

Soil Contamination in China: Current Status and Mitigation Strategies

Fang-Jie Zhao, Yibing Ma, Yong-Guan Zhu, Zhong Tang, Steve P. McGrath

Supporting information: 1 Table

Table S1. Quantitative trait loci (QTLs) for grain Cd and As concentrations in rice

Traits	Population	QTLs	Chromosome	Nearest marker	Marker type	R ² (%)	Reference
Grain Cd concentration	CSSLs (Koshihikari×Kasalath)	CdG3	3	S1513	RFLP	-	1
		CdG6	6	R2171	RFLP	-	
		CdG8	8	C390	RFLP	-	
	BILs (Nipponbare×Kasalath)	qcd4-1	4	R93	RFLP	8.2	2
		qcd4-2	4	R514	RFLP	7.9	
		qcd11	11	C189	RFLP	10.5	
	BILs (Sasanishiki×Habataki)	qGCd2	2	R2511	RFLP	11.8	3
		qGCd7	7	C383	RFLP	35.5	
	RILs (Balax×Azucena)	qCd1	1	C949	RFLP	18.9	4
		qCd2	2	RM6	SSR	9.7	
		qCd3	3	RG191	RFLP	8.7	
		qCd7	7	G338	RFLP	20.2	
		qCd9	9	C506	RFLP	12.2	
		qCd10	10	AB1001	Undefined	16.8	
	RILs (Fukuhibiki×LAC23)F6	qLCdG3-1	3	RM426	SSR	13.86	5
		qLCdG11	11	NBLAC61	CAPS	9.41	
	RILs (Fukuhibiki×LAC23)F7	qLCdG3-2	3	RM1940	SSR	8.29	
		qLCdG11	11	NBLAC61	CAPS	12.91	
	BILs (Koshihikari×Jarjan)	qCdp7	7	RM3859	SSR	46	6
	DH (JX17×ZYQ8)	qCdc3	3	G249	RFLP	18.21	

Grain As concentration		qCdc4	4	C513	RFLP	22.44	
		qCdc6	6	G122	RFLP	13.56	
	CSSLs (Koshihikari×LAC23)	qlGCd3	3	RM16153	SSR	-	⁸
	RILs (Suwon490×SNU-SG1)	gcc3	3	RM545	SSR	16.7	⁹
		gcc9	9	RM1328	SSR	17.8	
		gcc11	11	RM286	SSR	16.1	
	LT-RILs (Lemont×TeQing)	Cd1	1	RG236	RFLP	6.3	¹⁰
		Cd9	9	RG570	RFLP	5.8	
	BILs (TeQing-into-Lemont) unflooded	Cd2.1	2	RM6840	SSR	-	
		Cd2.2	2	RM166	SSR	-	
	BILs (TeQing-into-Lemont) flooded	Cd3	3	RM132	SSR	-	
		Cd5	5	RM13	SSR	-	
		Cd6	6	OSR21	SSR	-	
		Cd8	8	RM149	SSR	-	
	DH (CJ06×TN1)	AsSe1	6	RM3	SSR	26.3	¹¹
		AsSe2	8	RM1111	SSR	35.2	
	RILs (Bala×Azucena)	qAs8	8	R902	RFLP	22.8	¹²
		qAs10	10	a12372	Genomic DNA	8.5	
	LT-RILs (Lemont×TeQing)	As5	5	RG13	RFLP	3.7	¹⁰
	BILs (TeQing-into-Lemont) flooded	As2	2	RM341	SSR	-	
		As9	9	RM1189	SSR	-	
		As11	11	RM167	SSR	-	

	BILs (TeQing-into-Lemont) unflooded	As3	3	RM16	SSR	-	
Grain DMA concentration*	F2 (Padi Perak×Koshihikari)	qDMA6.1	6	AE06000003	SNP	36	13
		qDMA6.2	6	AE06001721	SNP	25	
		qDMA8	8	AE08000162	SNP	12	

* DMA, dimethylarsinic acid.

REFERENCES

- (1) Ishikawa, S.; Ae, N.; Yano, M. Chromosomal regions with quantitative trait loci controlling cadmium concentration in brown rice (*Oryza sativa*). *New Phytol.* **2005**, *168* (2), 345-350.
- (2) Kashiwagi, T.; Shindoh, K.; Hirotsu, N.; Ishimaru, K. Evidence for separate translocation pathways in determining cadmium accumulation in grain and aerial plant parts in rice. *BMC Plant Biology* **2009**, *9*.
- (3) Ishikawa, S.; Abe, T.; Kuramata, M.; Yamaguchi, M.; Ando, T.; Yamamoto, T.; Yano, M. A major quantitative trait locus for increasing cadmium-specific concentration in rice grain is located on the short arm of chromosome 7. *J. Exp. Bot.* **2010**, *61* (3), 923-934.
- (4) Norton, G. J.; Deacon, C. M.; Xiong, L.; Huang, S.; Meharg, A. A.; Price, A. H. Genetic mapping of the rice ionome in leaves and grain: identification of QTLs for 17 elements including arsenic, cadmium, iron and selenium. *Plant Soil* **2010**, *329* (1-2), 139-153.
- (5) Sato, H.; Shirasawa, S.; Maeda, H.; Nakagomi, K.; Kaji, R.; Ohta, H.; Yamaguchi, M.; Nishio, T. Analysis of QTL for lowering cadmium concentration in rice grains from 'LAC23'. *Breed. Sci.* **2011**, *61* (2), 196-200.
- (6) Abe, T.; Taguchi-Shiobara, F.; Kojima, Y.; Ebitani, T.; Kuramata, M.; Yamamoto, T.; Yano, M.; Ishikawa, S. Detection of a QTL for accumulating Cd in rice that enables efficient Cd phytoextraction from soil. *Breed. Sci.* **2011**, *61* (1), 43-51.
- (7) Zhang, X.; Zhang, G.; Guo, L.; Wang, H.; Zeng, D.; Dong, G.; Qian, Q.; Xue, D. Identification of quantitative trait loci for Cd and Zn concentrations of brown rice grown in Cd-polluted soils. *Euphytica* **2011**, *180* (2), 173-179.
- (8) Abe, T.; Nonoue, Y.; Ono, N.; Omoteno, M.; Kuramata, M.; Fukuoka, S.; Yamamoto, T.; Yano, M.; Ishikawa, S. Detection of QTLs to reduce cadmium content in rice grains using LAC23/Koshihikari chromosome segment substitution lines. *Breed. Sci.* **2013**, *63* (3), 284-291.
- (9) Yan, Y.-F.; Lestari, P.; Lee, K.-J.; Kim, M. Y.; Lee, S.-H.; Lee, B.-W. Identification of quantitative trait loci for cadmium accumulation and distribution in rice (*Oryza sativa*). *Genome* **2013**, *56* (4), 227-232.
- (10) Zhang, M.; Pinson, S. R. M.; Tarpley, L.; Huang, X.-Y.; Lahner, B.; Yakubova, E.; Baxter, I.; Guerinot, M. L.; Salt, D. E. Mapping and validation of quantitative trait loci associated with concentrations of 16 elements in unmilled rice grain. *Theor. Appl. Genet.* **2014**, *127* (1), 137-165.
- (11) Zhang, J.; Zhu, Y. G.; Zeng, D. L.; Cheng, W. D.; Qian, Q.; Duan, G. L. Mapping quantitative trait loci associated with arsenic accumulation in rice (*Oryza sativa*). *New Phytol.* **2008**, *177* (2), 350-355.

- (12) Norton, G. J.; Duan, G. L.; Lei, M.; Zhu, Y. G.; Meharg, A. A.; Price, A. H. Identification of quantitative trait loci for rice grain element composition on an arsenic impacted soil: Influence of flowering time on genetic loci. *Ann. Appl. Biol.* **2012**, *161* (1), 46-56.
- (13) Kuramata, M.; Abe, T.; Kawasaki, A.; Ebana, K.; Shibaya, T.; Yano, M.; Ishikawa, S. Genetic diversity of arsenic accumulation in rice and QTL analysis of methylated arsenic in rice grains. *Rice* **2013**, *6*.