Table S1. Scale for seedling vigor (SES).

Score	Remarks
1	Extra vigorous
3	Vigorous
5	Normal
7	Weak
9	Very weak

Table S2. The detailed information on the 106 KASP assays used for molecular characterization of the breeding panel (adapted and modified from Sandhu et al., 2022).

SNP ID	Chr	MSU7 position (bp)	*QTL /gene*	Reference allele	Positive allele	Negative trait	Positive trait
K_1594302	6	1594302	*BPH3*	A	G	Susceptible	Resistant
K_1606487	6	1606487	*BPH3*	C	T		
K_1631244	6	1631244	*BPH3*	A	G		
K_1637921	6	1637921	*BPH3*	A	G		
K_1693594	6	1693594	*BPH3*	G	A		
K_1738798	6	1738798	*BPH3*	C	A		
K_5382269	4	5382269	*BPH17*	G	C		
K_5650499	4	5650499	*BPH17*	T	C		
K_5847738	4	5847738	*BPH17*	C	G		
K_6336060	4	6336060	*BPH17*	G	A		
K_5585652	8	5585652	*Gm4*	C	T		
K_5585772	8	5585772	*Gm4*	G	A		
K_5585944	8	5585944	*Gm4*	G	A		
K_5585994	8	5585994	*Gm4*	G	T		
K_5586508	8	5586508	*Gm4*	C	T		
K_10607281	12	10607281	*Pita2*	T	C		
K_27030975	11	27030975	*Xa4*	T	A		
K_27183490	11	27183490	*Xa4*	G	A		
K_27357030	11	27357030	*Xa4*	C	T		
K_27413024	11	27413024	*Xa4*	T	C		
K_27468611	11	27468611	*Xa4*	C	T		
K_27489986	11	27489986	*Xa4*	G	T		
K_27553861	11	27553861	*Xa4*	C	T		
K_27584500	11	27584500	*Xa4*	G	A		
K_27606117	11	27606117	*Xa4*	C	A		
K_437375	5	437375	*xa5*	G	T		
K_438206	5	438206	*xa5*	C	T		
K_438578	5	438578	*xa5*	C	T		
K_439616	5	439616	*xa5*	G	A		
K_441684	5	441684	*xa5*	T	C		
K_21274518	11	21274518	*Xa21*	A	G		
K_21276435	11	21276435	*Xa21*	T	C		
K_26727222	8	26727222	*xa13*	G	C		
K_31579287	4	31579287	*Xa38*	T	C		
K_31579822	4	31579822	*Xa38*	T	C		
K_31580379	4	31580379	*Xa38*	T	A		
K_12253431	9	12253431	*qAG*$_{9.1}$	T	C	no/very low germination under anaerobic conditions	good germination under anaerobic conditions
K_12253887	9	12253887	*qAG*$_{9.1}$	A	G		
K_1198917	5	1198917	*qNR*$_{5.1}$	T	C	less number of nodal roots	more number of nodal roots
K_1296530	5	1296530	*qNR*$_{5.1}$	A	G		
K_1688209	5	1688209	*qNR*$_{5.1}$	G	A		
K_1888209	5	1888209	*qNR*$_{5.1}$	C	A		
K_5786391	4	5786391	*qNR*$_{4.1}$	T	G		
K_5787060	4	5787060	*qNR*$_{4.1}$	A	T		

K_5787840	4	5787840	*qNR4.1*	C	G		
K_5819155	4	5819155	*qNR4.1*	C	T		
K_6494690	4	6494690	*qNR4.1*	T	C		
K_6941654	4	6941654	*qNR4.1*	C	T		
K_7154131	4	7154131	*qNR4.1*	G	A		
K_7073586	1	7073586	*qRHD1.1*	G	T	Sparse root hairs	Dense root hairs
K_7081184	1	7081184	*qRHD1.1*	C	T		
K_8791450	1	8791450	*qRHD1.1*	A	G		
K_8855279	1	8855279	*qRHD1.1*	T	C		
K_8887013	1	8887013	*qRHD1.1*	C	T		
K_8935224	1	8935224	*qRHD1.1*	G	T		
K_15997367	5	15997367	*qRHD5.1*	A	G		
K_2086213	8	2086213	*qRHD8.1*	G	T		
K_9653331	2	9653331	*qDTY2.1*	A	T	yield penalty under reproductive stage drought stress	Improved yield under reproductive stage drought stress
K_9780606	2	9780606	*qDTY2.1*	C	A		
K_30279242	3	30279242	*qDTY3.1*	G	T		
K_30270860	3	30270860	*qDTY3.1*	G	A		
K_30738342	3	30738342	*qDTY3.1*	G	C		
K_30796109	3	30796109	*qDTY3.1*	T	A		
K_30821108	3	30821108	*qDTY3.1*	T	C		
K_17464660	12	17464660	*qDTY12.1*	G	A		
K_17486676	12	17486676	*qDTY12.1*	C	T		
K_17489337	12	17489337	*qDTY12.1*	T	C		
K_17537562	12	17537562	*qDTY12.1*	G	T		
K_39538807	1	39538807	*qGY1.1*	G	T	low yield under DSR	Improved yield under DSR
K_39538868	1	39538868	*qGY1.1*	C	T		
K_39610271	1	39610271	*qGY1.1*	T	G		
K_39612639	1	39612639	*qGY1.1*	G	T		
K_16734396	10	16734396	*qGY10.1*	T	C		
K_18666765	10	18666765	*qGY10.1*	A	G		
K_18703848	10	18703848	*qGY10.1*	C	T		
K_18734396	10	18734396	*qGY10.1*	T	C		
K_18749935	10	18749935	*qGY10.1*	T	C		
K_18797856	10	18797856	*qGY10.1*	A	T		
K_18901381	10	18901381	*qGY10.1*	G	A		
K_19779370	10	19779370	*qGY10.1*	C	G		
K_19909715	10	19909715	*qGY10.1*	G	A		
K_20036149	10	20036149	*qGY10.1*	C	T		
K_456591	3	456591	*qLDG3.1*	G	A	susceptible to lodging	resistant to lodging
K_499461	3	499461	*qLDG3.1*	T	C		
K_610549	3	610549	*qLDG3.1*	C	G		
K_648480	3	648480	*qLDG3.1*	T	C		
K_673659	3	673659	*qLDG3.1*	T	C		
K_767400	3	767400	*qLDG3.1*	G	A		
K_1029593	3	1029593	*qLDG3.1*	T	C		
K_1083767	3	1083767	*qLDG3.1*	C	T		
K_1111246	3	1111246	*qLDG3.1*	G	C		
K_1179119	3	1179119	*qLDG3.1*	G	C		
K_1298111	3	1298111	*qLDG3.1*	C	T		
K_16279477	4	16279477	*qLDG4.1*	T	A		
K_16402594	4	16402594	*qLDG4.1*	G	A		
K_17734727	4	17734727	*qLDG4.1*	G	A		

K_18522689	4	18522689	*qLDG4.1*	G	A		
K_19027599	4	19027599	*qLDG4.1*	T	G		
K_19221785	4	19221785	*qLDG4.1*	C	T		
K_19760969	4	19760969	*qLDG4.1*	G	A		
K_264232	1	264232	*qEUE1.1*	C	T	poor emergence	early and uniform emergence
K_628981	1	628981	*qEUE1.1*	C	T		
K_728679	1	728679	*qEUE1.1*	G	T		
K_742759	1	742759	*qEUE1.1*	T	C		
K_780655	1	780655	*qEUE1.1*	G	T		
K_788995	1	788995	*qEUE1.1*	T	A		
K_4033148	11	4033148	*qEUE11.1*	C	T		
K_4974371	11	4974371	*qEUE11.1*	T	C		
K_5786143	11	5786143	*qEUE11.1*	C	T		
K_6581858	11	6581858	*qEUE11.1*	A	G		

Table S3. Mean performance of genotypes under DSR for morpho-physiological and quality traits.

Designation	DTF	TN	PH	YLD	SPAD	TGW	TRR	MRR	HRR	FER%	RL	AD	RV	S A	Tips	Forks	Crossings	RSR L	RSR B	SV
PAU 7180-36-5-0-0-0	101	322	90	4315.00	41	25.30	80.49	72.02	65.65	92	1187.09	0.33	0.68	88.04	7193	20774	6340	0.42	0.27	3
PAU 7180-8-13-0-0-0	110	313	90	5338.38	36	25.55	79.95	72.81	66.51	87	1684.37	0.37	1.19	134.17	10157	29064	7835	0.42	0.43	3
PAU 7180-9-17-0-0-0	102	284	98	5948.22	39	27.48	81.66	70.55	56.30	91	1332.40	0.35	0.87	101.92	8744	23784	7287	0.37	0.35	3
PAU 7180-3-9-0-0-0	108	308	88	5793.81	35	23.08	80.32	72.74	65.19	90	1268.83	0.36	0.79	91.54	8156	22211	5382	0.39	0.39	5
PAU 7180-3-15-0-0-0	108	254	84	5352.17	35	21.80	81.60	71.17	62.56	85	1029.50	0.34	0.62	75.32	7526	18728	4705	0.36	0.38	3
PAU 7180-4-2-0-0-0	110	326	86	5350.51	36	24.43	80.10	71.32	62.37	88	1167.81	0.36	0.83	88.75	8709	20427	6215	0.39	0.44	3
PAU 7180-113-14-0-0-0	105	332	91	4791.82	40	22.97	79.84	71.21	61.19	79	1260.74	0.32	0.78	99.61	13040	28646	10035	0.39	0.38	5
PAU 7180-5-14-0-0-0	108	316	91	5297.04	36	24.05	78.76	71.44	59.73	89	1336.39	0.33	0.83	99.81	10706	25969	8691	0.40	0.41	3
PAU 7180-9-15-0-0-0	110	330	88	4987.07	35	24.12	81.33	71.54	63.32	89	956.61	0.32	0.56	70.01	8194	18332	5998	0.38	0.45	3
PAU 5187-RIL1649-F8	99	228	97	6296.48	40	22.27	78.17	68.73	44.39	89	1066.34	0.33	0.46	53.91	11805	21124	10980	0.41	0.40	3
PAU 5567-32-3-1-5	98	256	114	5395.87	33	24.68	79.59	68.48	53.19	88	665.16	0.35	0.52	50.53	5388	9674	2973	0.32	0.34	5
PAU 5729-60-5-4-1	96	259	98	5421.52	36	21.38	79.65	68.00	54.25	89	2744.45	0.31	0.82	116.55	24431	50088	24496	0.40	0.38	5
RP 6273-HHZ4-DT3-LI1-LI1	88	238	98	4945.94	35	18.70	79.18	67.71	30.82	94	1943.96	0.33	0.66	92.87	25223	42535	21352	0.36	0.38	3
RP 6314-GSR IR 1-DQ 150-R5-Y1	92	251	102	4463.51	32	20.12	80.54	66.38	33.49	89	1857.78	0.34	0.99	129.84	19442	40941	14964	0.36	0.37	5
NVSR 2107	95	220	115	5498.57	38	31.15	80.85	71.13	34.45	90	2090.10	0.33	0.86	124.54	27465	49785	22970	0.59	0.55	3
PAU 6778-12-1-4-1-1	94	270	111	5422.08	35	19.43	80.95	68.17	48.94	88	1821.69	0.32	0.94	127.63	22086	42351	16854	0.36	0.39	3
PAU 6456-8-1-1-1-3	97	250	104	6077.37	38	25.18	80.86	69.46	51.05	92	1921.01	0.32	1.11	144.47	20345	42305	15822	0.37	0.51	3
PAU 6456-8-2-1-1-1	98	260	100	6503.83	37	25.78	79.90	69.98	53.93	93	1763.64	0.32	0.95	122.14	21608	37783	13468	0.42	0.42	3
PAU 6456-8-2-1-1-2	100	256	99	5758.21	40	26.50	80.62	69.14	45.66	93	1784.71	0.31	0.78	111.86	22394	38319	14359	0.36	0.50	3
PAU 5533-56-3-1-2-3-1-2	96	276	111	2851.80	36	21.47	78.75	69.08	55.10	90	2264.50	0.35	0.87	130.12	25032	48587	17782	0.35	0.44	5
PAU 5533-56-3-1-3-1-1-1	94	263	108	5231.56	36	23.93	79.11	69.06	43.57	95	1982.81	0.33	0.91	127.43	23284	42118	14202	0.33	0.34	3
CR 4116-3-2-1-1-1	102	254	112	4922.28	36	25.02	81.89	71.40	41.93	81	1908.02	0.35	1.04	126.01	19651	37596	12193	0.31	0.29	3
PR 121	107	308	85	4238.23	40	22.37	81.81	71.38	64.25	91	1656.70	0.34	0.82	110.52	17015	33187	10950	0.36	0.38	3
PR 126	88	286	97	5412.15	33	21.03	79.67	69.47	56.71	92	1903.20	0.32	0.78	112.43	22168	39862	15974	0.38	0.35	3
PAU 9562-1-1	106	318	99	4296.33	37	23.00	81.04	68.90	52.53	85	1828.36	0.33	0.96	132.40	16271	37821	10137	0.38	0.40	3
PAU 9562-2-1	102	310	104	4990.86	39	21.83	78.12	68.40	55.59	88	1907.32	0.32	0.74	110.42	23584	47110	19743	0.37	0.35	3
PAU 9562-3-1	103	295	99	4525.96	38	23.98	79.10	67.89	47.72	70	1245.78	0.37	0.67	77.32	8647	20490	6730	0.41	0.37	1
PAU 7180-36-5-0-0-0	107	305	97	3451.43	34	21.68	79.96	68.83	58.63	82	1359.58	0.33	0.93	108.65	12617	28007	10284	0.42	0.29	3
PAU 7180-8-13-0-0-0	98	279	109	3870.19	35	21.95	79.64	65.77	28.48	82	1111.00	0.36	0.67	79.04	8339	21263	6549	0.34	0.32	3

PAU 7180-9-17-0-0-0	100	311	94	1720.57	36	22.10	78.68	65.69	54.24	73	1279.02	0.34	0.75	92.75	11780	27193	8923	0.34	0.34	3
PAU 7180-3-9-0-0-0	97	325	88	3156.48	35	18.73	81.59	67.76	57.14	74	1693.66	0.33	0.61	77.10	10828	24244	9394	0.37	0.37	3
PAU 7180-3-15-0-0-0	98	243	100	3123.69	36	19.90	80.41	63.07	35.83	78	1261.51	0.39	1.08	107.20	9340	23898	7348	0.38	0.31	3
PAU 7180-4-2-0-0-0	99	278	112	3383.39	32	25.02	79.85	69.76	34.96	83	1104.30	0.39	0.87	86.57	6759	18703	5477	0.31	0.49	3
PAU 7180-113-14-0-0-0	100	309	100	2969.56	35	23.65	79.82	56.18	35.99	78	1242.59	0.36	0.91	102.18	9916	26026	8798	0.40	0.44	3
PAU 7180-5-14-0-0-0	106	278	132	1983.77	36	17.95	79.49	51.34	57.87	77	1535.12	0.38	0.85	108.48	9632	30137	8618	0.42	0.43	3
PAU 7180-9-15-0-0-0	98	286	85	3074.39	39	22.89	79.30	63.39	44.40	75	1378.16	0.34	0.68	82.59	6908	18912	5774	0.39	0.35	3

DTF: days to 50% flowering (days), TN: tiller number (m^{-2}), PH: plant height (cm), YLD: yield (kg ha^{-1}), SPD: Soil Plant Analysis Development Meter Value (nmol cm^{-1}), TGW: thousand grain weight (gm), TRR: total rice recovery (%), MRR: milled rice recovery (%), HRR: head rice recovery (%), FER %: Spikelet fertility (%), RL: root length (cm), AD: average diameter (mm), RV: root volume (cm^3), RSR L: root shoot ratio (length), RSR B: root shoot ratio (biomass), SV: seedling vigor.

Table S4: Mean performance of genotypes under TPR for morpho-physiological and quality traits.

SR NO	DTF	TN	PH	YLD	SPAD	TGW	TRR	MRR	HRR	FER%	RL	AD	RV	S A	Tips	Forks	Crossings	RSR L	RSR B	SV
PAU 7180-36-5-0-0-0	106	318	95	5452.25	39	25.20	79.78	52.49	65.52	90	989.42	0.40	0.99	114.75	7691	24155	16407	0.43	0.23	3
PAU 7180-8-13-0-0-0	106	333	95	6710.59	40	29.37	78.91	54.14	63.90	88	1395.31	0.43	1.56	140.34	10728	31546	21601	0.32	0.28	3
PAU 7180-9-17-0-0-0	104	311	100	6412.15	38	27.72	81.00	54.36	58.92	93	1235.30	0.36	1.32	125.43	9301	26788	18317	0.39	0.29	3
PAU 7180-3-9-0-0-0	108	314	93	5741.60	38	30.18	79.67	54.93	60.13	88	1189.79	0.37	1.41	122.59	9440	25593	16748	0.37	0.28	5
PAU 7180-3-15-0-0-0	107	300	94	6186.94	36	27.32	80.94	54.13	61.05	85	968.34	0.36	0.97	115.97	7932	20427	13770	0.35	0.29	3
PAU 7180-4-2-0-0-0	109	305	93	5864.29	39	28.08	79.69	53.89	59.74	89	1101.01	0.33	1.04	101.70	8876	20970	14538	0.33	0.24	5
PAU 7180-113-14-0-0-0	109	339	95	6586.65	39	25.52	79.77	52.64	61.85	81	1199.52	0.39	1.32	161.01	12911	28390	20687	0.39	0.25	5
PAU 7180-5-14-0-0-0	105	291	98	6493.06	36	28.97	78.17	53.57	61.40	87	1179.05	0.44	1.37	135.51	10600	27064	19706	0.37	0.28	3
PAU 7180-9-15-0-0-0	110	288	95	5867.28	37	29.57	80.71	55.14	62.92	85	900.89	0.39	1.27	131.53	8417	21160	14169	0.35	0.30	3
PAU 5187-RIL1649-F8	105	277	100	6718.90	41	25.13	77.46	51.30	62.63	87	926.62	0.35	1.08	115.89	13766	25539	19097	0.37	0.22	3
PAU 5567-32-3-1-5	100	253	108	6575.50	35	25.85	79.17	52.51	54.45	88	577.94	0.40	1.24	88.42	5451	11734	7314	0.30	0.25	1
PAU 5729-60-5-4-1	100	285	98	6383.59	37	23.58	78.52	51.05	60.78	91	1718.49	0.39	1.39	151.47	24593	50427	40321	0.40	0.30	3
RP 6273-HHZ4-DT3-LI1-LI1	92	262	106	6581.45	38	20.88	77.97	49.43	56.37	94	1659.24	0.36	1.25	126.82	26378	44549	35484	0.31	0.24	3
RP 6314-GSR IR 1-DQ 150-R5-Y1	100	261	106	6652.89	37	28.20	80.31	54.26	56.56	88	1660.32	0.43	1.61	152.61	19030	41200	30871	0.34	0.32	3
NVSR 2107	94	272	121	7182.57	39	32.68	80.58	56.63	38.52	85	1922.61	0.40	2.04	151.48	27829	51423	40003	0.34	0.41	3
PAU 6778-12-1-4-1-1	102	274	115	6622.74	39	26.38	80.91	53.65	59.81	90	1717.46	0.39	1.67	134.27	22531	41784	32315	0.37	0.32	3
PAU 6456-8-1-1-1-3	102	256	106	7047.72	40	28.60	81.45	55.02	58.48	90	1714.64	0.37	1.89	145.37	20450	41369	30733	0.39	0.32	3
PAU 6456-8-2-1-1-1	101	293	106	7070.07	40	27.85	79.08	53.47	58.37	92	1611.31	0.38	1.66	128.62	22048	38719	28197	0.40	0.42	3
PAU 6456-8-2-1-1-2	101	264	109	7003.56	38	25.72	80.03	52.87	56.70	91	1605.19	0.34	1.45	130.57	22527	38111	28346	0.29	0.34	1
PAU 5533-56-3-1-2-3-1-2	98	275	117	5430.81	40	24.27	77.81	51.04	60.52	89	1956.65	0.41	1.80	154.51	26296	50666	38442	0.34	0.28	3
PAU 5533-56-3-1-3-1-1-1	102	310	117	6551.28	39	23.60	77.80	50.70	54.75	95	1758.55	0.39	1.71	143.48	23209	42766	31874	0.35	0.29	3
CR 4116-3-2-1-1-1	102	264	123	6631.50	38	26.92	81.32	54.12	48.43	90	1508.75	0.38	1.52	159.56	20134	38883	28103	0.29	0.32	1
PR 121	107	322	94	6890.17	40	25.98	81.11	53.55	65.24	89	1444.68	0.42	1.61	129.43	17413	34817	25394	0.37	0.31	3
PR 126	93	272	97	7333.84	39	22.22	79.29	50.75	62.03	89	1669.51	0.37	1.48	146.33	22975	40585	30558	0.33	0.21	3
PAU 9562-1-1	107	326	102	5268.23	40	22.77	80.48	51.62	61.35	92	1562.51	0.40	1.54	160.22	16164	37054	26662	0.33	0.38	3
PAU 9562-2-1	106	259	102	5647.99	38	23.50	78.02	50.76	60.75	92	1714.39	0.35	1.22	141.57	23779	48717	37342	0.35	0.24	3
PAU 9562-3-1	102	299	103	5243.37	42	24.07	78.69	51.38	57.84	88	1031.76	0.35	1.00	111.48	9913	23368	15874	0.31	0.33	1

PAU 7180-36-5-0-0-0	101	260	109	6215.50	39	25.63	78.88	52.26	59.32	86	1142.26	0.37	1.07	111.39	12517	27818	20261	0.27	0.39	3
PAU 7180-8-13-0-0-0	99	248	114	5333.73	39	23.09	79.48	51.28	48.70	86	1108.97	0.39	1.25	109.81	9007	23808	16545	0.25	0.32	3
PAU 7180-9-17-0-0-0	107	297	108	3685.80	36	19.81	78.13	48.97	62.45	84	1023.02	0.41	1.41	127.03	13476	29525	21028	0.28	0.18	3
PAU 7180-3-9-0-0-0	105	302	101	5617.08	37	19.82	79.86	49.84	61.74	88	1658.75	0.36	1.40	88.96	11868	25725	18180	0.26	0.36	3
PAU 7180-3-15-0-0-0	100	309	113	5041.56	39	24.22	79.63	51.92	50.10	88	1089.57	0.36	1.17	107.96	10354	26786	18558	0.22	0.41	3
PAU 7180-4-2-0-0-0	96	255	124	5469.13	35	22.18	78.56	50.37	49.09	87	1072.43	0.38	1.30	93.87	7663	21321	14327	0.25	0.28	3
PAU 7180-113-14-0-0-0	94	320	106	5885.57	37	23.21	78.00	50.60	52.19	87	2346.31	0.38	1.44	113.55	10553	27549	19590	0.26	0.27	3
PAU 7180-5-14-0-0-0	101	305	109	4403.05	38	18.40	79.07	48.73	54.66	87	1311.95	0.38	1.15	136.43	10795	33396	23432	0.25	0.33	3
PAU 7180-9-15-0-0-0	101	322	96	5622.88	39	22.81	79.17	50.99	43.16	85	1258.45	0.37	0.85	109.34	7461	20611	18202	0.29	0.37	3

DTF: days to 50% flowering (days), TN: tiller number (m^{-2}), PH: plant height (cm), YLD: yield (kg ha^{-1}), SPD: Soil Plant Analysis Development Meter Value (nmol cm^{-1}), TGW: thousand grain weight (gm), TRR: total rice recovery (%), MRR: milled rice recovery (%), HRR: head rice recovery (%), FER %: Spikelet fertility (%), RL: root length (cm), AD: average diameter (mm), RV: root volume (cm^3), RSR L: root shoot ratio (length), RSR B: root shoot ratio (biomass), SV: seedling vigor.