***New Phytologist* Supporting Information**

Article title: Spatially resolved analysis of variation in barley (*Hordeum vulgare*) grain micronutrient accumulation

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Table S1 Description of the Barley Core Collection lines analysed in this study.

Table S2 Elemental composition of the soil used for glasshouse cultivation of the assembled BCC lines

Table S3 Elemental composition of the metal-contaminated soil from an agricultural field

Table S4 Pearson product moment correlation coefficients of Zn, Fe, Mn and Cu concentrations in the four different barley grain sample sets.

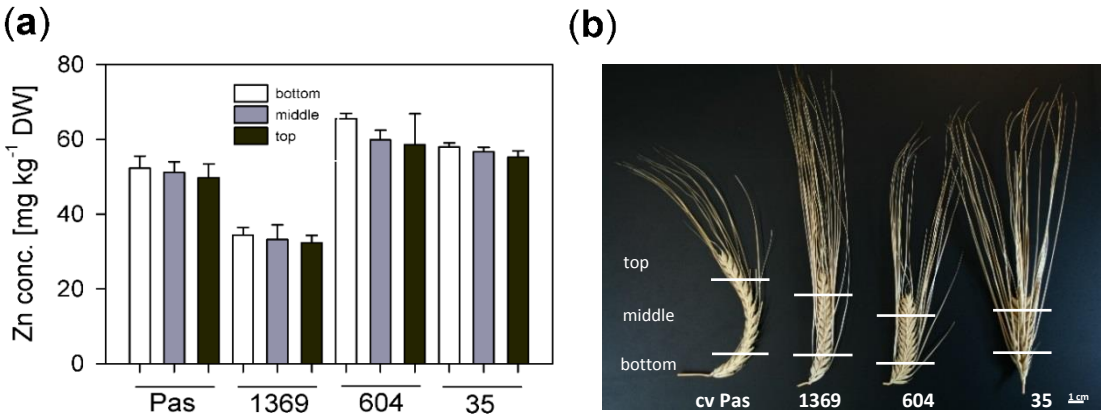

Fig. S1 Assessment of variation in Zn concentrations between grains from different positions within the ear. Grains of cv Pasadena, line 1369, 604 and 35 were sampled from the bottom, middle or top part of the ear (4 grains per position were pooled) and measured via ICP-OES. Bars represent mean + SD from three different ears. (b) Sampling positions are indicated for cv Pasadena, line 1369, 604 (all two-rowed) and 35 (six-rowed).

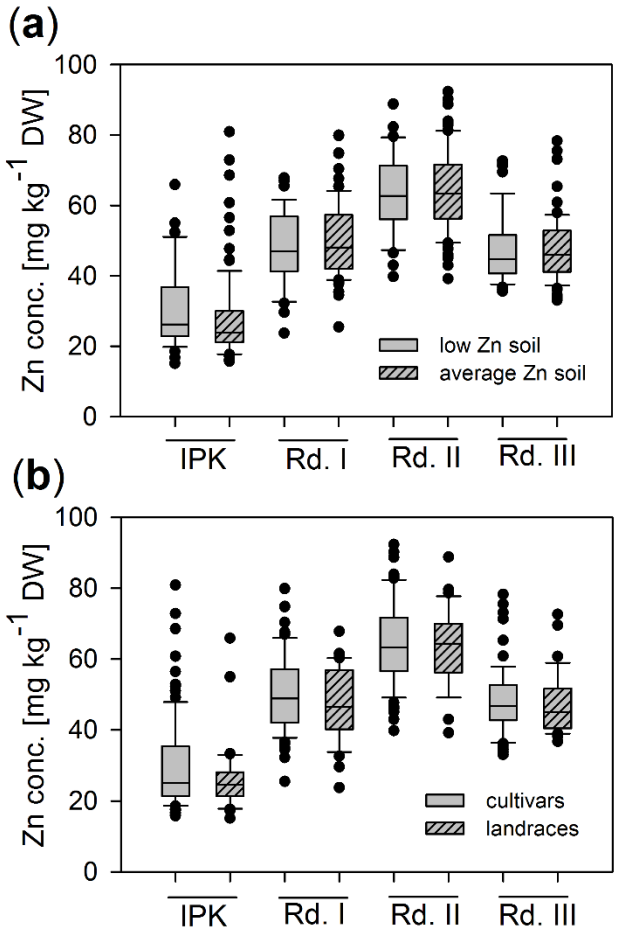

Fig. S2 Variation of Zn concentration among 136 barley lines grouped either based on predominant soil type of origin or into cultivars and landraces. Grain Zn concentration was either measured from material obtained from the genebank (IPK) directly or from plants grown in the glasshouse in three different cultivation rounds over three years (Rd. I, Rd. II, Rd. III). Shown in (**a**) are box plots for lines grouped based on the predominant soil type (low Zn vs average Zn) in the region of origin according to Alloway (2008) and in (**b**) box plots for lines grouped in cultivars or landraces. Box plots are displaying the median, the upper and lower quartile as well as extremes (number of total samples: 32-98). Pairwise comparison within rounds with t-test ($P \leq 0.05$) did not reveal any significant differences.

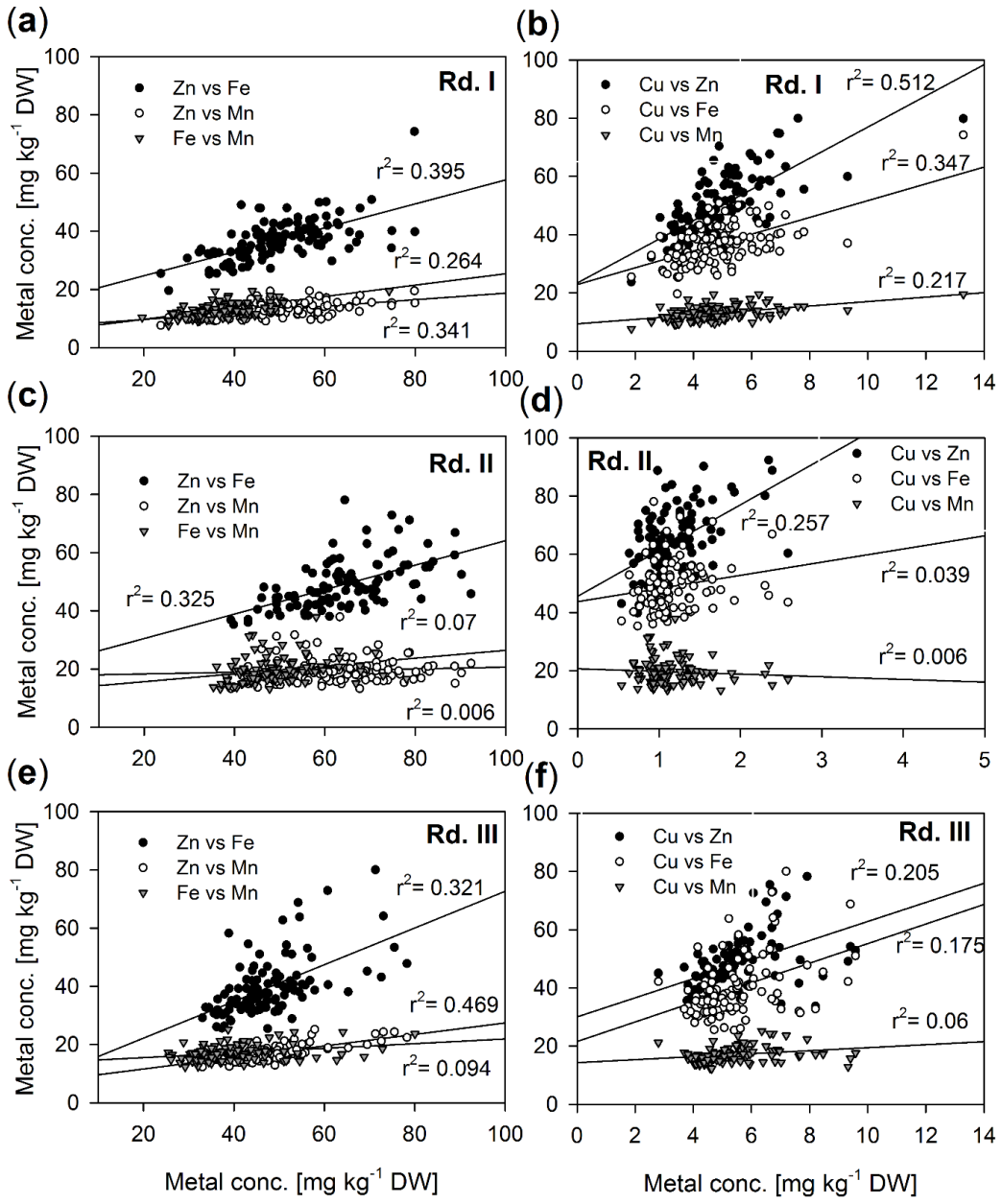

Fig. S3 Regression analysis of grain metal concentrations for separate cultivation rounds.

Figures show regression plots of barley grain metal concentrations for the three different glasshouse cultivations. (**a**)**:** Zn vs Fe and Mn, and Fe vs Mn in cultivation round I (Rd. I). (**b**)**:** Cu vs Zn, Fe and Mn in cultivation round I (Rd. I). (**c**)**:** Zn vs Fe and Mn, and Fe vs Mn in cultivation

round II (Rd. II). (**d**)**:** Cu vs Zn, Fe and Mn in cultivation round II (Rd. II). (**e**)**:** Zn vs Fe and Mn, and Fe vs Mn in cultivation round III (Rd. III). (**f**)**:** Cu vs Zn, Fe and Mn in cultivation round III (Rd. III). Only coefficients of determination calculated for significant Pearson correlation coefficients are displayed (number of samples per cultivation: 102-125).

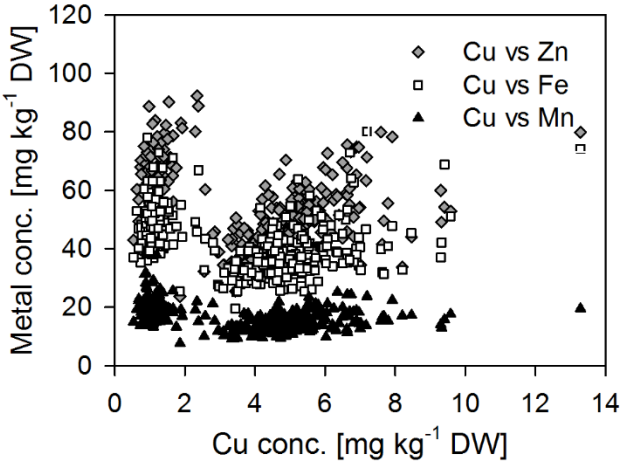

Fig. S4 Regression analysis of grain Cu concentrations over all cultivation rounds. Shown are the regression plots of barley grain concentrations of Cu vs Zn (diamonds), Fe (squares) and Mn (triangles) (total number of samples = 321).

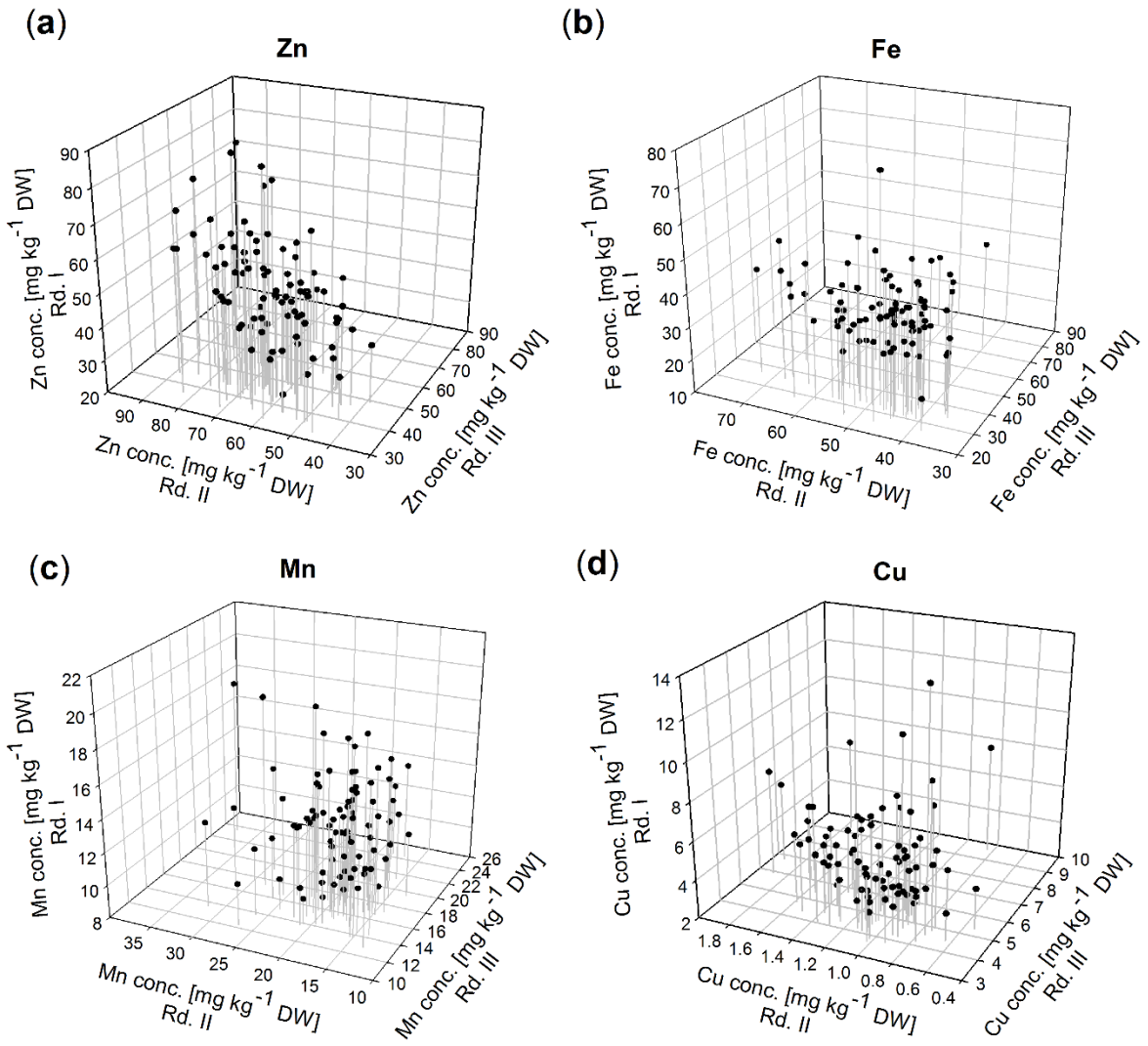

Fig. S5 Comparison of Zn, Fe, Mn and Cu concentrations of all selected Barley Core Collection lines over different cultivation rounds. Shown are grain Zn (**a**), Fe (**b**), Mn (**c**) and Cu (**d**) concentrations [mg kg^{-1} DW] of lines grown in three different cultivation rounds (total number of samples = 87). Please note that (**a**) is the same as Fig. 3 (**a**) and shown here again only for direct comparison.

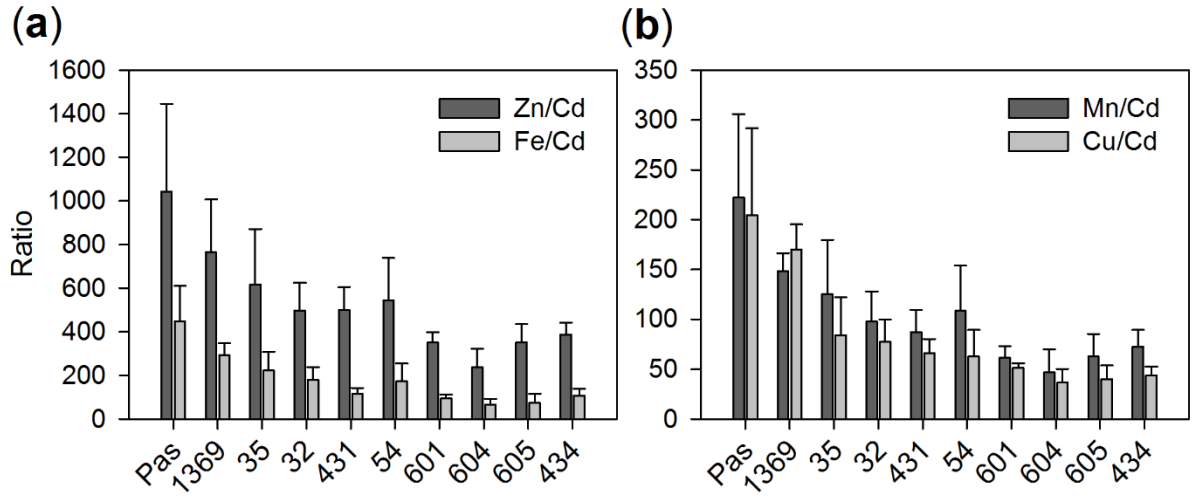

Fig. S6 Ratios between micronutrient and Cd concentrations in barley grains after cultivation in agricultural soil with background Cd contamination. Shown are the ratios of Zn and Fe vs Cd (**a**) and Mn and Cu vs Cd (**b**). Values are ratio means + SD (n=7).

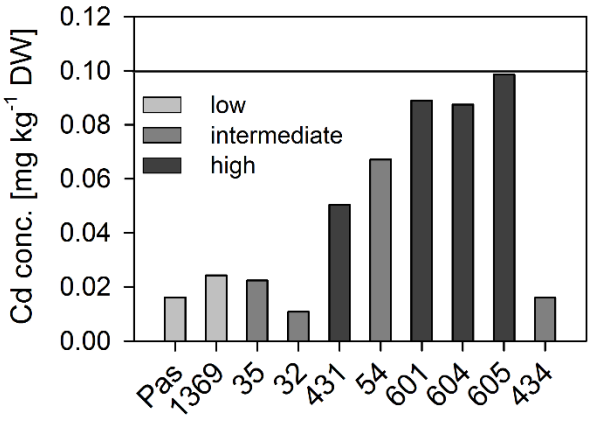

Fig. S7 Cd concentrations of grains obtained from the genebank. Shown are grain Cd concentrations of nine Barley Core Collection lines (1369, 35, 32, 431, 54, 601, 604, 605, 434) and the reference line cv Pasadena measured directly in genebank-derived material via ICP-MS. The threshold of 0.1 mg kg^{-1} DW established by the Codex Alimentarius for barley (Joint FAO/WHO Codex Alimentarius Commission, 1995) is indicated by a horizontal line.

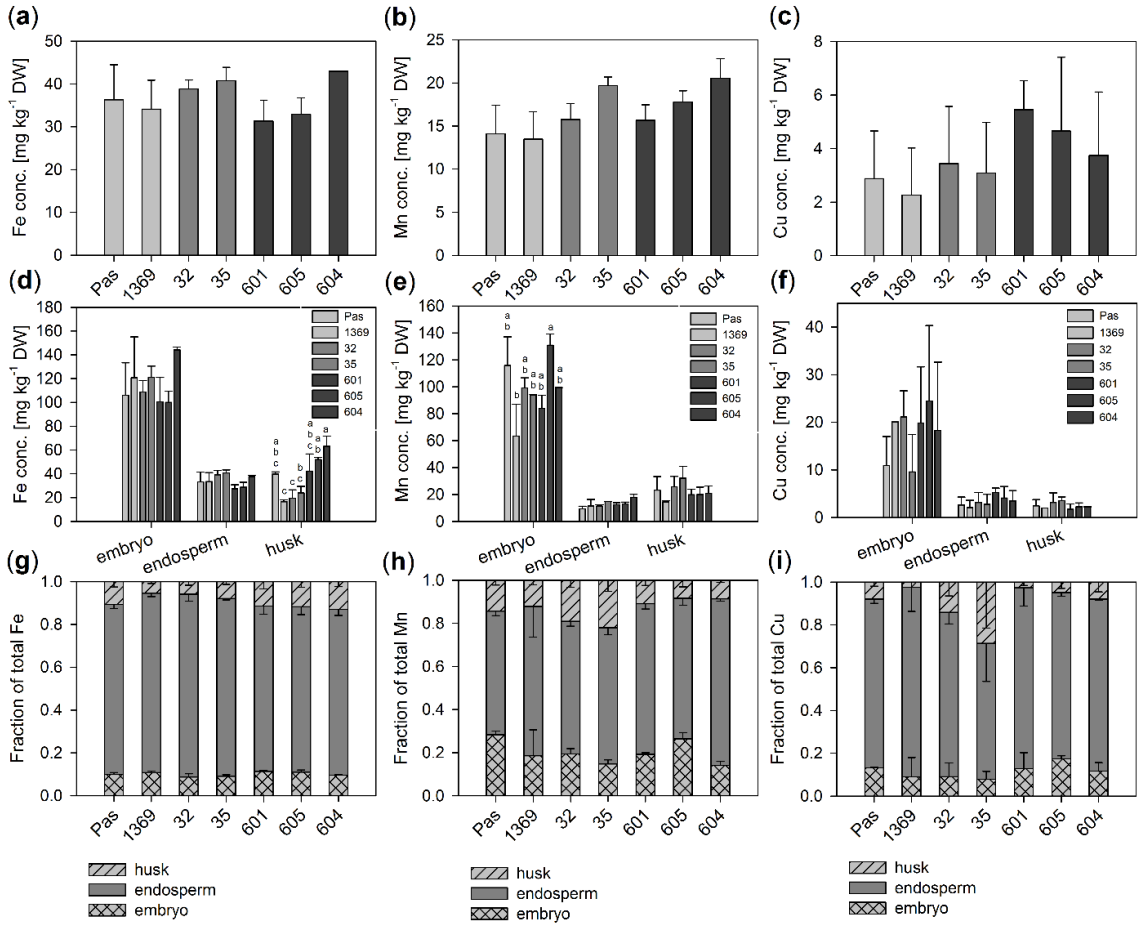

Fig. S8 Analysis of grain Fe, Mn and Cu distribution by grain dissection. Shown are grain Fe (**a**), Mn (**b**) and Cu (**c**) concentrations of two low (Pas=cv Pasadena, 1369), two intermediate (32, 35) and three high Zn accumulating (601, 605, 604) barley lines. Metal concentrations of separate grain parts (embryo, endosperm and husk) for the lines described before are shown in (**d**) for Fe, in (**e**) for Mn and in (**f**) for Cu. Relative contributions of dissected tissues (embryo, endosperm and husk) are shown in (**g**) for Fe, in (**h**) for Mn and in (**i**) for Cu. For each sample five grains per line and cultivation round were pooled. . Values are means + SD (n=2-3). Statistical differences were calculated based on differences of lines within tissues using ANOVA/Tukey's HSD post hoc test and are displayed as letters ($P \leq 0.05$).

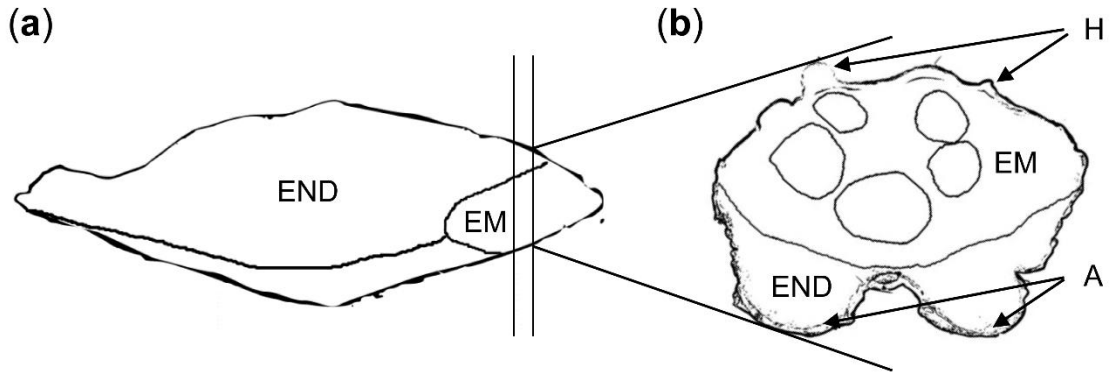

Fig. S9 Position of grain sections and analyzed tissues. (**a**): Grains were transversely sectioned at the embryonic side of the grain. (**b**) For calculation of tissue-specific metal concentrations from µ-PIXE maps Regions of Interest (ROIs) were defined as outer pericarp (*H* Husk), embryo tissues including scutellum (*EM* embryo), aleurone cells (*A* aleurone) and endosperm (*END* endosperm).

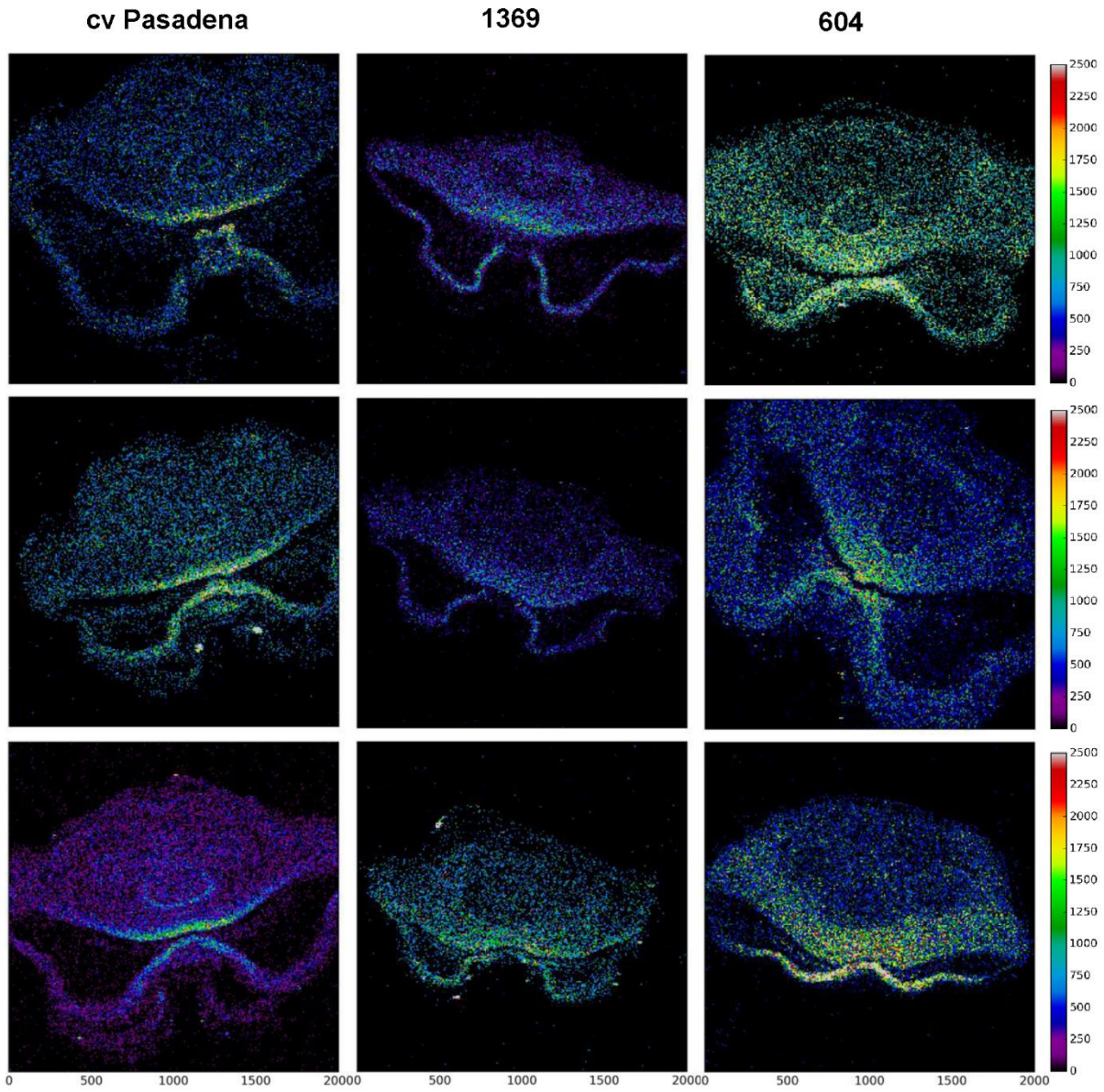

Fig. S10 Additional Zn distribution maps obtained by quantitative µ-PIXE for grains of lines representing the variation in grain Zn accumulation. µ-PIXE maps for Zn of three different barley grain sections of the reference line cv Pasadena, the low Zn line 1369 and the high Zn line 604 (in addition to the maps displayed in Fig. 6). Mature grains were transversely sectioned at the position of the embryo as indicated in Fig. S9.

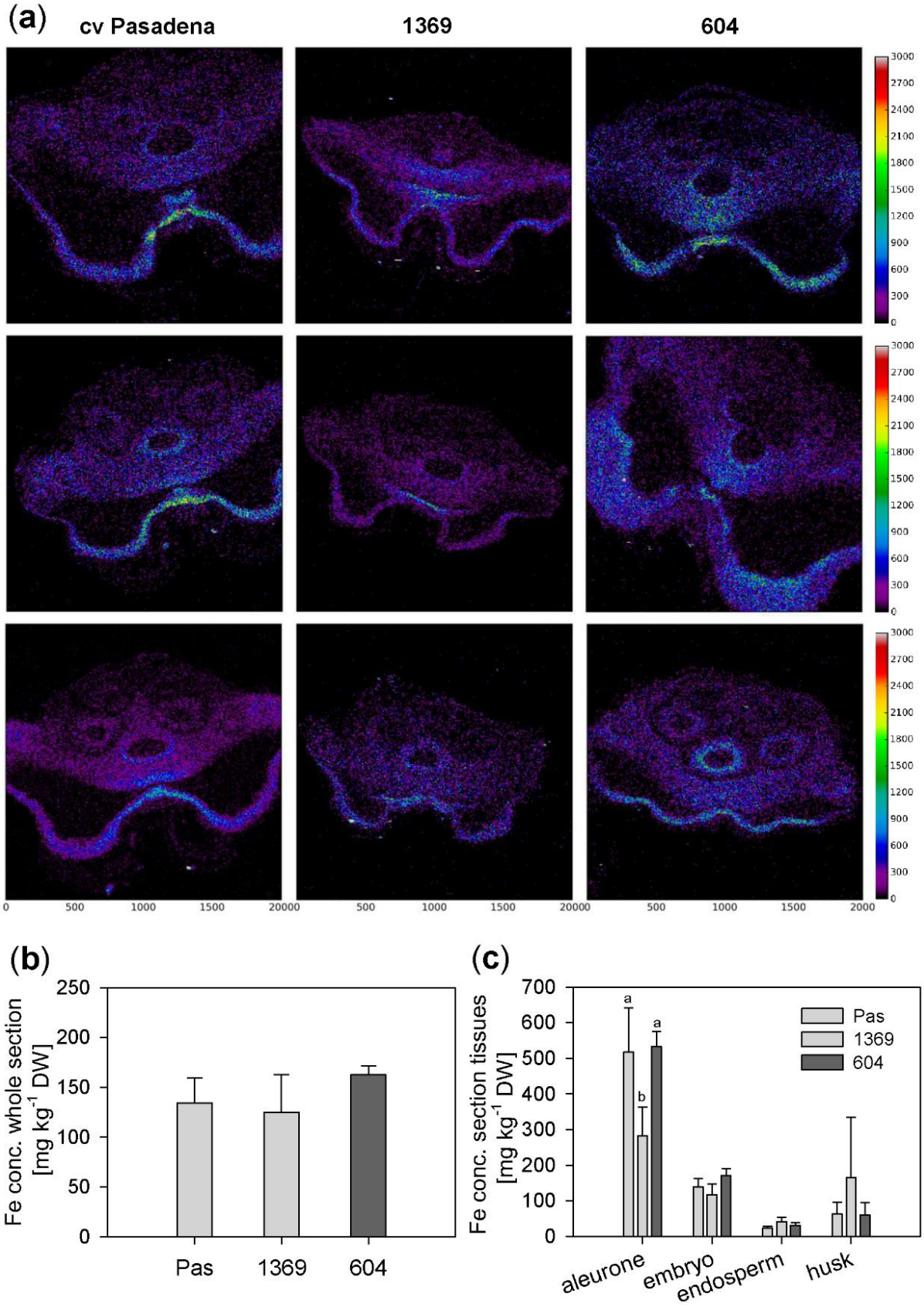
(a)
cv Pasadena
1369
604
(b)
Fe conc. whole section [mg kg-1 DW]
Pas
1369
604
(c)
Fe conc. section tissues [mg kg-1 DW]
Pas
1369
604
aleurone
embryo
endosperm
husk

Fig. S11 Fe distribution maps obtained by quantitative µ-PIXE for grains of lines representing the variation in grain Zn accumulation. (**a**)**:** µ-PIXE maps of barley grain sections of the reference line cv Pasadena, the low Zn line 1369 and the high Zn line 604. Mature grains were transversely sectioned at the position of the embryo as indicated in Fig. S9. (**b**)**:** Shown are the Fe concentrations averaged over µ-PIXE maps of four sections per line. (**c**)**:** Fe concentrations of different tissues (aleurone, embryo, endosperm and husk) derived from µ-PIXE maps of four sections per line. Values are means + SD. Statistical differences in grain tissue concentrations between the lines were calculated using ANOVA/Tukey's HSD post hoc test and are displayed as letters ($P < 0.05$).

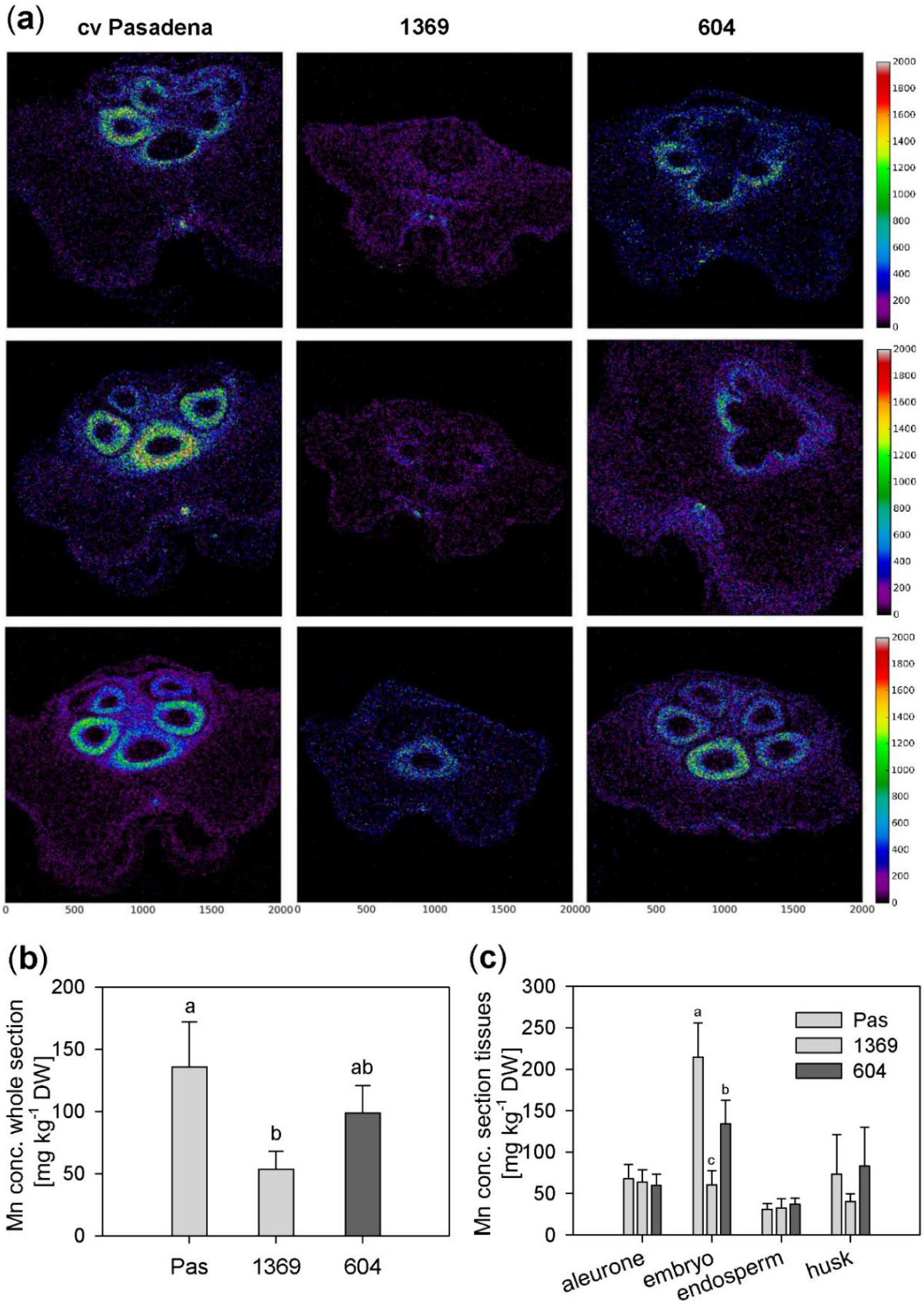
(a)
cv Pasadena
1369
604
(b)
Mn conc. whole section [mg kg-1 DW]
Pas
1369
604
(c)
Mn conc. section tissues [mg kg-1 DW]
Pas
1369
604
aleurone
embryo
endosperm
husk

Fig. S12 Mn distribution maps obtained by quantitative µ-PIXE for grains of lines representing the variation in grain Zn accumulation. (**a**)**:** µ-PIXE maps of barley grain sections of the reference line cv Pasadena, the low Zn line 1369 and the high Zn line 604. Mature grains were transversely sectioned at the position of the embryo as indicated in Fig. S9. (**b**)**:** Shown are the Mn concentrations averaged over µ-PIXE maps of four sections per line. (**c**)**:** Mn concentrations of different tissues (aleurone, embryo, endosperm and husk) derived from µ-PIXE maps of four sections per line. Values are means + SD. Statistical differences in grain tissue concentrations between the lines were calculated using ANOVA/Tukey's HSD post hoc test and are displayed as letters ($P < 0.05$).

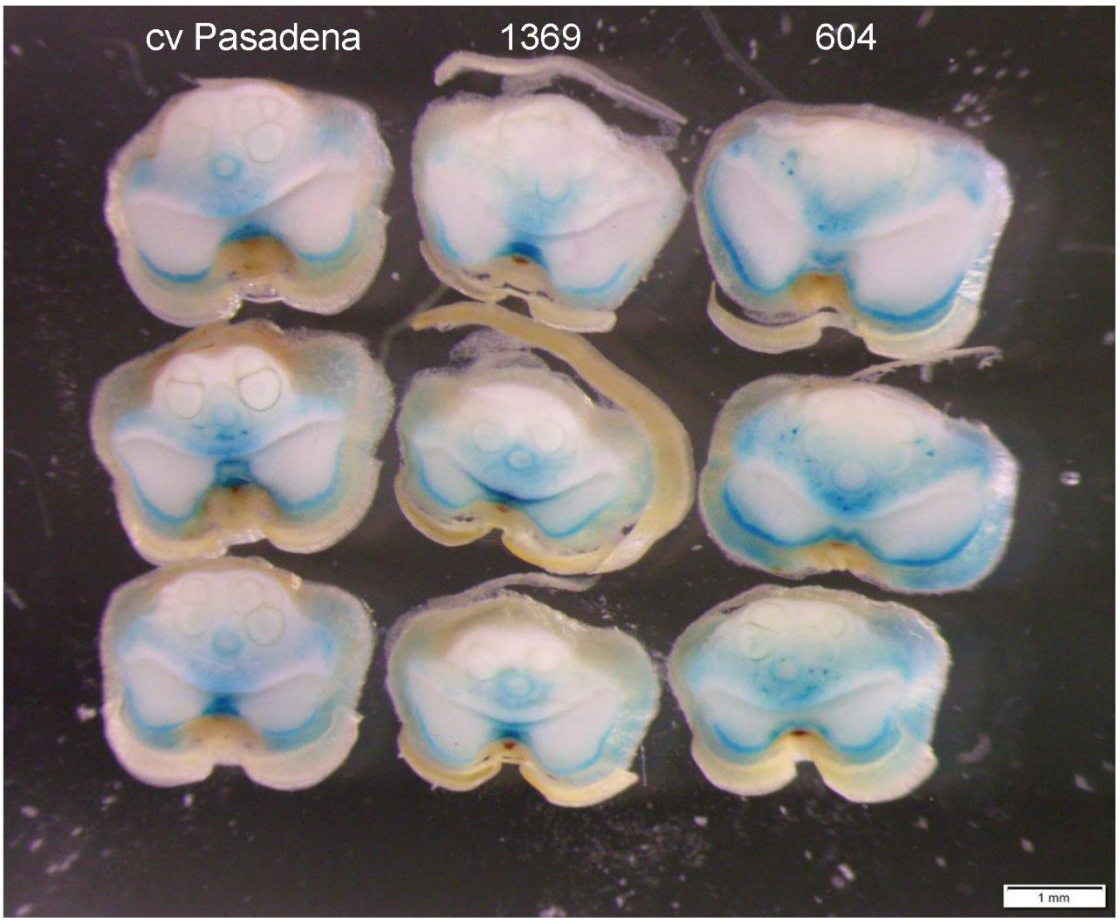

Fig. S13 Perl's staining of barley grains. Three grains each of the reference line cv Pasadena, the low Zn line 1369 and the high Zn line 604 were transversely sectioned at the embryo side of the grain and stained with Perl's staining. Fe is appearing in blue. Cross-sections were stained with Perl's Prussian blue as described previously (Cvitanich et al., 2010). The only difference was that grains were not incubated or stored in 70% ethanol, but rather photographed immediately. Images were taken under a Leica M50/Olympus DP26 stereomicroscope using the cellSens Dimension software (vers.1.11).

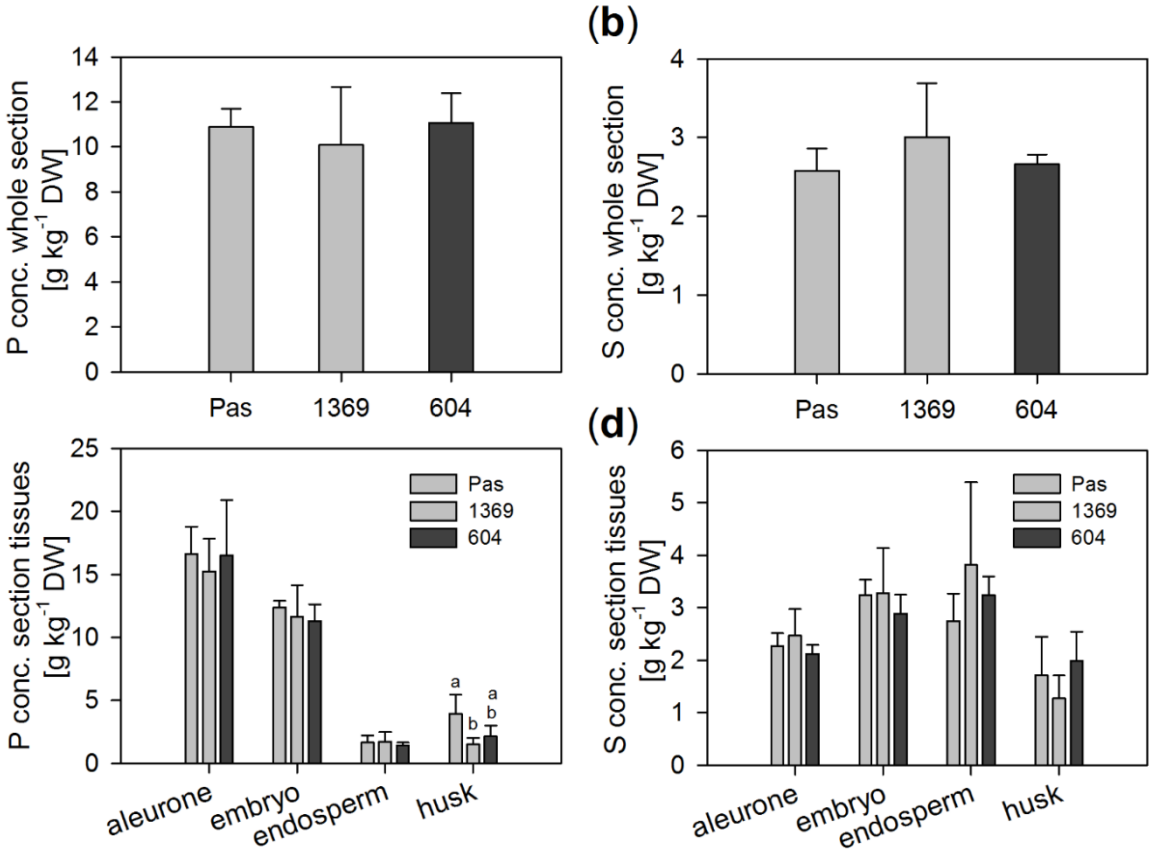

Fig. S14 Average P and S concentrations obtained from µ-PIXE quantitative distribution maps. (**a**,**b**): Shown are the average P (**a**) and S (**b**) concentrations derived from µ-PIXE maps of four sections each of barley grain sections of the reference line cv Pasadena, a low Zn accumulating line 1369 and a high Zn accumulating line 604. Mature grains were transversely sectioned at the position of the embryo as indicated in Fig. S8. (**c**,**d**)**:** Average P (**c**) and S (**d**) concentrations of different tissues (aleurone, embryo, endosperm and husk) derived from µ-PIXE maps of four sections per line. Values are means + SD. Statistical differences in seed tissue concentrations between the lines were calculated using ANOVA/Tukey's HSD post hoc test and are displayed as letters ($P < 0.05$).

Table S1 Description of the Barley Core Collection lines analysed in this study. Accession number, country of sampling origin, genus, subtaxa, conventional crop names as well as presumed soil types are given. Highlighted in bold face are the lines selected for in-depth analysis.

Accession number	Country of origin	Subtaxa	Cropname	Estimated soil type
BCC 14	AFG	*convar. vulgare*	IG 128100	
BCC 15	AFG	*convar. distichon var. nutans*	IG 128109	
BCC 16	AFG	*convar. vulgare*	IG 128110	calcic soils, high pH
BCC 17	AFG	*convar. vulgare*	K 5921	calcic soils, high pH
BCC 18	AFG	*convar. distichon var. nigrescens*	IG 128188	calcic soils, high pH
BCC 31	CYP	*convar. vulgare var. hybernum*	Paphitico	
BCC 32	**CYP**	***convar. vulgare var. hybernum***	**Mooro**	**calcic soils, high pH**
BCC 33	DZA	*convar. vulgare var. hybernum*	IG 33029	calcic soils, high pH
BCC 34	DZA	*convar. vulgare var. hybernum*	IG 33036	
BCC 35	**DZA**	***convar. vulgare var. hybernum***	**IG 33055**	**calcic soils, high pH**
BCC 36	DZA	*convar. vulgare var. hybernum*	IG 33063	
BCC 53	EGY	*convar. vulgare var. hybernum*	IG 32498	calcic soils, high pH
BCC 54	**EGY**	***convar. vulgare var. hybernum***	**IG 32508**	**calcic soils, high pH**
BCC 55	EGY	*convar. distichon var. nutans*	IG 32513	calcic soils, high pH
BCC 57	EGY	*convar. vulgare*	K 10014	calcic soils, high pH
BCC 58	EGY	*convar. vulgare var. hybernum*	IG 128204	calcic soils, high pH
BCC 64	IRN	*convar. vulgare*	IG 128124	calcic soils, high pH
BCC 65	IRN	*convar. vulgare*	IG 128125	calcic soils, high pH
BCC 67	IRN	*convar. distichon var. nigrescens*	IG 128127	calcic soils, high pH
BCC 68	IRN	*convar. distichon*	IG 128128	calcic soils, high pH
BCC 129	MAR	*convar. vulgare var. hybernum*	IG 31925	calcic soils, high pH
BCC 130	MAR	*convar. vulgare var. hybernum*	IG 31927	calcic soils, high pH
BCC 131	MAR	*convar. vulgare var. hybernum*	IG 31933	calcic soils, high pH
BCC 133	MAR	*convar. vulgare var. hybernum*	IG 31938	calcic soils, high pH
BCC 224	TUR	*convar. distichon var. medicum*	IG 128073	
BCC 225	TUR	*convar. distichon var. nutans*	IG 128074	calcic soils, high pH
BCC 226	TUR	*convar. vulgare var. hybernum*	IG 128075	
BCC 227	TUR	*convar. distichon var. nigrescens*	IG 128076	calcic soils, high pH
BCC 228	TUR	*convar. distichon*	IG 128077	calcic soils, high pH
BCC 243	TUR	*convar. vulgare var. hybernum*	IG 128117	

BCC 244	TUR	*convar. distichon var. medicum*	IG 128118	
BCC 245	TUR	*convar. distichon var. medicum*	IG 128119	calcic soils, high pH
BCC 246	TUR	*convar. vulgare var. hybernum*	IG 128120	calcic soils, high pH
BCC 247	TUR	*convar. vulgare var. hybernum*	IG 128134	calcic soils, high pH
BCC 248	TUR	*convar. vulgare var. hybernum*	IG 128135	
BCC 430	CHN		Jing luo 2 hao	flooded and polluted soils
BCC 431	**CHN**	***convar. distichon var. breve***	**Han 85-222**	**flooded and polluted soils**
BCC 432	CHN	*convar. distichon var. nutans*	Fu 8	flooded and polluted soils
BCC 433	CHN		Hu mai 10 hao	flooded and polluted soils
BCC 434	**CHN**	***convar. distichon var. breve***	**E nong 82-6003**	**flooded and polluted soils**
BCC 443	CHN	*convar. vulgare var. griseinigrum*	Mongolia 6-row	
BCC 447	CHN	*convar. vulgare var. hybernum*	Mulan	flooded and polluted soils
BCC 448	CHN		Taonan	flooded and polluted soils
BCC 449	CHN		Tungfeng	flooded and polluted soils
BCC 476	CHN	*convar. vulgare var. asiaticum*	Chinniu 1	
BCC 477	CHN	*convar. vulgare var. hybernum*	Chinniu 3	
BCC 478	CHN	*convar. vulgare var. hybernum*	Hsin-antien 1	
BCC 600	JPN	*convar. vulgare var. brevisetum*	Shiratama Hadaka	
BCC 601	**JPN**	***convar. distichon var. nutans***	**Amagi Nijo 3**	**flooded and polluted soils**
BCC 602	JPN	*convar. vulgare var. subnudipyramidatum*	Senbon Hadaka	flooded and polluted soils
BCC 603	JPN		Ishuku Shirazu	flooded and polluted soils
BCC 604	**JPN**		**Kawamizuki**	**flooded and polluted soils**
BCC 605	**JPN**		**Haruna Nijo**	
BCC 801	CAN		AC Oxbow	saline soils
BCC 802	PER	*convar. vulgare var. asiaticum*	Acora	
BCC 805	CAN		Albany	saline soils
BCC 819	DEU		Betzes	Zn deficient soils
BCC 825	PER	*convar. vulgare var. himalayense*	Cabanillas	
BCC 832	PER	*convar. vulgare var. trifurcatum*	Capachica 3	
BCC 833	USA	*convar. vulgare var. densum*	Casbon	
BCC 838	CAN		Centennial	saline soils
BCC 842	CAN		Chapais	saline soils
BCC 859	CAN		Fergus	saline soils
BCC 867	CAN		Galt	saline soils
BCC 883	PER	*convar. distichon var. griseinudum*	Ilave	

BCC 911	FIN	*convar. vulgare var. hybernum*	Olli	heavy soils, low pH
BCC 917	DEU		Piroline	Zn deficient soils
BCC 937	PER	*convar. vulgare var. duplinigrum*	Taraco	
BCC 1302	DEU	*convar. distichon var. nutans*	Angora	
BCC 1304	DEU	*convar. distichon var. nutans*	Calix	
BCC 1307	DEU	*convar. distichon var. nutans*	Igri	
BCC 1309	DEU	*convar. distichon var. nutans*	Malta;Ackermanns Malta [synonym]	Zn deficient soils
BCC 1316	DEU	*convar. distichon var. nutans*	Sonja	
BCC 1318	DEU	*convar. distichon var. nutans*	Prima	
BCC 1325	DEU	*convar. vulgare var. hybernum*	Colonia	
BCC 1326	DEU	*convar. vulgare var. hybernum*	Dea	
BCC 1328	DEU	*convar. vulgare var. hybernum*	Dura	
BCC 1329	DEU	*convar. vulgare var. hybernum*	Express	
BCC 1330	DEU	*convar. vulgare var. hybernum*	Friedrichswerther Berg	
BCC 1334	DEU	*convar. vulgare var. hybernum*	Hasso	
BCC 1344	DEU		Sigra	
BCC 1363	RUS	*convar. vulgare var. densum*	Siluet	
BCC 1366	DEU	*convar. distichon var. nutans*	Alexis	Zn deficient soils
BCC 1367	DEU	*convar. distichon var. nutans*	Apex	Zn deficient soils
BCC 1369	**DEU**	***convar. distichon var. nutans***	**Baronesse**	Zn deficient soils
BCC 1375	DEU	*convar. distichon var. nutans*	Carina	Zn deficient soils
BCC 1380	FRA	*convar. distichon var. nutans*	Gavotte	
BCC 1384	DEU	*convar. distichon var. nutans*	Grit	Zn deficient soils
BCC 1386	DEU	*convar. distichon var. nutans*	Haisa II	Zn deficient soils
BCC 1388	DEU	*convar. distichon var. nutans*	Hora	Zn deficient soils
BCC 1391	DEU	*convar. distichon var. nutans*	Isaria;Ackermanns Isaria [synonym]	Zn deficient soils
BCC 1393	DEU	*convar. distichon var. nutans*	Krona	
BCC 1399	SWE	*convar. distichon var. nutans*	Nancy	heavy soils, low pH
BCC 1411	DEU	*convar. distichon var. nutans*	Salome	Zn deficient soils
BCC 1412	SWE	*convar. distichon var. nutans*	Särla	heavy soils, low pH
BCC 1413	DEU	*convar. distichon var. nutans*	Sissy	Zn deficient soils
BCC 1417	DEU	*convar. distichon var. nutans*	Trumpf;Triumph [synonym]	Zn deficient soils
BCC 1424	DEU	*convar. distichon var. nutans*	Volla	Zn deficient soils
BCC 1425	DEU	*convar. distichon var. nutans*	Wisa	
BCC 1427	DEU	*convar. distichon var. nutans*	Danubia;Ackermanns Danubia [synonym]	Zn deficient soils
BCC 1433	DEU	*convar. distichon var. nutans*	Heils Franken	

BCC 1441	DEU	*convar. distichon var. nutans*	Pflugs Intensiv	Zn deficient soils
BCC 1443	DEU	*convar. distichon var. nutans*	Probsteiner Landgerste	
BCC 1449	FIN	*convar. vulgare var. hybernum*	Pirkka	heavy soils, low pH
BCC 1450	FIN	*convar. vulgare var. parallelum*	Pomo	heavy soils, low pH
BCC 1456	RUS	*convar. distichon var. nutans*	Viking	heavy soils, low pH
BCC 1461	RUS	*convar. distichon var. medicum*	Omskij 80	heavy soils, low pH
BCC 1465	UKR	*convar. distichon var. nutans*	Doneckij 650	saline soils
BCC 1475	UKR	*convar. vulgare var. hybernum*	Rosava	
BCC 1478	RUS	*convar. vulgare var. asiaticum*	K 9537	heavy soils, low pH
BCC 1502	RUS	*convar. vulgare var. nudipyramidatum*	K 16420	heavy soils, low pH
BCC 1507	DEU	*convar. vulgare var. hybernum*	Borwina	
BCC 1508	DEU	*convar. vulgare var. hybernum*	Franka	
BCC 1509	DEU	*convar. vulgare var. hybernum*	Hauters	
BCC 1510	DEU	*convar. distichon var. nutans*	Nebelia	Zn deficient soils
BCC 1511	DEU	*convar. vulgare var. hybernum*	Tapir	
BCC 1512	RUS	*convar. vulgare var. hybernum*	Prikumskij 43;Parallelum 43773 [synonym]	
BCC 1520	YUG	*convar. distichon var. nutans*	Novosadski 293;NS 293 [synonym]	
BCC 1524	DEU	*convar. distichon var. nutans*	Bavaria;Ackermanns Bavaria [synonym]	Zn deficient soils
BCC 1541	YUG	*convar. distichon var. nutans*	Novosadski 294;NS 294 [synonym]	saline soils
BCC 1542	YUG	*convar. distichon var. nutans*	Viktor	saline soils
BCC 1543	YUG	*convar. distichon var. nutans*	Milan	saline soils
BCC 1549	CYP	*convar. vulgare var. hybernum*	Lefkonoiko	calcic soils, high pH
BCC 1550	CYP	*convar. vulgare var. rikotense*	Kythraia	
BCC 1556	CYP	*convar. distichon var. nutans*	Sanokrithi-94	calcic soils, high pH
BCC 1558	DEU	*convar. vulgare var. hybernum*	Hansens Huebitzer	saline soils
BCC 1562	BGR	*convar. vulgare var. hybernum*	HOR 386	saline soils
BCC 1567	BGR	*convar. vulgare var. nigrum*	HOR 875	
BCC 1568	DEU	*convar. vulgare var. hybernum*	Stotz's Salemer	Zn deficient soils
BCC 1569	DEU	*convar. distichon var. nutans*	Zweizeilige aus Franken	Zn deficient soils
BCC 1570	DEU	*convar. vulgare var. hybernum*	Ostfriesische	
BCC 1699	FIN		Otra	heavy soils, low pH
BCC 1701	AUS	*convar. distichon var. nutans*	Forrest	calcic soils, high pH
BCC 1702	AUS	*convar. distichon var. nutans*	Galleon	calcic soils, high pH
BCC 1703	AUS	*convar. distichon var. nutans*	Stirling	calcic soils, high pH

BCC 1704	AUS	*convar. distichon var. nutans*	Grimmett	calcic soils, high pH
BCC 1705	AUS	*convar. distichon var. nutans*	Clipper	
BCC 1706	AUS	*convar. distichon var. nutans*	Lara	calcic soils, high pH
BCC 1707	AUS	*convar. distichon var. nutans*	Weeah	calcic soils, high pH
BCC 1708	AUS	*convar. distichon var. nutans*	Brindabella	calcic soils, high pH
BCC 1709	AUS	*convar. vulgare var. hybernum*	Yerong	calcic soils, high pH
BCC 1711	AUS	*convar. distichon var. nutans*	Kaputar	calcic soils, high pH

Table S2 Elemental composition of the soil used for the three glasshouse cultivations of BCC lines.

Element	Exchangeable ($BaCl_2$) (mg kg^{-1})	Total (mg kg^{-1})
Al	1.4	16,000
Fe	2.3	14,100
K	550	3,600
Mg	301	4,500
Mn	14.1	460
Zn	1.1	82.2

Table S3 Elemental composition of the metal-contaminated soil from an agricultural field.

Element	Exchangeable ($BaCl_2$) (mg kg^{-1})	Total (mg kg^{-1})
Al	17	20,000
Fe	31	29,000
K	600	5,100
Mg	61	3,700
Mn	2.6	2,800
Zn	8.6	3,400
Cd	0.08	10.0

Table S4 Pearson product moment correlation coefficients of Zn, Fe, Mn and Cu concentrations in the four different barley grain sample sets. Significance codes: *, *P* < 0.05; **, *P* < 0.01; ***, *P* < 0.001; *ns*, not significant.

	Zn Rd. I	Zn Rd. II	Zn Rd. III	Fe IPK	Fe Rd. I	Fe Rd. II	Fe Rd.III	Mn IPK	Mn Rd. I	Mn Rd. II	Mn Rd. III	Cu IPK	Cu Rd. I	Cu Rd. II	Cu Rd.III
Zn IPK	**0.443** ***	**0.592** ***	**0.291** ***	**0.389** ***	-0.001 ns	0.209 ns	-0.037 ns	**0.338** **	0.168 ns	-0.014 ns	**0.262** *	**0.512** ***	**0.281** **	**0.289** **	0.163 ns
Zn Rd. I		**0.706** ***	**0.295** **	0.204 ns	**0.675** ***	**0.335** **	0.061 ns	0.201 ns	**0.503** ***	0.096 ns	0.119 ns	**0.239** *	**0.696** ***	**0.318** **	0.107 ns
Zn Rd. II			**0.261** *	0.21 ns	**0.317** **	**0.585** ***	0.019 ns	**0.314** **	**0.272** **	0.057 ns	0.135 ns	**0.287** ***	**0.492** ***	**0.478** ***	0.108 ns
Zn Rd.III				0.155 ns	0.152 ns	0.054 ns	**0.625** ***	0.2 ns	0.199 ns	$-6E^{-05}$ ns	**0.742** ***	0.134 ns	0.158 ns	**0.353** ***	**0.445** ***
Fe IPK					0.043 ns	0.045 ns	0.192 ns	0.117 ns	0.1 ns	**-0.288** **	0.155 ns	**0.559** ***	0.183 ns	**0.298** **	0.191 ns
Fe Rd. I						**0.224** *	0.149 ns	0.051 ns	**0.62** ***	**0.228** *	0.061 ns	-0.083 ns	**0.602** ***	0.079 ns	0.001 ns
Fe Rd. II							0.032 ns	0.113 ns	0.098 ns	**0.266** *	-0.083 ns	-0.017 ns	0.189 ns	**0.213** *	-0.069 ns
Fe Rd.III								0.036 ns	0.045 ns	-0.058 ns	**0.421** ***	0.055 ns	0.008 ns	**0.233** *	**0.396** ***
Mn IPK									**0.342** ***	0.196 ns	**0.375** ***	**0.289** ***	0.204 ns	0.155 ns	0.148 ns
Mn Rd. I										**0.246** *	**0.332** ***	0.143 ns	**0.486** ***	0.007 ns	0.016 ns
Mn Rd. II											0.066 ns	-0.062 ns	0.166 ns	-0.092 ns	-0.064 ns
Mn Rd.III												0.207 ns	0.087 ns	0.171 ns	**0.332** **
Cu IPK													**0.255** *	**0.309** **	**0.357** ***
Cu Rd.I														**0.244** *	**0.391** ***
Cu Rd.II															**0.306** **

References

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