Supplementary Material

Introgression of QTLs for constitutive aerenchyma formation from *Zea nicaraguensis* improves tolerance of root-zone oxygen deficiency in maize

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			Chromosome 1														Chromosome 2															
		Bin	1.01	1.01	1.02	1.03	1.03	1.04	1.05	1.06	1.06	1.06-7	1.07	1.07	1.07	1.07	1.07	1.07	1.10	1.11	1.11	1.12	2.00	2.01	2.02	2.02	2.03	2.04	2.06	2.07	2.07	2.08
		Code	*P21	*P41L	*P22	*P1110	*PA	*P81	*P140	*P1104	*P1008	*P1226Q	*P1003	*P1903Q	*P1906Q	*P1908Q	*P1010Q	*P1006	*P103Q	*P1123Q	*P1125	*P197	*P198	*P83	*P2001	*P2004Q	*P144	*P2101	*P105	*P2017	*P106	*P2008
	Plant No.	Name	bnlg1014	bnlg1112	bnlg1007	bnlg1484	phi001	bnlg1016	bnlg1832	umc1754	umc1254	umc2396	bnlg1556	IDP8950	IDP8577	IDP7842	umc1278	umc1128	bnlg1347	umc1500	umc1862	umc1819	phi96100	bnlg1092	bnlg2277	umc1422	bnlg2248	umc1541	bnlg1887	umc2402	mmc0271	bnlg1662
#268 (BC3F2#268) ^a	463		Α		Α	В	В	С	В	В	В	В	В			Н	Н	Н	Н	Α	Α	Α	Α	Α	Α	Α	Α	Α	Α	A	Α	Α
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#268-463	135		Α	Α	Α	В	В	В	В	В	В	В	В	В		Η	Н	Н	Η	Α	Α	Α	Α	Α	Α	Α	Α	Α	-	Α	Α	Α
S72	36		Α	Α	Α	Α	Α	Α	Α	Α	Α	В	Α			Α	Α	Α	Α	В	В	Α	Α	Α	Α	Α	Α	Α	Α	Α	Α	Α
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AE-24 (F2)	50						Α		Η	Η	Η		Η	Η		Η	Η	В			В											I
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AE-24-50	44						Α		Α	Η	Η		Η	Η		В	В	В			В											
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AE-24-50-44 (AE91)	91		Α	Α	Α	В	Α	Α	Α	B	В	В	В	В	В	В	В	В	B	В	В	Α	А	Α	Α	Α	Α	Α	Α	Α	Α	Α

Table S1. Scheme used for the development of IL-AE91, possessing chromosome segments of *Qaer1.06-1.07*, *Qaer1.11*, *Qaer5.09n* and *Qaer8.05* from *Z. nicaraguensis* in the genetic background of Mi29.

Chromosome 3												(Chro	mose	ome 4	1						Ch	romo	osom	e 5						Ch	romo	osom	e 6		
3.00	3.023	3.04	3.05	3.05	3.06	3.06	3.07	3.09	3.10	4.01	4.03	4.04	4.05	4.06	4.06	4.07	4.10	4.11	5.00	5.02	5.01	5.03	5.04	5.05	5.05	5.06	2.07	5.09	6.00	6.01	6.02	6.04	6.05	6.06	6.07	6.078
*P215	*P222	*P42	*P28	*P3017	*P224	*P148	*P3003	*P86	*P150	*P237	*P47	*P67	*P4010	*P4005	*P4105	*P152	*P114	*P4003	*P116	*P5112	*P5113	*P259	*P5016	*P5307	*P5108	*P5109	*P266	*P118	*PB	*P71	*P119	*P277Q	*P6015	*P6010	*P6108	*P6114
phi404206	bnlg1325	bnlg1113	mmc0022	umc1973	phi102228	bnlg197	umc1825	bnlg1182	umc1136	nc135	phi021	phi096	umc1662	mmc0371	umc1299	bnlg1784	bnlg1917	umc1716	nc130	umc1587	umc1894	bnlg557	umc1747	umc1155	umc1853	umc1019	umc2013	umc1153	phi126	bnlg1371	umc1006	umc2006	umc1751	umc1520	umc1350	bnlg1521
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Α	А	Α	Α	A	A	A	A	Α	В	Α	Α	Α	Α	Α	A	Α	Α	Α	Α	Α	A	Α	Α	Α	A	А	А	Α	Α	Α	Α	Α	Α	Α	Α	Α
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		Ch	rom	osom	e 7			Chromosome 8													Chromosome 9 Chromosome 10													
7.00	7.01	7.01	7.02	7.03	7.03	7.04	7.06	8.00	8.01	8.01	8.02	8.02	8.02	8.03	8.05	8.05	8.06	8.06	8.09	9.01	9.02	9.04	9.04	9.05	9.07	9.07-8	10.00	10.01-2	10.03	10.03	10.04	10.05	10.06	10.07
*P7019	*P7003	*P7001	*P7005	*P73	*P7010	*P94	*P35	*P294	*P8319	*P75	*P8302	*P8304	*P173Q	*P8043	*P52	*P8110	*P8021	*P8316	*P299	*P131	*P9012	*P9002	*P9005	*P9006	*P78	*P98	*P57	*P0103	*P58	*P10	*P0002	*P99	*P335	*P0007
mmc0171	umc1159	umc1270	umc1983	bnlg1305	umc1134	dupssr13	phil 16	umc1359	umc1592	bnlg1194	umc1790	umc1872	bnlg1352	umc2075	phi014	umc1712	umc1960	umc1724	phi233376	bnlg1724	umc1170	bnlg1209	umc1771	umc1078	bnlg1191	bnlg1129	phi118	umc1152	bnlg210	phi050	umc1911	bnlg1074	umc1045	bnlg1839
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А	Α	А	Α	Α	Α	Α	В	Α	Α	А	Α	Α	Α	Α	Α	В	Α	Α	Α	Α	Α	А	Α	Α	Α	Α	Α	Α	Α	Α	Α	A	Α	A

"A", "B", and "H" indicate Mi29 allele, Z. nicaraguensis allele and heterozygous, respectively.

Line #268 was obtained from segregant during the development of a library of introgression lines, each containing a chromosome segment from *Z. nicaraguensis* in the genetic background of Mi29 (Mano & Omori, 2013*b*).



Time after transfer to stagnant conditions (days)

Figure S1. Cross-sections of Mi29, IL-AE91 and *Z. nicaraguensis* roots under stagnant deoxygenated conditions. Seedlings with around 100 mm long 4th nodal roots grown under aerated conditions were transferred to stagnant deoxygenated conditions for four days (days 0, 1, 2, 3 and 4). Distances from the root tip (mm) are displayed on the left side of figures. Arrows indicate aerenchyma. Bar = 100 μ m.



Time after transfer to stagnant conditions (days)



Time after transfer to stagnant conditions (days)



Time after transfer to stagnant conditions (days)

Figure S2. Aerenchyma formation at 30 mm, 60 mm and 80 mm from the root tips of Mi29, IL-AE91 and *Z. nicaraguensis* (*Z. nica.*) roots under stagnant deoxygenated conditions for four days (days 0, 1, 2, 3 and 4). Data was selected from Figure 6. Statistical analyses were performed using one-way ANOVA followed by Dunnett's multiple comparisons test. *, ** and *** indicate significant differences between the value of each line at day 0 and those of days 1-4 at the P < 0.05, P < 0.01 and P < 0.001 levels, respectively.



Figure S3. ROL from aerobically grown roots of Mi29, IL-AE91 and *Z. nicaraguensis* on day 4 under stagnant deoxygenated conditions. Different letters indicate significant difference within each line at each root position (P < 0.05, one-way ANOVA and then Tukey's test for multiple comparisons). Values are means \pm SD (n = 3).



Figure S4. ROL from roots of Mi29, IL-AE91 and *Z. nicaraguensis* emerged after transfer to stagnant deoxygenated conditions. The total root lengths were 40-60 mm. Three root points including root tip (5-10 mm from the root tips), root middle (25-30 mm from the root tips) and root base (45-50 mm from the root tips) were used to measure the ROL amount. Different letters indicate significant difference between distances (P < 0.05, one-way ANOVA and then Tukey's test for multiple comparisons). Values are means \pm SD (*n* = 3).