

## Supplementary Materials

### **Grain mineral composition of Argentinean-adapted wheat cultivars: a case study**

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## Supplementary Tables

**Table S1. List of cultivars sown in Marcos Juárez, Córdoba-Argentina, during 2015 and 2016**

Cultivar/Year	2015/2016	2015	2016	Habit
ACA 602 (I)	X			Intermediate
ACA 906	X			Spring
ACA 908	X			Spring
ACA 909	X			Spring
ACA 910	X			Spring
BIOINTA 1006	X			Spring
BIOINTA 1007	X			Spring
BIOINTA 2006 (I)	X			Intermediate
Buck Pleno	X			Spring
Buck Saeta	X			Spring
Cambium	X			Spring
Ceibo	X			Spring
Fuste	X			Spring
Floripan 100	X			Spring
Klein León	X			Spring
Klein Liebre (I)	X			Intermediate
Klein Nutria	X			Spring
Klein Proteo (I)	X			Intermediate
Klein Rayo	X			Spring
Klein Tauro	X			Spring
MS INTA 815	X			Spring
MS INTA Bonaerense 514 (I)	X			Intermediate
SY 300	X			Spring
SY 330	X			Spring
BIOINTA 1005		X		Spring
Buck Tilcara (I)		X		Intermediate
Baguette 501		X		Spring
SY 100 (I)		X		Intermediate
Virgile		X		Spring
BIOCERES 1008			X	Spring
Buck Claraz			X	Spring
Floripan 200 (I)			X	Intermediate
Klein Lanza			X	Spring
Klein Prometeo			X	Spring
MS INTA 415 (I)			X	Intermediate

**Table S2. Concentration of nine elements in the mature grains of Argentinean wheat cultivars obtained in the 2015 field experiment**

The total number of samples considered (n), mean, minimum (min), maximum (max) and standard deviation (sd) values expressed in mg kg<sup>-1</sup> are shown. At the bottom p-values obtained for the effect of the Genotype (G) are also shown

	P	Ca	Mg	Zn	Fe	Mn	Sr	Cu	Mo
2015	(mg kg <sup>-1</sup> )	(mg kg <sup>-1</sup> )	(mg kg <sup>-1</sup> )	(mg kg <sup>-1</sup> )	(mg kg <sup>-1</sup> )	(mg kg <sup>-1</sup> )	(mg kg <sup>-1</sup> )	(mg kg <sup>-1</sup> )	(mg kg <sup>-1</sup> )
n	85	85	86	84	81	85	84	83	85
Mean	3694.76	467.11	1224.38	16.74	27.90	49.97	2.20	3.17	0.15
Min	2992.62	359.52	945.49	13.19	19.31	36.57	1.48	2.45	0.00
Max	5034.17	610.93	1524.67	24.83	54.49	67.05	2.87	3.99	0.27
sd	391.70	48.69	119.33	2.08	5.73	5.58	0.31	0.40	0.002
G	2.0E-14	1.7E-10	2.5E-09	<2E-16	<2E-16	2.6E-08	<2E-16	5.5E-11	4.3E-08
Error	1774868	40357	279069	36.3	219.7	629.2	0.76	2.42	0.04

**Table S3. Concentration of nine elements in the mature grains of Argentinean wheat cultivars in the 2016 field experiment**

The total number of samples considered (n), mean, minimum (min), maximum (max) and standard deviation (sd) values expressed in mg kg<sup>-1</sup> are shown. At the bottom p-values obtained for the effect of the Genotype (G) are also shown

	P	Ca	Mg	Zn	Fe	Mn	Sr	Cu	Mo
2016	(mg kg <sup>-1</sup> )	(mg kg <sup>-1</sup> )	(mg kg <sup>-1</sup> )	(mg kg <sup>-1</sup> )	(mg kg <sup>-1</sup> )	(mg kg <sup>-1</sup> )	(mg kg <sup>-1</sup> )	(mg kg <sup>-1</sup> )	(mg kg <sup>-1</sup> )
n	90	89	90	88	88	90	90	90	83
Mean	3213.84	401.13	1074.59	15.92	29.30	59.88	2.28	3.32	0.12
Min	2483.95	301.38	834.03	11.78	23.22	41.38	1.67	2.25	0.05
Max	4402.73	532.90	1435.70	22.47	38.38	86.91	3.19	4.56	0.20
sd	398.40	48.44	143.67	1.96	3.55	8.77	0.33	0.48	0.04
G	0.0206	2.7E-10	0.2730	5.3E-06	4.2E-06	2.0E-05	4.1E-09	0.0002	2.0E-08
Error	5173080	27501	904595	69.8	230	1627	1.5	5.8	0.01

**Table S4. Correlations values obtained between each one of the mineral elements and the three components of the Principal Component Analysis (PCA), accounting for most of the variation found, for 29 Argentinean cultivars sown in Marcos Juárez, Córdoba-Argentina, during 2015**

	PC1 (31.55%)	PC2 (19.30%)	PC3 (15.33%)
P	0.749	-0.197	-0.394
Ca	0.256	0.812	-0.170
Mg	0.585	-0.387	-0.454
Zn	0.580	-0.290	0.572
Fe	0.457	-0.221	0.700
Mn	0.713	-0.101	0.045
Sr	0.287	0.794	0.327
Cu	0.496	0.274	0.006
Mo	0.700	0.205	-0.251

**Table S5. Correlations values obtained between each one of the mineral elements and the three components of the Principal Component Analysis (PCA), accounting for most of the variation found, for 30 Argentinean cultivars sown in Marcos Juárez, Córdoba-Argentina, during 2016**

	PC1 (36.79%)	PC2 (20.04%)	PC3 (14.62%)
P	0.809	0.125	0.343
Ca	-0.197	0.873	-0.148
Mg	0.816	0.178	0.325
Zn	0.776	0.002	0.095
Fe	0.825	-0.169	0.093
Mn	0.414	-0.365	0.671
Sr	0.105	0.845	0.251
Cu	0.698	0.170	0.498
Mo	0.024	0.299	0.541

**Table S6. Mineral yield determined for nine elements and ANOVA p-values of Argentinean wheat cultivars cultured in both 2015 and 2016 field experiments**

Total samples considered for the analysis (n), mean, minimum (Min), maximum (Max), standard deviation (sd), expressed in  $\text{g ha}^{-1}$  are shown. At the bottom, p-values obtained for the effect of the Genotype (G), Environment (E) and the genotype by environment (GxE) interaction are also posted.

2015/ 2016	PY ( $\text{g ha}^{-1}$ )	CaY ( $\text{g ha}^{-1}$ )	MgY ( $\text{g ha}^{-1}$ )	ZnY ( $\text{g ha}^{-1}$ )	FeY ( $\text{g ha}^{-1}$ )	MnY ( $\text{g ha}^{-1}$ )	SrY ( $\text{g ha}^{-1}$ )	CuY ( $\text{g ha}^{-1}$ )	MoY ( $\text{g ha}^{-1}$ )
n	144	144	141	144	142	141	144	144	140
Mean	18900.49	2047.68	6234.34	89.44	154.71	299.75	12.47	17.86	0.771
Min	8076.88	1077.85	2973.70	41.31	56.83	123.13	4.61	8.33	0.184
Max	28834.85	3853.22	9916.72	143.58	250.98	540.40	19.58	34.38	1.429
sd	4002.46	550.79	1371.23	20.61	38.57	84.07	2.79	4.77	0.253
G	3.50E-14	< 2E-16	< 2E-16	< 2E-16	< 2E-16	< 2E-16	< 2E-16	< 2E-16	7.5E-12
E	0.043	0.267	0.146	0.009	2.1E-12	< 2E-16	2.0E-09	1.4E-06	0.004
GxE	0.0003	8.7E-06	0.0002	5.0E-06	0.0002	3.7E-10	2.0E-05	0.031	0.002
Error	4.3E+08	75231	36407401	7044	24855	66896	164	544.3	1.915

**Table S7. Mineral yield for nine elements and ANOVA *p*-values of Argentinean wheat cultivars in the 2015 field experiment**

Total samples considered (n), mean, minimum (min), maximum (max), standard deviation (sd) and Genotype (G) effects. Mineral yields are expressed in g ha<sup>-1</sup>

2015	PY	CaY	MgY	ZnY	FeY	MnY	SrY	CuY	MoY
	(g ha <sup>-1</sup> )	(g ha <sup>-1</sup> )	(g ha <sup>-1</sup> )	(g ha <sup>-1</sup> )	(g ha <sup>-1</sup> )	(g ha <sup>-1</sup> )	(g ha <sup>-1</sup> )	(g ha <sup>-1</sup> )	(g ha <sup>-1</sup> )
n	83	83	84	84	82	83	83	82	85
Mean	18591.17	2321.25	6128.62	84.78	142.73	251.52	11.15	15.75	0.78
Min	9189.29	1077.85	3084.38	42.92	56.83	123.13	4.61	8.33	0.00
Max	28834.85	3316.59	8834.27	143.58	286.31	379.05	16.20	25.04	1.43
sd	4005.23	504.14	1273.85	20.13	39.52	58.37	2.73	3.48	0.27
G	7.7E-16	2.8E-15	1.5E-13	< 2E-16	< 2E-16	9.1E-15	< 2E-16	4.1E-13	3.8E-12
Error	1.5E+08	2543746	19656422	3152	12513	33321	56.1	135.8	1.1



**Table S8. Mineral yield for nine mineral elements and ANOVA *p*-values of Argentinean wheat cultivars for 2016 field experiment**

Total samples considered (n), mean, minimum (min), maximum (max), standard deviation (sd) and Genotype (G) effects. Mineral yields are expressed in g ha<sup>-1</sup>

2016	PY (g ha <sup>-1</sup> )	CaY (g ha <sup>-1</sup> )	MgY (g ha <sup>-1</sup> )	ZnY (g ha <sup>-1</sup> )	FeY (g ha <sup>-1</sup> )	MnY (g ha <sup>-1</sup> )	SrY (g ha <sup>-1</sup> )	CuY (g ha <sup>-1</sup> )	MoY (g ha <sup>-1</sup> )
n	90	90	88	87	90	90	90	90	86
Mean	18856.93	2359.83	6249.70	92.07	172.74	351.28	13.31	19.48	0.71
Min	8076.88	1296.73	2973.70	41.31	71.48	170.72	7.27	9.65	0.18
Max	27459.62	3853.22	9916.72	142.57	259.04	540.40	19.58	34.38	1.28
sd	3953.53	529.84	1377.92	19.56	38.74	78.78	2.63	4.56	0.24
G	2.3E-07	1.5E-13	1.2E-07	1.7E-13	3.8E-09	8.5E-09	9.9E-08	9.2E-08	1.3E-05
Error	2.5E+08	2220925	26711233	2558	19948	82438	109.4	327.4	1.04

**Table S9. Means of mineral yield for 29 Argentinean cultivars sown in Marcos Juárez, Córdoba-Argentina, during 2015**

Values within each column with the same letter are not significantly different at  $P = 0.05$  by Tukey test. Values within each column colored with gray show the top five highest concentrations. The asterisk (\*) indicate cultivars that were sown in 2015 but not in 2016.

2015	PY (g ha <sup>-1</sup> )		CaY (g ha <sup>-1</sup> )		MgY (g ha <sup>-1</sup> )		ZnY (g ha <sup>-1</sup> )		FeY (g ha <sup>-1</sup> )		MnY (g ha <sup>-1</sup> )		SrY (g ha <sup>-1</sup> )		CuY (g ha <sup>-1</sup> )		MoY (g ha <sup>-1</sup> )	
ACA 602	19569.36	bcd	2393.84	bcdef	5873.89	bcde	82.32	defghij	138.73	defg	259.79	bcde	12.57	abc	19.11	abc	1.05	abcd
ACA 906	17906.29	bcdef	2821.39	abc	5543.08	bcdef	77.50	defghij	134.87	defg	243.43	bcdefg	13.25	ab	15.70	bcdefg	0.60	defgh
ACA 908	22115.31	abc	2503.67	abcd	7660.82	ab	93.30	cdefg	167.98	bcde	290.25	abcde	12.02	abcd	20.60	ab	0.80	bcdefg
ACA 909	21549.68	bcd	2723.31	abc	6751.52	abcd	93.23	cdefg	146.12	cdef	286.18	abcde	11.26	abcde	17.45	abcdef	0.88	abcdefg
ACA 910	20917.40	bcd	2439.02	abcde	7400.84	ab	75.46	efghij	144.63	cdef	251.10	bcdef	11.23	abcde	16.38	bcdefg	0.78	cdefg
BAGUETTE 501*	16301.87	def	2188.41	bcdefg	5844.16	bcde	71.03	fghijk	120.43	efgh	228.73	cdefg	8.80	defg	13.73	efgh	0.65	defg
BIOINTA 1005*	16267.72	def	2181.09	bcdefg	4928.73	def	85.21	defgh	265.75	a	267.72	bcde	10.63	bcdef	16.28	bcdefg	0.82	bcdefg
BIOINTA 1006	20638.06	bcd	2868.89	ab	6387.73	abcde	94.78	cdef	148.07	cdef	285.25	abcde	13.15	ab	22.30	a	0.89	abcdefg
BIOINTA 1007	13809.02	efg	2118.17	cdefg	4659.99	ef	59.93	ijk	93.27	ghi	173.01	fgh	9.66	bcdefg	13.44	efgh	0.49	fgh
BIOINTA 2006	12872.17	fg	1499.20	gh	3845.42	f	62.05	hijk	72.70	hi	154.13	gh	7.75	fgh	11.57	gh	0.69	defg
BUCK PLENO	15749.18	defg	2005.23	cdefg	5151.52	cdef	66.69	ghijk	106.77	fghi	199.33	efgh	9.59	bcdefg	13.82	defgh	0.70	defg
BUCK SAETA	17684.28	bcdef	1894.15	defg	5388.34	cdef	76.70	efghij	122.98	efgh	271.70	bcde	9.89	bcdefg	13.96	cdefgh	0.72	defg
BUCK TILCARA*	18249.71	bcdef	1908.67	defg	6422.48	abcde	76.94	efghij	111.93	fghi	241.10	bcdefg	7.25	gh	14.14	cdefgh	0.88	abcdefg
CAMBIUM	20384.24	bcd	2659.23	abc	7067.87	abc	76.08	efghij	164.19	bcde	276.48	abcde	11.42	abcde	18.03	abcde	0.94	abcdef
CEIBO	19987.95	bcd	2956.20	ab	7915.86	ab	111.30	bc	190.62	bc	353.71	a	14.06	a	19.03	abcd	1.32	a
FLORIPAN 100	20616.23	bcd	2652.51	abc	6760.69	abcd	94.96	cdef	154.20	bcdef	310.10	abc	14.32	a	17.34	abcdef	1.01	abcde
FUSTE	23086.36	ab	2686.34	abc	7673.00	ab	120.64	ab	159.71	bcdef	317.86	ab	14.45	a	23.01	a	1.25	ab
KLEIN LEON	21937.93	abcd	2421.60	abcdef	6339.42	bcde	79.16	defghij	133.16	defg	242.33	bcdefg	14.94	a	15.87	bcdefg	0.68	defg

KLEIN LIEBRE	27538.70	a	3110.90	a	8307.69	a	136.21	a	174.62	bcde	319.46	ab	14.08	a	20.66	ab	1.21	abc
KLEIN NUTRIA	18670.95	bcde	2329.82	bcdef	6086.52	bcde	93.71	cdefg	156.67	bcdef	224.47	defg	11.85	abcd	14.66	cdefgh	0.70	defg
KLEIN PROTEO	19718.26	bcd	1707.50	fgh	5986.50	bcde	97.41	bcde	158.37	bcdef	236.31	bcdefg	9.52	bcdefg	12.72	fgh	0.62	defgh
KLEIN RAYO	19758.49	bcd	2112.85	cdefg	6190.04	bcde	87.10	cdefg	139.71	defg	234.61	bcdefg	9.38	cdefg	12.61	fgh	0.74	defg
KLEIN TAURO	21665.26	bcd	2687.23	abc	7066.16	abc	102.68	bcd	176.09	bcd	323.99	ab	14.72	a	17.84	abcdef	0.95	abcdef
MS INTA 815	20293.71	bcd	2737.85	abc	6336.91	bcde	79.27	defghij	143.53	cdefg	260.80	bcde	11.95	abcd	14.23	cdefgh	0.59	efgh
MS INTA B. 514	9738.28	g	1136.09	h	3361.26	f	47.75	k	69.62	i	141.48	h	4.90	h	9.46	h	0.46	gh
SY 100*	12827.30	fg	1785.45	efgh	4618.36	ef	58.85	jk	104.54	fghi	171.16	fgh	8.32	efg	11.54	gh	0.56	efgh
SY 300	17493.90	cdef	2524.21	abcd	6388.86	abcde	84.65	defghi	141.17	cdefg	241.63	bcdefg	14.22	a	17.18	abcdef	0.64	defg
SY 330	19301.28	bcd	2801.68	abc	6653.97	abcd	94.60	cdef	166.62	bcde	292.80	abcd	10.43	bcdefg	15.93	bcdefg	0.57	efgh
VIRGILE*	12900.47	fg	1768.17	efgh	5193.24	cdef	68.92	ghijk	208.80	ab	172.97	fgh	8.06	efgh	14.42	cdefgh	0.17	h

**Table S10. Means of mineral yield for 30 Argentinean cultivars sown in Marcos Juárez, Córdoba-Argentina, during 2016**

Values within each column with the same letter are not significantly different at  $P = 0.05$  by Tukey test. Values within each column colored with gray show the top five highest concentrations. The asterisk (\*) indicate cultivars that were sown in 2015 but not in 2016

2016	PY (g ha <sup>-1</sup> )		CaY (g ha <sup>-1</sup> )		MgY (g ha <sup>-1</sup> )		ZnY (g ha <sup>-1</sup> )		FeY (g ha <sup>-1</sup> )		MnY (g ha <sup>-1</sup> )		SrY (g ha <sup>-1</sup> )		CuY (g ha <sup>-1</sup> )		MoY (g ha <sup>-1</sup> )	
ACA 602	21729.97	abc	2829.07	abcdef	7040.97	abcd	111.44	abcde	179.35	abcdef	406.10	abc	16.78	a	24.95	ab	0.89	a
ACA 906	19251.24	abcd	2904.05	abcd	6014.06	abcde	86.04	efghij	166.63	abcdef	330.66	bcdefg	15.23	abcd	17.39	bcdef	0.68	abc
ACA 908	22359.84	abc	2677.56	abcdefg	7976.06	abc	87.38	defghij	207.57	abcd	396.29	abcd	15.63	abc	23.23	abc	0.77	ab
ACA 909	9210.65	e	1453.75	j	3341.65	f	47.34	k	80.59	g	223.50	efg	8.30	g	10.98	f	0.22	c
ACA 910	20823.84	abcd	2378.05	cdefgh	6718.61	abcde	83.50	fghij	185.41	abcde	330.63	bcdefg	12.89	abcdefg	20.51	abcde	0.69	abc
BIOCERES 1008*	18689.54	abcd	2165.16	defghij	5368.13	cdef	78.55	hij	148.61	cdefg	359.69	bcde	11.79	abcdefg	18.46	bcdef	0.69	abc
BIOINTA 1006	23199.66	ab	3077.04	abc	7243.42	abcd	120.55	abc	192.01	abcde	352.57	bcdef	15.81	abc	22.84	abcd	0.78	ab
BIOINTA 1007	15148.22	cde	2157.56	efghij	4794.68	def	66.20	ijk	132.19	efg	204.18	g	11.16	bcdefg	12.67	ef	0.62	abc
BIOINTA 2006	18376.26	abcd	2218.86	defghi	5608.18	abcdef	87.09	efghij	155.40	bcdef	253.34	defg	13.14	abcdefg	15.66	cdef	0.71	abc
BUCK CLARAZ*	21961.68	abc	2668.11	abcdefg	7091.75	abcd	100.56	bcdefgh	217.21	abc	390.47	abcd	14.87	abcde	21.22	abcde	0.61	abc
BUCK PLENO	13141.97	de	1888.65	hij	4308.45	ef	60.65	jk	110.20	fg	216.31	fg	9.58	fg	13.96	def	0.54	abc
BUCK SAETA	16770.15	abcde	2058.30	ghij	5504.98	bcdef	85.24	efghij	162.24	bcdef	345.78	bcdefg	11.88	abcdefg	17.93	bcdef	0.64	abc
CAMBIUM	20073.44	abcd	2504.69	bcdefgh	6847.84	abcde	91.47	defghi	188.83	abcde	366.57	bcde	14.30	abcdef	21.98	abcd	0.89	ab
CEIBO	21179.68	abc	3379.19	a	8153.39	ab	98.52	bcdefgh	188.83	abcde	431.04	abc	14.05	abcdef	18.30	bcdef	0.94	a
FLORIPAN 100	18212.28	abcd	2268.14	defghi	6117.06	abcde	86.72	efghij	176.79	abcdef	367.52	abcd	14.55	abcdef	19.08	bcdef	0.65	abc
FLORIPAN 200*	15976.01	bcde	2131.39	fghij	5411.17	cdef	88.34	defghi	165.30	abcdef	366.23	bcde	14.48	abcdef	19.52	bcdef	0.93	a
FUSTE	21332.18	abc	3020.68	abc	7581.22	abc	114.08	abcd	215.28	abc	450.47	ab	16.37	ab	29.22	a	1.03	a
KLEIN LANZA*	22113.60	abc	2456.21	bcdefgh	6701.67	abcde	106.67	abcdef	189.28	abcde	420.37	abc	15.27	abcd	21.98	abcd	0.35	bc

KLEIN LEON	15730.84	bcde	2243.03	defghi	5605.20	abcdef	89.47	defghi	152.13	bcdef	296.43	cdefg	14.11	abcdef	16.24	bcdef	0.80	ab
KLEIN LIEBRE	24044.59	a	2877.06	abcde	7841.37	abc	128.49	a	208.43	abcd	372.67	abcd	15.41	abc	23.45	abc	1.01	a
KLEIN NUTRIA	18760.56	abcd	2483.83	bcdefgh	5799.37	abcdef	97.35	bcdefgh	189.49	abcde	379.63	abcd	13.96	abcdef	19.48	bcdef	0.56	abc
KLEIN PROMETEO*	19757.94	abcd	1814.58	hij	6764.83	abcde	95.79	cdefgh	187.19	abcde	364.79	bcde	10.09	defg	23.08	abc	0.50	abc
KLEIN PROTEO	18807.89	abcd	1626.75	ij	6031.16	abcde	96.73	bcdefgh	171.72	abcdef	337.33	bcdefg	9.78	efg	15.79	cdef	0.35	bc
KLEIN RAYO	17687.31	abcd	1869.42	hij	5420.03	cdef	85.40	efghij	149.96	bcdefg	343.11	bcdefg	11.58	abcdefg	16.14	bcdef	1.00	a
KLEIN TAURO	17090.38	abcde	1885.07	hij	5761.04	abcdef	92.20	defghi	181.65	abcde	365.06	bcde	12.06	abcdefg	19.13	bcdef	0.87	ab
MS INTA 415*	23276.82	ab	2388.54	cdefgh	8215.49	a	122.73	ab	232.78	a	387.43	abcd	13.81	abcdef	23.74	abc	0.66	abc
MS INTA 815	18551.18	abcd	2193.94	defghij	5825.39	abcdef	84.64	fghij	153.41	bcdef	322.92	bcdefg	10.70	cdefg	17.56	bcdef	0.72	abc
MS INTA B. 514	16401.92	abcde	1838.41	hij	5361.86	cdef	80.23	ghij	134.81	efg	340.78	bcdefg	11.46	bcdefg	19.83	bcdef	0.82	ab
SY 300	14847.23	cde	2143.60	efghij	5988.06	abcdef	80.77	fghij	139.66	defg	305.78	cdefg	15.43	abc	17.52	bcdef	0.50	abc
SY 330	21201.10	abc	3194.21	ab	7060.00	abcd	105.93	abcdefg	219.30	ab	510.61	a	14.94	abcde	22.60	abcd	0.80	ab