7	4	2.7	0.5	2.0	4.3
DwL16	8	52	a-d	5	38	79	38	a-d	3	26	52	5	14.4	a	0.4	13	15.6	4	2.7	0.6	1.5	4.4
DwL17	8	42	e-g	3	33	55	35	b-d	4	22	56	5	12.9	a-b	0.4	12.2	14.3	4	3.0	0.7	1.8	4.9
DwL18	8	47	c-f	6	32	80	41	a-b	6	26	75	5	13.6	a-b	0.4	12.4	14.6	4	2.8	0.5	1.7	4.3
DwL19	8	56	a	6	38	79	44	a	2	36	55	5	14.2	a	0.4	13.6	15.8	4	2.8	0.5	2.2	4.3
DwL20	8	48	b-f	4	34	65	41	a-b	2	29	52	5	13.6	a-b	0.4	12.9	14.9	4	2.6	0.3	2.1	3.6
Amílcar	7	36		3	26	52	30		3	22	44	4	12.1		0.5	11.5	13.5	4	5.0	1.1	3.8	8.2
Avispa	7	36		3	27	48	31		3	23	45	4	12.2		0.5	11.3	13.5	4	5.0	1.3	3.3	9.0
Don Pedro	7	36		3	30	51	31		3	24	45	4	11.9		0.4	11.2	12.9	4	4.4	0.8	3.0	6.5
Don Sebastián	7	38		3	30	50	35		4	25	50	4	12.6		0.6	11.7	14.3	4	4.6	0.7	3.7	6.6

ENVIRONMENT	N4	GZn (mg/kg)				GFe (mg/kg)				N5	GPC (%)				N6	Yield (t/ha)				
		Mean	S.E.	Min	Max	Mean	S.E.	Min	Max		Mean	S.E.	Min	Max		Mean	S.E.	Min	Max	
Madrid-10	20	63	3	47	80	34	2	24	47	20	12.6	0.3	9.3	14.2		n. d.				
Madrid-13	20	53	2	40	68	29	1	20	39	20	13	0.3	10.9	15		n. d.				
Madrid-14	20	63	2	47	79	34	1	27	44	20	14.8	0.2	13	16		n. d.				
Madrid-15	20	47	1	38	54	27	1	22	45		n. d.					n. d.				
Carmona-14	20	45	1	38	54	50	2	40	75	20	13.4	0.1	12	14	20	2.2	0.1	1.1	3.4	
Carmona-15	20	35	1	28	47	40	1	32	48		n. d.				20	2.4	0.1	1.5	4.1	
Jerez-14 ^a	20	40	1	33	49	44	2	33	56	20	13.7	0.2	11.9	14.7	16	2.1	0.1	1.5	3.1	
Elorz-15	20	40	1	32	48	38	1	29	49		n. d.				20	3.9	0.2	2.7	7.4	

^a Varieties DwL02, 05, 06 and 11 resulted severely affected by stripe rust (7-9 scoring, on a 0-9 scale) and then were excluded from yield estimation.

Supplementary Table S6. Geographic coordinates, soil characteristics and relevant climatic records of the ENVIRONMENTS where the MULTI-LOCATION FIELD TRIAL EXPERIMENTS were conducted

Soil samples (500 g) were taken in the first 20 cm depth and analyses were conducted by AGQ Labs & Technological Services (Seville, Spain). See the Materials and Methods section for reference values according to the mineral extraction method used. The ranges noted in Madrid and Elorz correspond to 3 soil samples taken in the fields where the trials were established at these locations. Climatic records have been extracted from the AEMET (Meteorological Agency of Spain) web page. For Carmona and Elorz, records from the close meteorological stations of Seville and Pamplona Airport, respectively, have been used.

Location (Province) · Environment	Latitude	Longitude	Altitude (m above sea)	Soil pH	Soil Zn (ppm)	Soil Fe (ppm)	May mT_Max (°C)	Jun mT_Max (°C)	May Precip (mm)	Jun Precip (mm)	Ann Precip (mm)
Madrid (Madrid) · Madrid-10 · Madrid-11 · Madrid-12 · Madrid-13 · Madrid-14 · Madrid-15	40°27' N	03°43' W	667	7.5 to 7.7	2.0 to 3.5	5.2 to 10.0	21.8 24.7 25.2 20.5 24.1 27.2	26.7 29.1 30.7 28.0 28.6 31.2	23 61 34 29 12 0	59 29 2 6 14 0	557 380 331 373 417 278
Carmona (Seville) · Carmona-11 · Carmona-12 · Carmona-13 · Carmona-14 · Carmona-15	37°28' N	05°38' W	253	8.49	0.2	6.3	29.2 30.7 26.5 30.3 31.4	34.5 34.6 32.3 31.7 32.6	16 15 7 7 0	0 0 3 2 0	396 464 405 634 336
Elorz (Navarra) · Elorz-11 · Elorz-12 · Elorz-13 · Elorz-15	42°44' N	01°33' W	480	8.3 to 8.4	0.4 to 1.8	5.2 to 9.3	24.0 23.0 16.3 21.1	25.0 27.7 22.3 26.8	36 84 82 7	94 42 111 111	511 760 1062 810
Jerez (Cadiz) · Jerez-14	36°42' N	06°07' W	35	nd	nd	nd	29.2	30.4	21	7	417

May mT_Max: Mean of the daily maximum temperatures registered in May; **Jun mT_Max**: Mean of the daily maximum temperatures registered in June
May Precip: Total precipitation registered in May; **Jun Precip**: Total precipitation registered in June; **Ann Precip**: Total annual precipitation