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Approaches to relating rice root plasticity with yield stability across different drought stress and establishment conditions

Supplemental File

Table S1. Parentage of the breeding lines used in this study.

Designation	Parentage
IR 115844-B-154	(NSICRc 222/IR 87707-446-B-B)/(IR 87707-446-B-B/IR 74371-54-1-1)//(VANDANA/KALI AUS)
IR 115844-B-32	(NSICRc 222/IR 87707-446-B-B)/(IR 87707-446-B-B/IR 74371-54-1-1)//(VANDANA/KALI AUS)
IR 115844-B-332	(NSICRc 222/IR 87707-446-B-B)/(IR 87707-446-B-B/IR 74371-54-1-1)//(VANDANA/KALI AUS)
IR 115845-B-154	(Sahbhagi dhan/UPLRI 7)/(F1 PSBRC 82/KALI AUS)//(VANDANA/IR 74371-54-1-1)
IR 115845-B-310	(Sahbhagi dhan/UPLRI 7)/(F1 PSBRC 82/KALI AUS)//(VANDANA/IR 74371-54-1-1)
IR 115845-B-388	(Sahbhagi dhan/UPLRI 7)/(F1 PSBRC 82/KALI AUS)//(VANDANA/IR 74371-54-1-1)
IR 92801-504-B	Kali Aus /2*MTU1010
IR 92801-527-B	Kali Aus /2*MTU1010
IR 94226-B-265	Aus276/3*MTU1010
IR 94226-B-364	Aus 276/3*MTU1010
IR 94226-B-419	Aus 276/3*MTU1010
IR 95783-6-2-2-3	IR 83372-B-B-133-2 / IR 83894-B-B-46-4
IR 97041-5-1-1-2	IR 83383-B-B-140-4/ IR 84874-B-29-2-4
IR 98976-20-1-2-1	IR 87795-7-1-3-4/SABITRI

Table S2. Average soil characteristics across the field and lysimeter experiments in this study.

	DSR field trials	PTR field trials	Lysimeter study
Avail P-O (mg/kg)	44.8	45.2	41.5
pH (H2O)	6.72	6.62	6.03
Exch K (meq/100g)	1.54	1.53	3.07
Exch Mg (meq/100g)	9.55	9.73	11.25
Exch Ca (meq/100g)	16.2	15.5	19.8
Kj N (%)	0.117	0.116	0.180
Clay P (%)	34.2	32.0	42.3
Sand P (%)	17.2	18.0	16.0
Silt P (%)	48.7	50.0	41.8
Org C (%)	0.98	1.03	
Bulk density 5-10 cm (g/cm3)	1.30	1.30	
Bulk density 25-30 cm (g/cm3)	1.28	1.36	1.1

Table S3. Grain yield, biomass, harvest index, nitrogen use efficiency based on grain yield (NUEg), nitrogen use efficiency based on biomass (NUEb), and root length density (RLD) in each field environment for both direct-seeded rice (DSR) and puddled-transplanted rice (PTR).

Environment	Grain yield ($g\ m^{-2}$)	Biomass ($g\ m^{-2}$)	Harvest index (%)	NUEg ($g\ g^{-1}$)	NUEb $g\ g^{-1}$)	RLD_15-30 cm ($cm\ cm^{-3}$)	RLD_30-45 cm ($cm\ cm^{-3}$)
DSR							
2016DS_DSR_CN(S)	1.50e	418.31e	0.34f	0.77e	193.82c	1.09bc	0.47a
2016DS_DSR_CN(W)	262.8a	926.64a	25.72b	90.34a	315.72a	1.17b	0.32b
2016WS_DSR_CN(S)	181.50c	714.20b	22.68c	29.12d	114.98d	0.97cd	0.53a
2016WS_DSR_CN(W)	227.10b	699.23b	29.00a	37.08c	116.16d	0.78e	0.47a
2017DS_DSR_LN(S)	0.24e	519.04d	0.04f	0.12e	243.95b	1.06bc	0.34b
2017DS_DSR_LN(W)	166.41c	717.63b	20.65d	55.20b	235.29b	1.01c	0.46a
2017DS_DSR_HN(S)	0.01e	583.78c	0.003f	0.005e	185.11c	0.85de	0.22c
2017DS_DSR_HN(W)	139.10d	898.32a	13.87e	31.69cd	196.53c	1.39a	0.33b
Mean	121.52	684.58	14.04	30.54	200.19	1.04	0.39
PTR							
2016DS_PTR_CN(S)	213.10d	687.37e	26.66d	—	—	1.27b	0.38c
2016DS_PTR_CN(W)	422.24b	810.68d	44.85a	—	—	0.65d	0.20d
2016WS_PTR_CN(S)	26.81f	531.84g	4.13g	5.06f	108.05e	1.91a	0.83a
2016WS_PTR_CN(W)	416.98b	1173.45a	31.09c	58.26d	163.71d	1.74a	0.78a
2017DS_PTR_LN(S)	138.60e	488.69h	25.13e	86.11c	302.92b	1.42b	0.30c
2017DS_PTR_LN(W)	372.65c	861.42c	38.12b	161.27a	373.31a	0.91c	0.55b
2017DS_PTR_HN(S)	135.03e	626.25f	19.08f	42.39e	193.21c	1.25b	0.50b
2017DS_PTR_HN(W)	488.69a	1112.47b	38.89b	139.88b	316.74b	0.74cd	0.34c
Mean	278.56	784.65	28.49	82.16	242.99	1.22	0.47

Within each parameter of each establishment, means followed by a common letter are not significantly different by the LSD test at the 5% level of significance. – indicates no measurement in those environments.

Table S4. Grain yield, biomass, harvest index, nitrogen use efficiency based on grain yield (NUEg), nitrogen use efficiency based on biomass (NUEb), and root length density (RLD) of genotypes in field environments for both direct-seeded rice (DSR) and puddled-transplanted rice (PTR), with stress and nitrogen treatments grouped together. Genotypes selected as stable yielding and root plastic are shown in bold, and stable yielding, less root plastic genotypes are underlined.

Genotype	Grain yield ($g\ m^{-2}$)	Biomass ($g\ m^{-2}$)	Harvest index (%)	NUEg ($g\ g^{-1}$)	NUEb $g\ g^{-1}$)	RLD_ 15-30 cm ($cm\ cm^{-3}$)	RLD_ 30-45 cm ($cm\ cm^{-3}$)
DSR							
IR 115844-B-154	112.49efgh	679.05abcde	13.28c	32.32abcd	220.80abc	0.94def	0.36a
IR 115844-B-32	121.06cdef	749.72a	12.55c	31.57abcde	221.83ab	1.10abcdef	0.40a
IR 115844-B-332	139.02abcd	632.48de	17.60a	32.84abcd	185.23cdef	1.07abcdef	0.39a
IR 115845-B-154	134.46abcde	736.88ab	14.16bc	30.47abcdef	213.37abcd	0.93ef	0.40a
IR 115845-B-310	115.94defg	729.35abc	12.82c	27.67bcdefg	213.37abcd	1.05bcdef	0.39a
IR 115845-B-388	129.77bcdef	699.03abcd	14.13bc	36.84ab	225.74a	1.15abc	0.37a
IR 92801-504-B	103.40fgh	667.01bcde	13.18c	23.12defg	182.25cdef	0.93ef	0.46a
IR 92801-527-B	91.81gh	621.40e	12.83c	16.90g	153.16f	0.93ef	0.37a
IR 94226-B-265	110.47efgh	685.88abcde	13.98bc	25.54cdefg	178.90def	1.28a	0.45a
IR 94226-B-364	105.96fgh	660.46cde	12.68c	22.02efg	166.00ef	1.08abcdef	0.36a
IR 94226-B-419	90.45h	703.79abcd	9.93d	20.92fg	180.92def	0.95def	0.35a
IR 95783-6-2-2-3	156.44a	699.44abcd	17.08a	37.71a	189.24bcdef	1.18ab	0.39a
IR 97041-5-1-1-2	142.89abc	696.64abcd	16.25ab	33.24abcd	192.34abcdef	0.91f	0.39a
IR 98976-20-1-2-1	122.76cdef	677.81abcde	14.45bc	29.04abcdef	199.48abcde	1.13abcd	0.40a
IR64	110.77efgh	622.94e	13.73c	34.18abc	214.26abcd	0.98cdef	0.39a
MTU1010	107.98fgh	620.93e	13.61c	27.24bcdefg	186.36bcdef	0.91f	0.34a
UPLRi7	154.84ab	732.57abc	16.09ab	36.31ab	213.7abcd	1.12abcde	0.49a
PTR							
IR 115844-B-154	297.17bcd	787.89bcd	31.40bcd	91.3bcd	251.51bc	1.31abcd	0.56a
IR 115844-B-32	293.01cd	800.08abc	29.32e	83.57de	240.49bc	1.42ab	0.42a
IR 115844-B-332	319.35ab	818.62ab	31.24bcd	92.21bcd	239.74bc	1.30abcde	0.46a
IR 115845-B-154	293.41cd	833.02a	29.54de	81.94def	254.55bc	1.35abc	0.49a
IR 115845-B-310	300.25bcd	802.56abc	30.15cde	87.50cde	249.83bc	1.32abcd	0.48a
IR 115845-B-388	266.87efg	764.93cdef	28.85e	76.97defg	223.68cd	1.25abcde	0.55a
IR 92801-504-B	190.28k	743.26efg	20.85g	63.46gh	232.35cd	1.50a	0.57a
IR 92801-527-B	208.42jk	695.97g	23.38f	66.01fgh	225.24cd	1.30abcde	0.58a
IR 94226-B-265	250.54ghi	842.53a	22.92fg	75.66defg	254.66bc	1.23abcdef	0.39a
IR 94226-B-364	240.64hi	810.82ab	23.70f	74.15efg	255.38bc	1.19bcdef	0.43a
IR 94226-B-419	224.43ij	745.27ef	23.55f	52.12h	198.79d	0.94f	0.44a
IR 95783-6-2-2-3	320.07ab	786.40bcde	33.98a	106.71ab	260.90bc	1.15bcdef	0.45a
IR 97041-5-1-1-2	316.56abc	817.06ab	31.84bc	86.86cde	232.05cd	1.13cdef	0.45a
IR 98976-20-1-2-1	327.45a	820.29ab	32.92ab	102.5abc	277.1ab	1.30abcde	0.49a

IR64	260.32fgh	730.83fg	28.84e	79.44defg	226.13cd	1.06def	0.45a
MTU1010	279.92def	748.20def	30.14cde	86.99cde	248.61bc	1.03ef	0.48a
UPLRi7	292.64cde	764.42cdef	32.33ab	118.19a	321.82a	1.06def	0.40a

Within each parameter of each establishment, means followed by a common letter are not significantly different by the LSD test at the 5% level of significance.

Table S5. Analysis of variance for biomass and root-related traits in the lysimeter study

Establishment	Source	Biomass	RDW_ 0-20 cm	RDW_ 20-40 cm	RDW_ 40-60 cm	Root length>60cm
DSR	Water (W)	***	NS	NS	***	***
	Genotype (G)	**	***	***	*	NS
	W × G	NS	NS	NS	NS	NS
PTR	Water (W)	***	NS	***	***	***
	Genotype (G)	**	***	NS	NS	NS
	W × G	NS	NS	NS	NS	NS

*** Significant at P < 0.001; ** significant at P < 0.01; * significant at P < 0.05; NS not significant. Root length<60cm = root length under 60 cm depth below soil; RDW_0-20 cm = root dry weight at 0-20 cm depth below soil; RDW_20-40 cm = root dry weight at 20-40 cm depth below soil; RDW_40-60 cm = root dry weight at 40-60 cm depth below soil.

Table S6. Correlations between grain yield, biomass, nitrogen use efficiency based on grain yield (NUEg), and nitrogen use efficiency based on biomass (NUEb) with root architectural plasticity based on root length density (RLD) at 15-30 and 30-45 cm depths, both determined using the same approach: Approach I Plasticity Index, Approach II Slope, Approach III AMMI (distance from the origin of PC1 vs PC2), and Approach IV Factor Analytic (absolute loading values of factor 1). These relationships were different when A) all experiments were grouped, B) puddled transplanted rice (PTR) experiments only were considered, and C) direct-seeded rice (DSR) experiments only were considered. Significant relationships are highlighted.

A. All experiments

		RLD_15-30 cm Plasticity		RLD_30-45 cm Plasticity	
	Stability	R^2	P-Value	R^2	P-Value
Approach I. Plasticity index	Grain yield	0.1121	0.189	0.0811	0.2678
	Biomass	0.0100	0.7026	0.0211	0.5775
	NUEg	0.2420	0.0449	0.0866	0.2516
	NUEb	0.0604	0.3419	0.0050	0.7885
Approach II. Slope	Grain yield	0.0169	0.8440	0.0576	0.3442
	Biomass	0.0049	0.7887	0.1521	0.1217
	NUEg	0.0324	0.4784	0.0049	0.7752
	NUEb	0.0784	0.2817	0.1156	0.1880
Approach III. AMMI	Grain yield	0.0102	0.7004	0.0540	0.3695
	Biomass	0.2266	0.0534	0.0517	0.38
	NUEg	0.1849	0.0833	0.04	0.4307
	NUEb	0.09	0.2479	0.0001	0.9796
Approach IV. Factor Analytic	Grain yield	0.0121	0.6635	0.0256	0.5357
	Biomass	0.0324	0.4956	0.0225	0.5575
	NUEg	0.0169	0.6095	0.1600	0.1143
	NUEb	0	0.9864	0.01	0.6904

B. PTR experiments only

		RLD_15-30 cm Plasticity		RLD_30-45 cm Plasticity	
		R^2	P-Value	R^2	P-Value
Approach I. Plasticity index	Grain yield	0.2384	0.0467	0.1905	0.0798
	Biomass	0.1916	0.0789	0.2568	0.0379
	NUEg	0.1050	0.2045	0.1606	0.1109
	NUEb	0.0010	0.9038	0.0562	0.3598
Approach II. Slope	Grain yield	0.0144	0.6554	0.1521	0.1198
	Biomass	0.1156	0.1835	0.2209	0.0546
	NUEg	0.0196	0.5879	0.0121	0.6715
	NUEb	0.1156	0.1754	0.2304	0.0522
Approach III. AMMI	Grain yield	0.0143	0.6476	0.0895	0.2436
	Biomass	0.0001	0.9634	0.1449	0.1318
	NUEg				
	NUEb				
Approach IV.	Grain yield	0.1024	0.2065	0.0025	0.8346

Factor Analytic	Biomass	0.1764	0.0914	0.0256	0.5430
	NUEg	0.0169	0.6192	0.0036	0.8089
	NUEb	0.0225	0.5542	0.0961	0.2250

C. DSR experiments only

		RLD_15-30 cm Plasticity		RLD_30-45 cm Plasticity	
		R^2	P-Value	R^2	P-Value
Approach I. Plasticity index	Grain yield	0.0092	0.7142	0.1063	0.2015
	Biomass	0.1255	0.163	0.0004	0.9387
	NUEg	0.0218	0.5716	0.0571	0.3557
	NUEb	0.2558	0.0383	0.0034	0.8231
Approach II. Slope	Grain yield	0.0016	0.8894	0.0441	0.4292
	Biomass	0.0400	0.4484	0.0049	0.7848
	NUEg	0.0100	0.7130	0.0016	0.8845
	NUEb	0.0196	0.6036	0.0004	0.9338
Approach III. AMMI	Grain yield	0.0278	0.5227	0.0140	0.6509
	Biomass	0.0436	0.4213	0.0683	0.3109
	NUEg				
	NUEb				
Approach IV. Factor Analytic	Grain yield	Could not be analyzed using the random structure of GxE FA			
	Biomass	0.0016	0.8909	0.0009	0.8945
	NUEg	Could not be analyzed using the random structure of GxE FA			
	NUEb	0.0081	0.7250	0.0256	0.5499

Table S7: Lysimeter root plasticity index based on root dry weight vs AMMI GY stability (PC1, PC2, and distance from origin of PC1 vs PC2) in both direct-seeded rice (DSR) and puddled transplanted rice (PTR) conditions.

		AMMI score					
		DSR			PTR		
		PC1	PC2	distance	PC1	PC2	distance
Correlation coefficient							
DSR	PlasRootDW_0-20 cm	-0.32	-0.27	0.17	-0.08	0.05	-0.06
	PlasRootDW_15-30 cm	-0.04	0.07	-0.23	-0.03	0.28	-0.36
	PlasRootDW_30-45 cm	0.17	0.1	0.07	0.27	0.2	-0.12
PTR	PlasRootDW_0-20 cm	0.03	0.23	-0.08	-0.45	0.17	0.05
	PlasRootDW_15-30 cm	-0.25	-0.01	-0.06	-0.27	0.25	0.04
	PlasRootDW_30-45 cm	-0.05	-0.02	0.21	0.1	0.04	-0.27
P-value							
DSR	PlasRootDW_0-20 cm	0.2123	0.2943	0.5139	0.7671	0.8631	0.8294
	PlasRootDW_15-30 cm	0.8690	0.7867	0.3655	0.9170	0.2807	0.1578
	PlasRootDW_30-45 cm	0.5054	0.6969	0.7907	0.2899	0.4332	0.6370
PTR	PlasRootDW_0-20 cm	0.9086	0.3721	0.7559	0.0697	0.5073	0.8397
	PlasRootDW_15-30 cm	0.3309	0.9620	0.8181	0.2966	0.3292	0.8835
	PlasRootDW_30-45 cm	0.8540	0.9463	0.4237	0.6893	0.8659	0.2902

Table S8. Yield stability and root plasticity for eight genotypes with most stable grain yield based on each approach, across all experiments except for I Plasticity index which only includes PTR (puddled transplanted) trials here. For Approaches I Plasticity Index, III AMMI (distance from the origin of PC1 vs PC2) and IV Factor Analytic (absolute loading values of factor 1), grain yield stability index values close to zero indicate that the genotype shows more stable yield, while larger root plasticity index indicates more plastic root. For Approach II Slope, grain yield stability index (slope) values less than one indicate below-average yield stability, while root plasticity index (slope) greater than one indicates above-average plasticity. The eight genotypes shown are those with the greatest degree of yield stability according to each Approach. Genotypes IR 115845-B-154, IR 115845-B-388 and UPLRi7 (in bold) were selected from those eight genotypes in each approach or more than 2 approaches as showing greater stable yield and greater root plasticity, whereas genotypes IR 94226-B-364, IR 94226-B-419 and IR64 (underlined) showed higher stable yield but less plastic root growth.

		Stability/plasticity value		
Approach	Genotype	Grain yield	RLD_15-30 cm	RLD_30-45 cm
I. Plasticity index	IR 115844-B-154	-0.6256	0.6323	0.6466
	IR 115845-B-154	-0.5902	0.6899	0.1484
	IR 115845-B-388	-0.6614	0.6538	0.4830
	IR 95783-6-2-2-3	-0.6499	0.8007	0.3674
	IR 98976-20-1-2-1	-0.6757	0.5788	0.8512
	IR64	-0.6652	0.6205	0.3424
	MTU1010	-0.6801	0.5749	0.4981
	UPLRi7	-0.5522	1.2056	0.4386
II. Slope	**IR 115845-B-154**	0.949	1.06	1.114
	IR 115845-B-388	0.92	1.061	1.446
	IR 92801-504-B	0.685	1.136	1.198
	IR 92801-527-B	0.8	0.965	1.242
	IR 94226-B-364	0.931	1.161	0.68
	IR 94226-B-419	0.851	0.543	0.806
	IR64	0.96	0.796	0.845
	UPLRi7	0.948	1.463	1.726
III. AMMI	**IR 115845-B-154**	1.7858	0.2870	0.0987
	IR 115845-B-310	4.0752	1.0699	0.6189
	IR 94226-B-265	2.8671	0.7005	0.4302
	IR 94226-B-364	2.7248	0.2253	0.2998
	IR 95783-6-2-2-3	4.7981	0.4016	0.4122
	IR64	1.9396	0.4265	0.0678
	MTU1010	1.3632	0.3978	0.2560
	UPLRi7	2.1045	0.0952	0.0102
IV. Factor analytic	IR 94226-B-364	0.3941	0.1136	0.1132
	IR 92801-527-B	1.0019	0.0959	0.0111
	IR 94226-B-265	1.7302	0.0827	0.0636
	IR 115844-B-154	2.1781	0.0427	0.0968
	IR64	2.9377	0.0159	0.001
	IR 92801-504-B	3.1512	0.08	0.0004
	MTU1010	3.3124	0.0014	0.0976
	IR 94226-B-419	3.6059	0.0988	0.037

Table S9. Physiological traits (normalized difference vegetation index (NDVI), leaf osmotic potential, and canopy temperature) of genotypes in field environments for both direct-seeded rice (DSR) and puddled-transplanted rice (PTR), with stress and nitrogen treatments grouped together. Genotypes selected as stable yielding and root plastic are shown in bold, and stable yielding, less root plastic genotypes are underlined.

	NDVI		Leaf Osmotic potential (MPa)		Canopy temp (°C)	
DSR						
IR 115844-B-154	0.574	cde	-1.731	bcd	38.38	abc
IR 115844-B-32	0.609	a	-1.725	bcd	37.46	defg
IR 115844-B-332	0.597	ab	-1.712	bc	37.57	defg
IR 115845-B-154	0.557	def	-1.708	bc	38.09	bcde
IR 115845-B-310	0.609	a	-1.768	cde	37.28	efgh
IR 115845-B-388	0.572	cde	-1.671	abc	38.92	a
IR 92801-504-B	0.580	bc	-1.847	e	38.34	abcd
IR 92801-527-B	0.613	a	-1.759	cde	38.19	abcde
IR 94226-B-265	0.598	ab	-1.762	cde	37.12	fgh
IR 94226-B-364	0.555	ef	-1.762	cde	36.86	gh
IR 94226-B-419	0.575	cd	-1.824	de	36.63	h
IR 95783-6-2-2-3	0.555	ef	-1.769	cde	37.91	bcdef
IR 97041-5-1-1-2	0.597	ab	-1.702	bc	37.29	efgh
IR 98976-20-1-2-1	0.569	cde	-1.658	ab	37.92	bcdef
IR64	0.561	cdef	-1.694	abc	38.70	ab
MTU1010	0.542	f	-1.739	bcd	38.56	ab
UPLRi7	0.578	bc	-1.601	a	37.60	cdefg
PTR						
IR 115844-B-154	0.595	bc	-1.368	bcde	34.55	b
IR 115844-B-32	0.620	ab	-1.369	bcde	34.68	ab
IR 115844-B-332	0.597	bc	-1.268	a	35.16	ab
IR 115845-B-154	0.595	bc	-1.255	a	34.85	ab
IR 115845-B-310	0.601	bc	-1.304	abc	35.07	ab
IR 115845-B-388	0.566	cd	-1.290	a	35.13	ab
IR 92801-504-B	0.576	bcd	-1.560	f	34.76	ab
IR 92801-527-B	0.587	bc	-1.395	e	35.34	ab
IR 94226-B-265	0.496	ef	-1.318	abcd	35.41	ab
IR 94226-B-364	0.438	g	-1.379	cde	34.53	b
IR 94226-B-419	0.466	fg	-1.389	de	34.99	ab
IR 95783-6-2-2-3	0.591	bc	-1.304	abc	35.35	ab
IR 97041-5-1-1-2	0.582	bc	-1.285	a	35.11	ab
IR 98976-20-1-2-1	0.591	bc	-1.320	abcd	34.95	ab
IR64	0.565	cd	-1.300	ab	35.56	a
MTU1010	0.535	de	-1.383	de	34.94	ab
UPLRi7	0.654	a	-1.446	e	35.14	ab

Within each column, means followed by a common letter are not significantly different by the LSD test at the 5% level of significance.

Table S10. Biomass and NUE of each genotype in the lysimeter trial. Genotypes IR 115845-B-154, IR 115845-B-388 and UPLRi7 (in bold) showed greater yield stability and greater root plasticity, whereas genotypes IR 94226-B-364, IR 94226-B-419 and IR64 (underlined) showed stable yield but less plastic root growth.

Genotype	Biomass (g plant^{-1})	N content (%)	N uptake (mg plant^{-1})	NUEb (g g^{-1})
DSR				
IR 115844-B-154	22.40bcd	1.30abc	291.12b	77.23fgh
IR 115844-B-32	28.56a	1.25abcde	356.78a	79.88defgh
IR 115844-B-332	20.61cd	1.24bcde	256.58bcd	80.77defg
IR 115845-B-154	20.53cd	1.29abcd	266.72bc	78.11efgh
IR 115845-B-310	23.72abc	1.28abcd	303.41ab	78.13efgh
IR 115845-B-388	22.14bcd	1.32a	292.88ab	75.89h
IR 92801-504-B	18.89cd	1.06g	201.17d	94.35a
IR 92801-527-B	19.29cd	1.29abcd	247.36bcd	77.67fgh
IR 94226-B-265	24.01abc	1.22de	290.73b	82.61de
IR 94226-B-364	26.98ab	1.14f	304.94ab	88.58bc
IR 94226-B-419	27.35ab	1.13fg	305.11ab	89.01b
IR 95783-6-2-2-3	23.91abc	1.29abc	311.05ab	77.70fgh
IR 97041-5-1-1-2	23.65abc	1.23cde	292.64ab	81.87def
IR 98976-20-1-2-1	22.24bcd	1.31ab	292.51ab	76.92gh
IR64	22.61bcd	1.28abcd	288.06bc	78.27efgh
MTU1010	17.64d	1.28abcd	225.00cd	78.04efgh
UPLRi7	24.07abc	1.20ef	286.20bc	84.01cd
PTR				
IR 115844-B-154	17.93cde	1.29b	231.17abcd	77.97fg
IR 115844-B-32	20.76abc	1.30b	269.85a	77.55fg
IR 115844-B-332	18.56bcde	1.28bc	234.51abcd	78.84ef
IR 115845-B-154	15.94de	1.28bc	200.65d	78.74ef
IR 115845-B-310	22.63ab	1.2cde	266.56ab	85.10bcd
IR 115845-B-388	19.84bcd	1.24bcd	244.97abcd	81.78cdef
IR 92801-504-B	18.12cde	1.12ef	199.58d	89.72ab
IR 92801-527-B	15.38e	1.40a	212.50bcd	72.05g
IR 94226-B-265	17.96cde	1.30b	234.34abcd	77.37fg
IR 94226-B-364	20.23bc	1.20cde	239.42abcd	84.23bcde
IR 94226-B-419	24.94a	1.08f	257.92abc	94.17a
IR 95783-6-2-2-3	17.34cde	1.27bc	221.07abcd	80.05def
IR 97041-5-1-1-2	16.95cde	1.26bc	214.03bcd	79.55def
IR 98976-20-1-2-1	18.10cde	1.31ab	238.65abcd	76.39fg
IR64	20.52bc	1.28bc	262.57abc	78.38ef
MTU1010	16.64cde	1.28bc	209.98cd	79.21def
UPLRi7	20.22bc	1.15def	231.35abcd	87.07bc

Within each column, means followed by a common letter are not significantly different by the LSD test at the 5% level of significance.

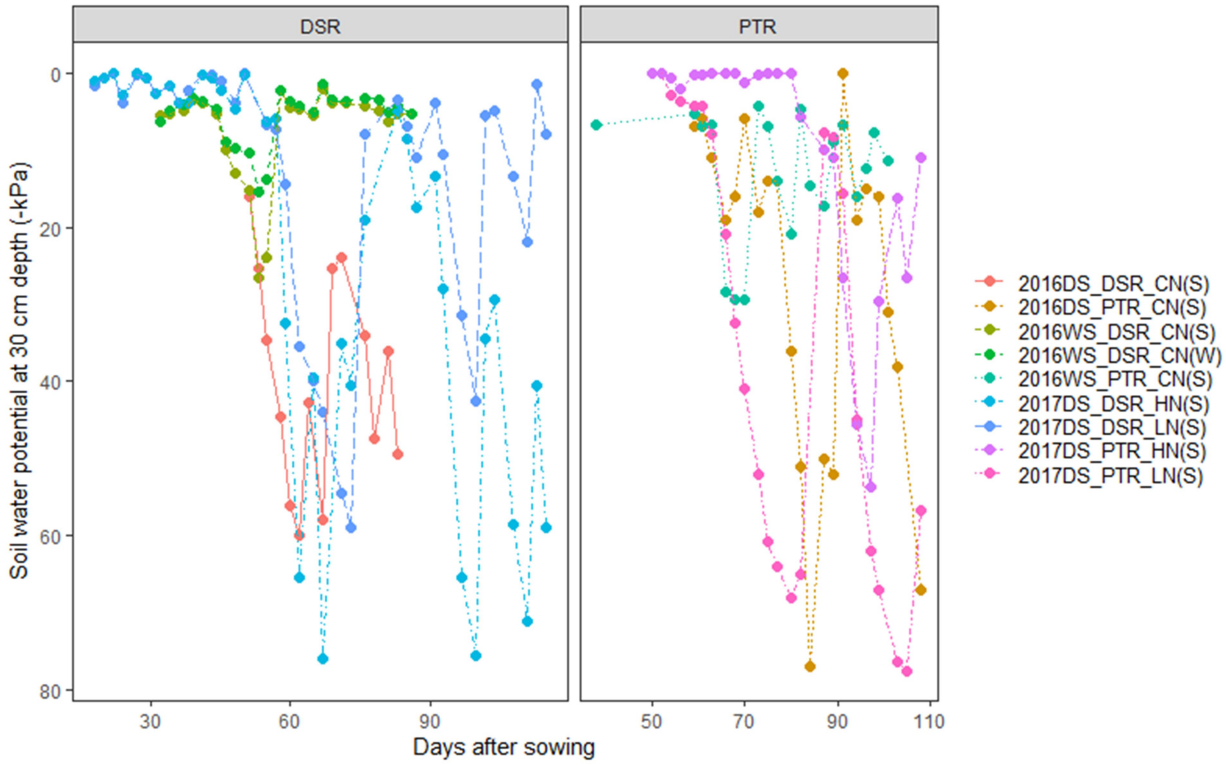

Fig. S1. Soil water potential was measured at a depth of 30 cm in the stress experiments of both direct-seeded rice (DSR) and puddled transplanted rice (PTR), as well as in the well-watered DSR experiment in 2016WS.

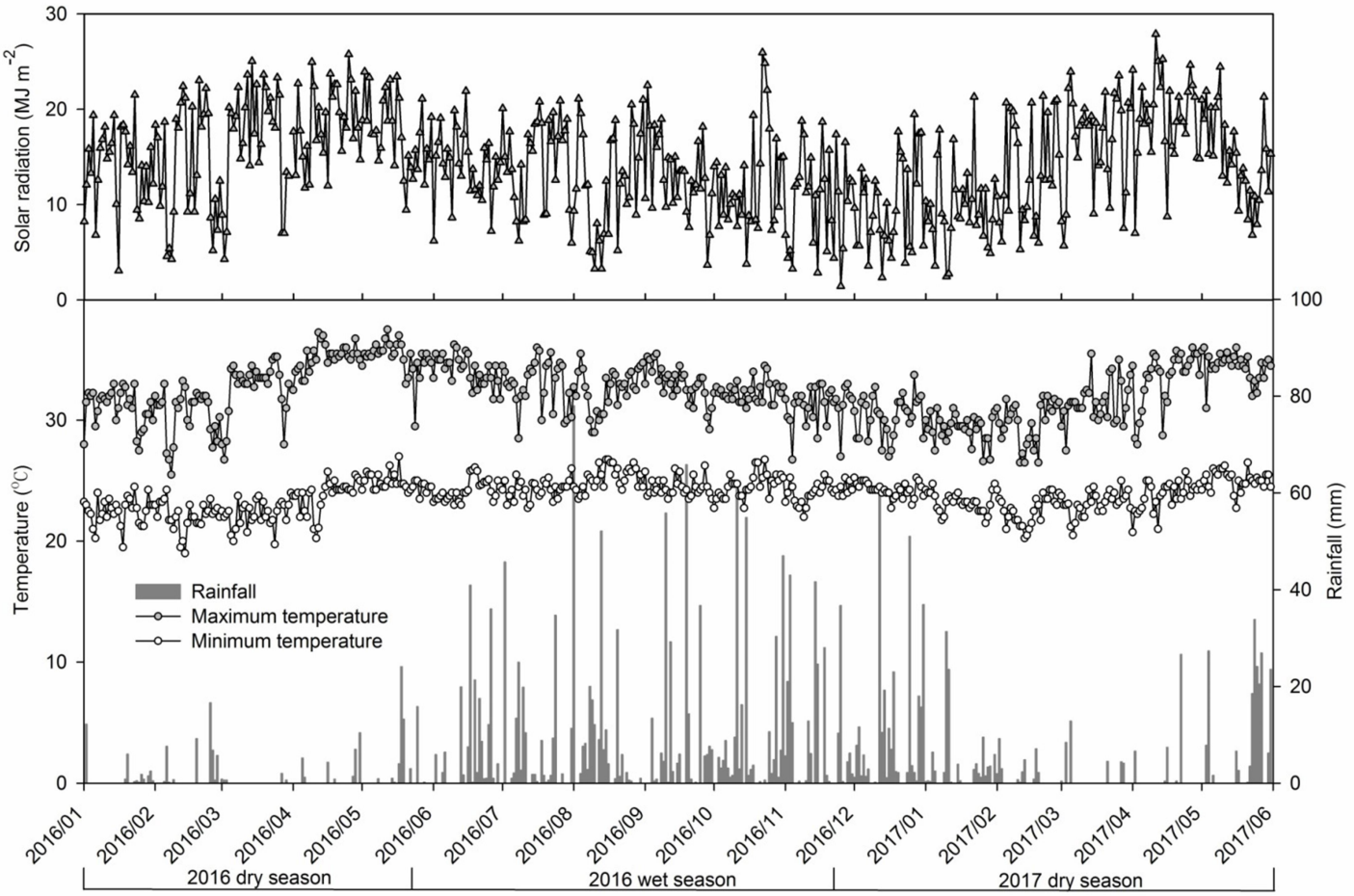

Fig. S2. Solar radiation, maximum and minimum temperature, and rainfall across the field experiments in this study.

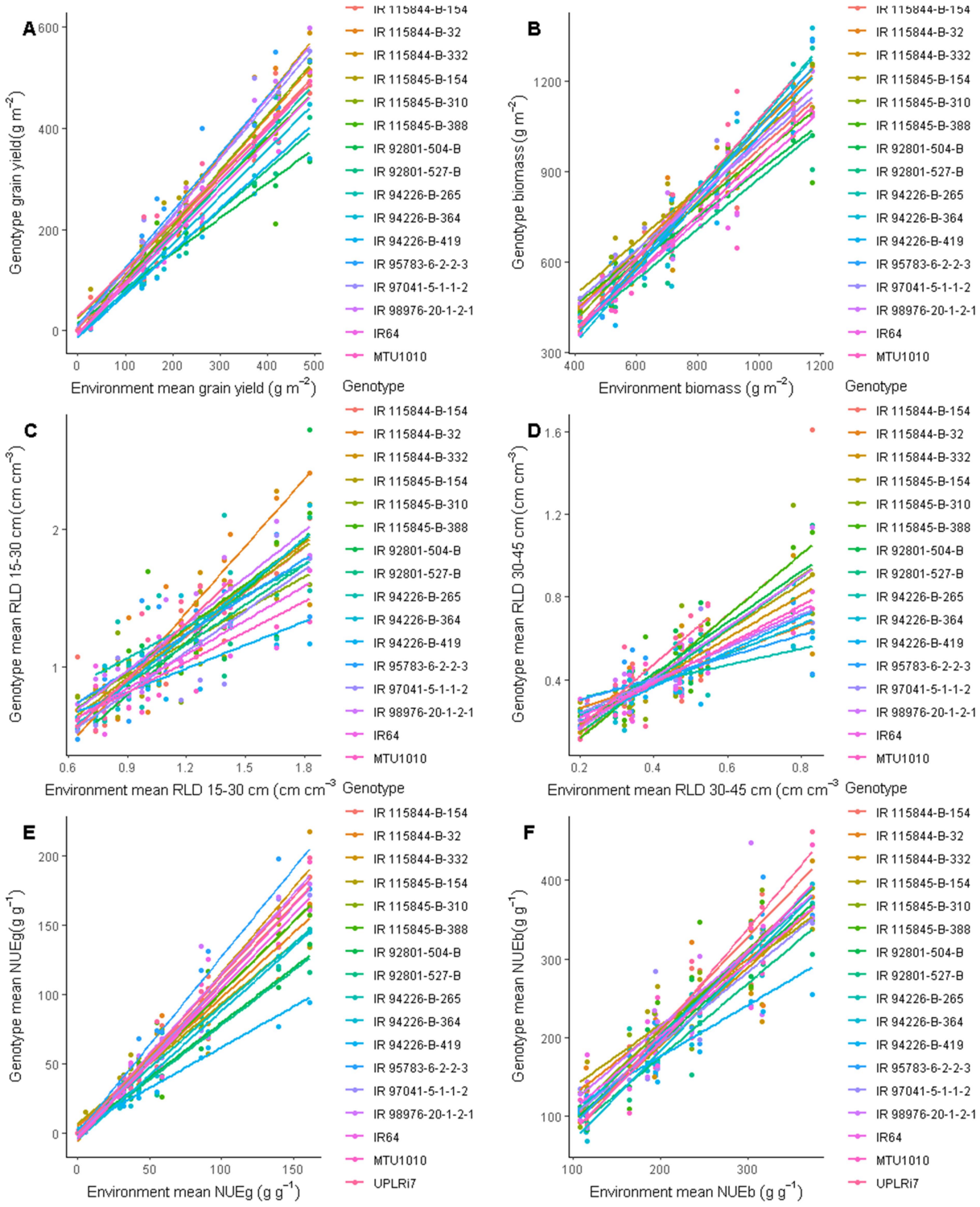

Fig S3. Genotypic means of grain yield, biomass, root length density (RLD) 15-30 cm, RLD 30-45 cm, nitrogen use efficiency based on grain yield (NUEg), and nitrogen use efficiency based on biomass (NUEb) as a function of the mean value in each environment. The slopes of these linear regressions were used as the stability/plasticity index for Approach II Slope.

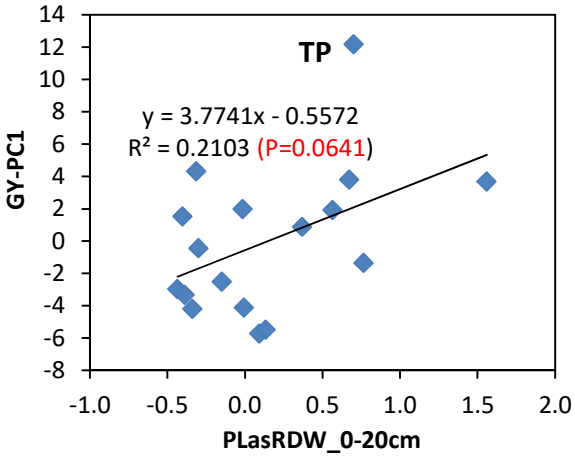

Fig S4. AMMI grain yield stability (PC1) vs. lysimeter root plasticity index at the most shallow depth sampled (0-20 cm).

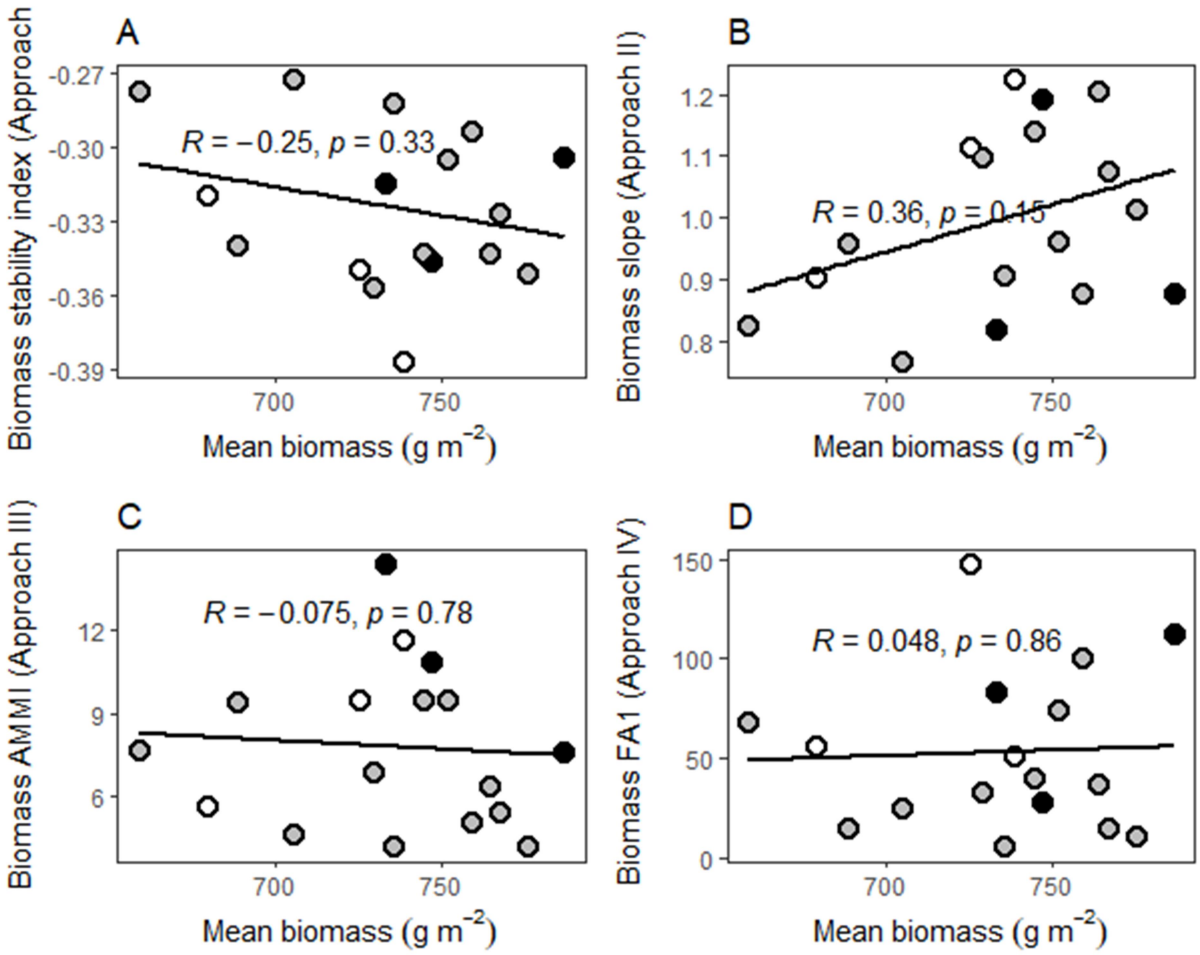

Fig S5. Linear regression between biomass and biomass stability index based on four approaches: I. Plasticity Index (A), II. Slope (B), AMMI (distance from the origin of PC1 vs PC2) (C) and Factor Analytic (absolute loading values of factor 1) (D).

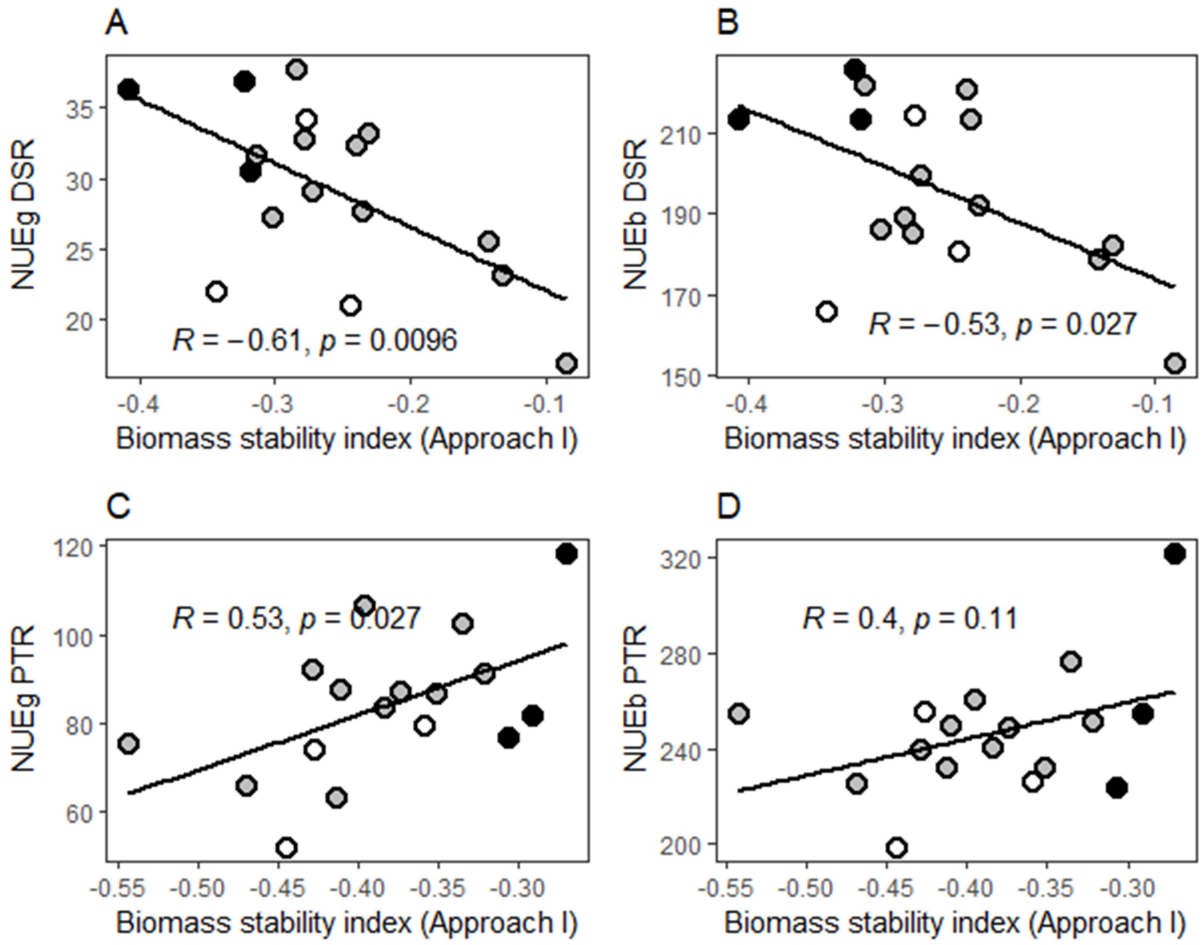

Fig S6. Correlations of NUEg (grain yield/N uptake; A,C) and NUEb (biomass/N uptake; B,D) with biomass stability of each genotype based on Approach I Plasticity Index for direct seeded (A,B) and puddled transplanted (C,D) rice across environments.

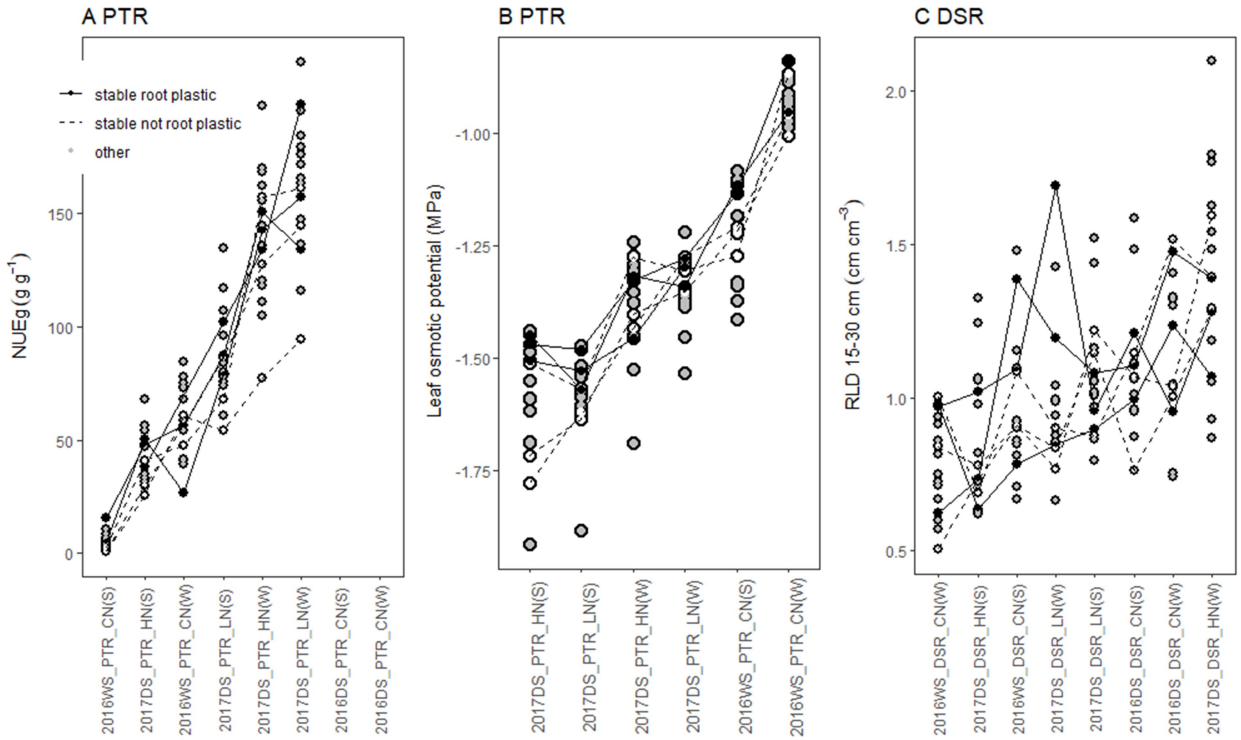

Fig S7. Counterpart to the establishment methods and treatments shown in Fig 5 comparing genotypes with stable yield and more plastic root growth (IR 115845-B-154, IR 115845-B-388 and UPLRi7), genotypes with stable yield but less plastic root growth (IR 94226-B-364, IR 94226-B-419 and IR64). Under puddled transplanted rice (PTR): A) nitrogen use efficiency (NUEg), and B) leaf osmotic potential. Under direct-seeded rice (DSR): C) root length density (RLD) at 15-30 cm depth. Genotypic comparisons are shown in Tables S4 and S9.

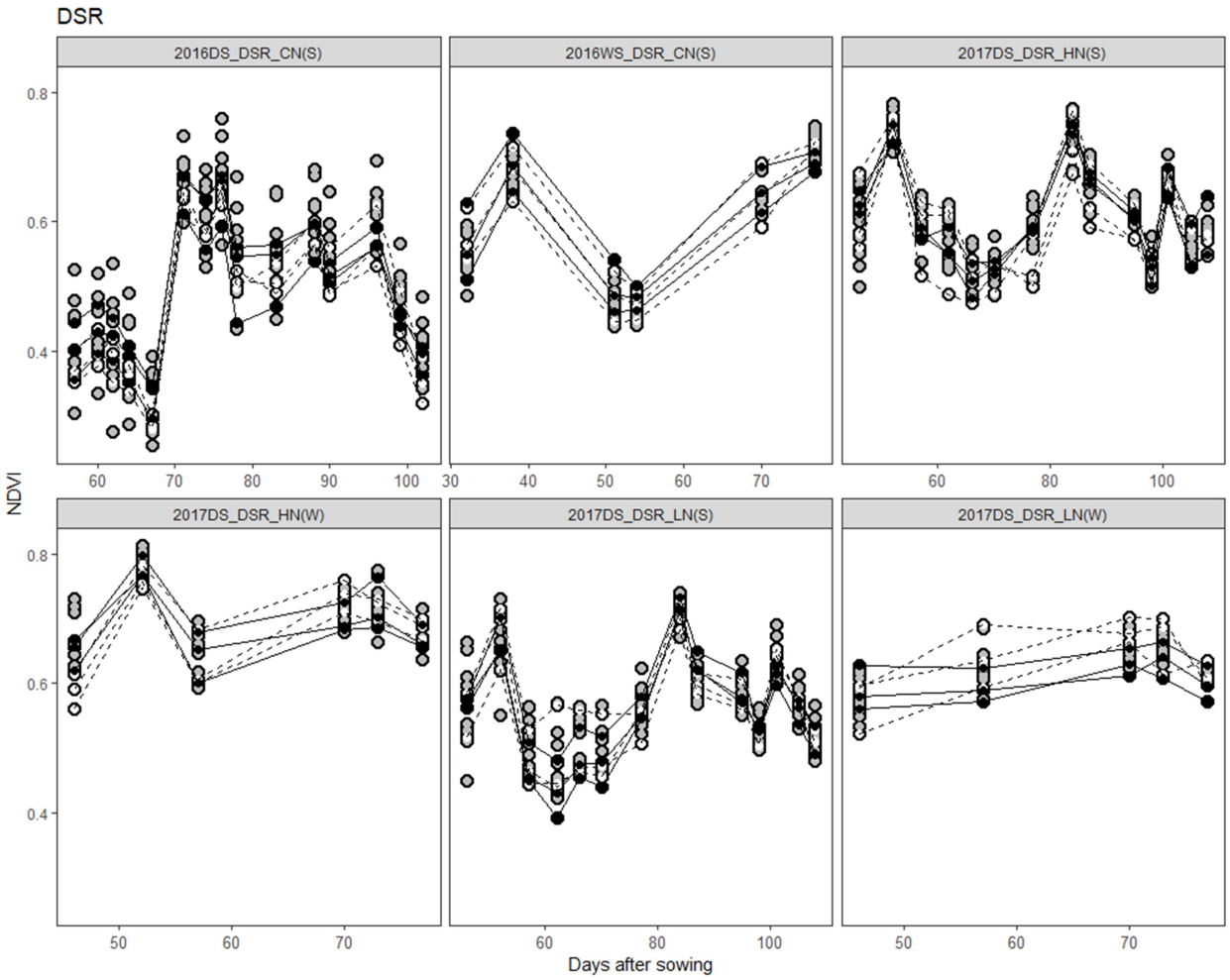

Fig. S8. Normalized difference vegetation index (NDVI) measured in direct-seeded rice (DSR) experiments. Genotypes with stable yield and more plastic root growth (IR 115845-B-154, IR 115845-B-388 and UPLRi7) are indicated by solid lines and genotypes with stable yield but less plastic root growth (IR 94226-B-364, IR 94226-B-419 and IR64) are indicated with dashed lines. Genotypic comparisons are shown in Table S9.

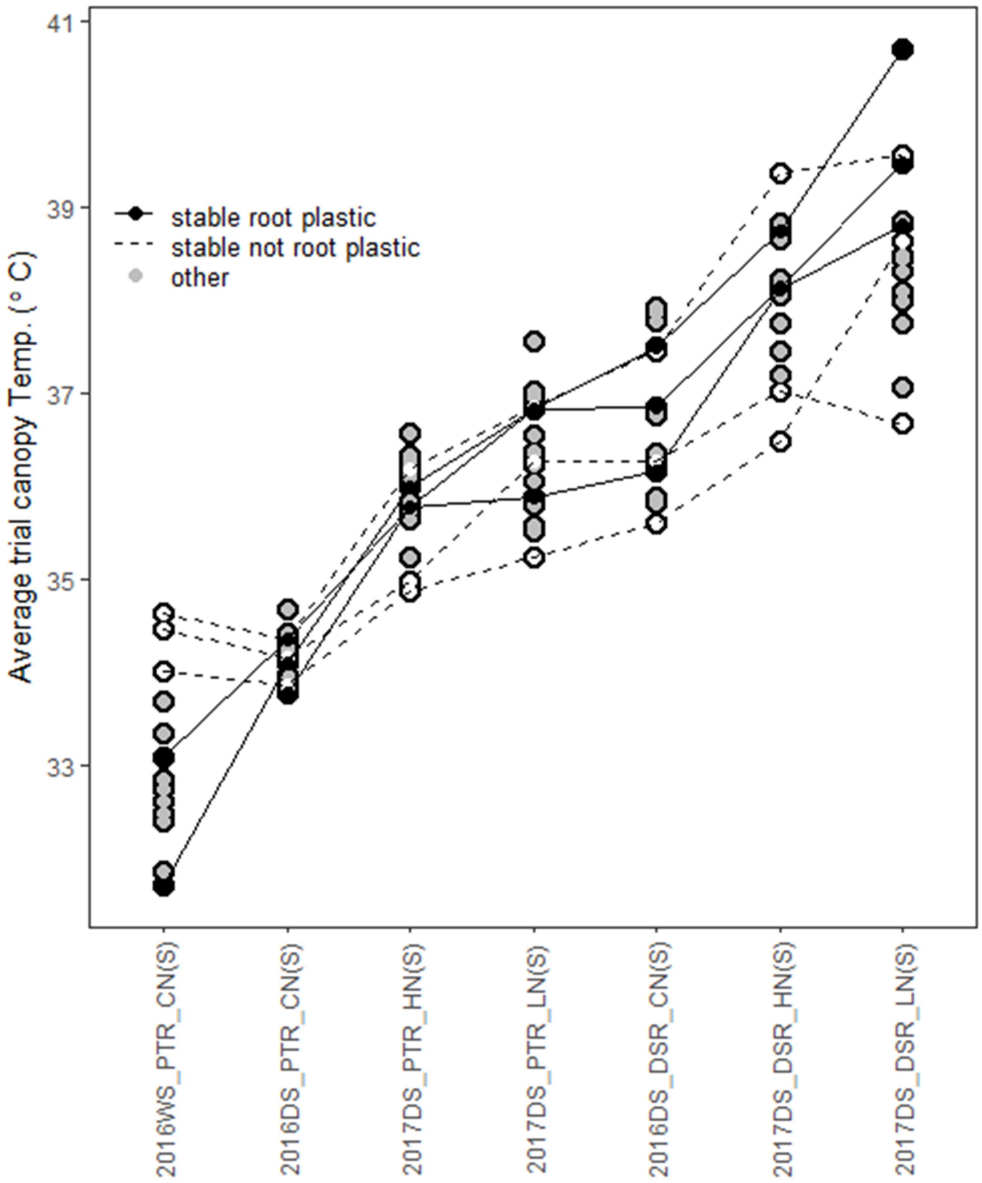

Fig. S9. Average canopy temperature in each trial. Genotypic comparisons are shown in Table S9.

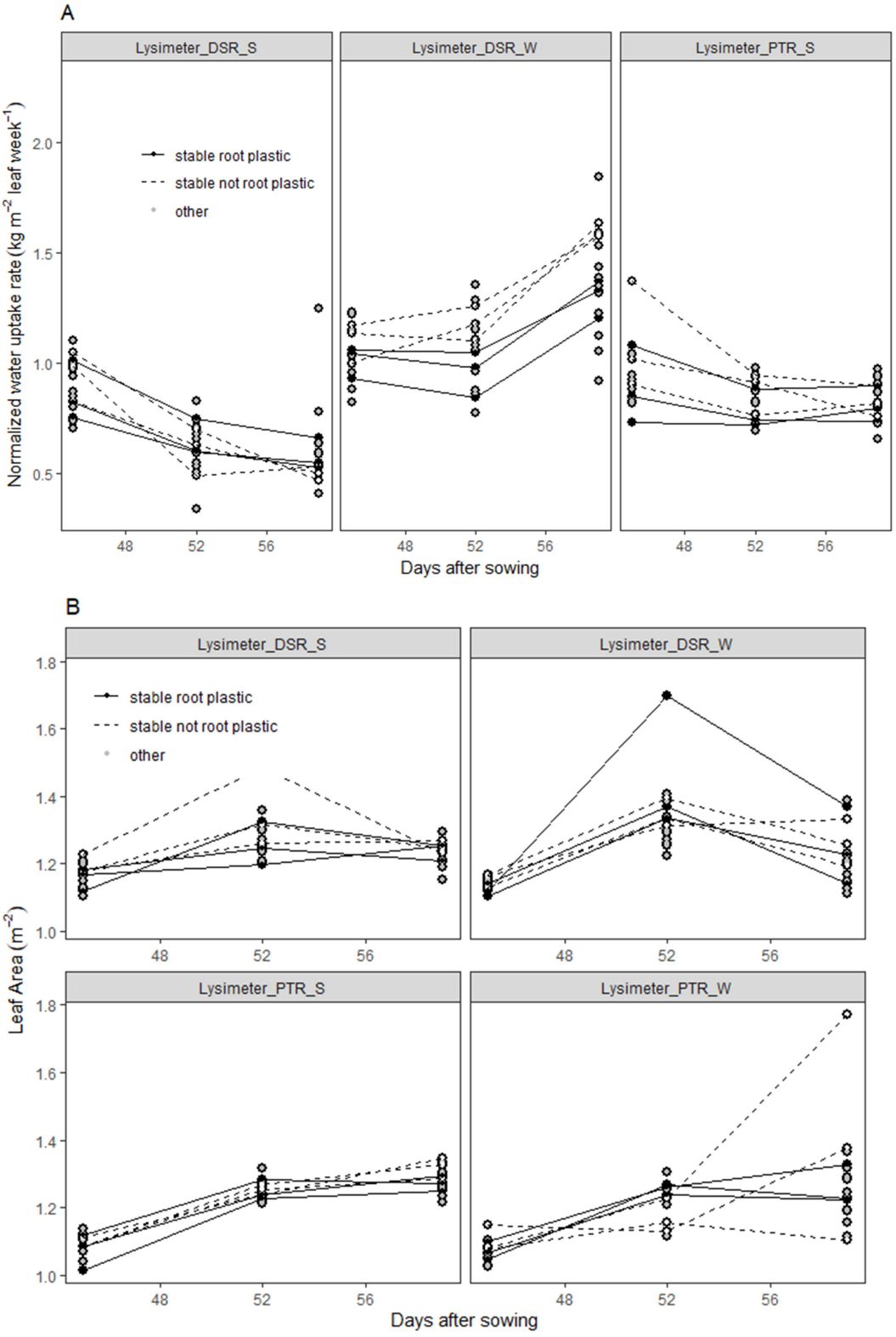

Fig. S10. Greenhouse lysimeter study results: A) normalized water uptake rates and B) apparent leaf area.

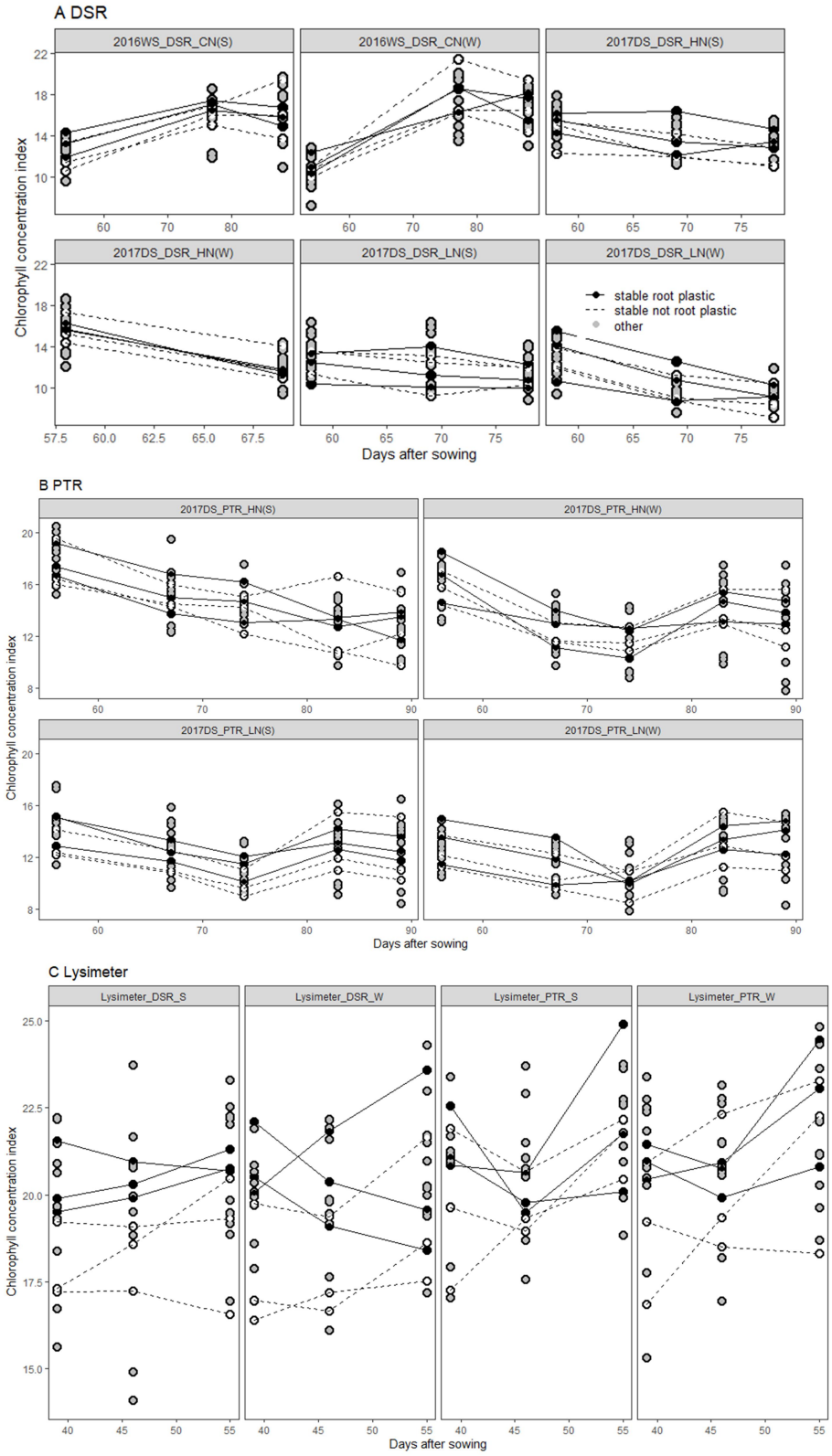

Fig. S11. Chlorophyll concentration index across trials in A) DSR treatments, B) PTR treatment and C) in the greenhouse lysimeter study.

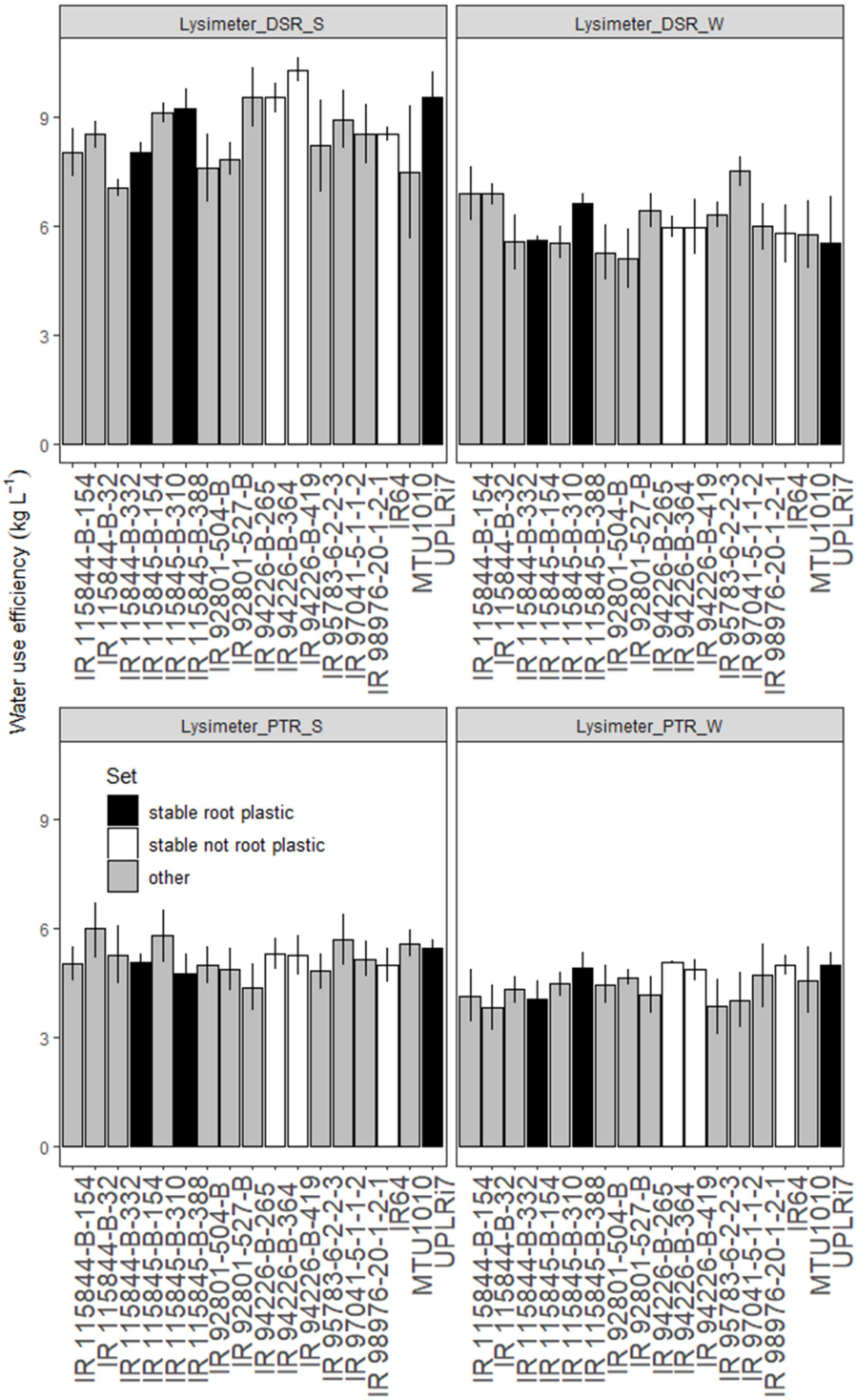

Fig. S12. Water use efficiency (shoot biomass/total water uptake) in the greenhouse lysimeter study.

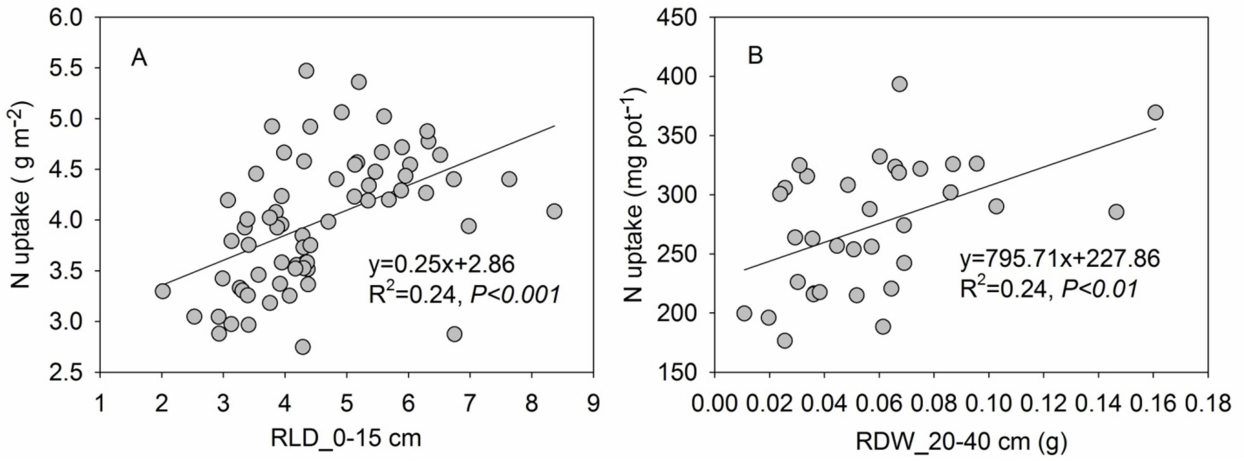

Fig S13. Linear regression of N uptake with shallow roots based on root length density at the 0-15 cm depth (A) in well water and drought stress treatments of two establishments in the field trials and with deeper roots based on root dry weight at 20-40 cm (B) in drought stress treatment of two establishments in the lysimeter trial.