Supplementary Tables

Supplementary Table S1. One-way ANOVA analysis of gas-exchange, SPAD, chlorophyll fluorescence, plant growth, Rubisco activity, and leaf mineral nutrient content traits of rice cultivars

Parameter	*F*-Value	*P*-Value	R-sq
P_n	4.57	0.002	67.27%
g_s	3.90	0.005	63.73%
C_i	3.57	0.007	59.21%
T_r	1.63	0.174	42.30%
SPAD	4.37	0.003	66.31%
F	1.77	0.197	39.48%
F_o'	2.85	0.043	51.22%
F_m'	2.91	0.025	56.03%
F_v/F_m	11.21	0.000	48.37%
Φ_{PSII}	7.53	0.000	39.88%
ETR	4.48	0.001	40.12%
qN	5.24	0.008	61.89%
qP	8.62	0.000	55.26%
qL	3.63	0.003	47.66%
NPQ	9.31	0.001	61.49%
Y(NO)	4.47	0.002	57.71%
Y(NPQ)	3.88	0.005	49.92%
Shoot length	4.36	0.000	37.54%
Root length	5.44	0.003	44.67%
Leaf area	7.86	0.000	52.38%
Plant biomass	3.77	0.001	62.55%
Rubisco enzyme activity	4.45	0.000	60.93%
Rubisco protein content	3.89	0.003	49.88%
Soluble protein content	7.65	0.000	32.58%
Leaf N content	10.13	0.000	55.61%
Leaf P content	4.12	0.021	61.78%
Leaf S content	3.72	0.033	59.25%

Supplementary Table S2. Gas-exchange and SPAD measurements of ten rice cultivars under low NPS in the screening experiment

Cultivars	P_n (μ mol m^{-2} s^{-1})	g_s (mol m^{-2} s^{-1})	C_i (μ mol CO_2 mol^{-1})	T_r (mmol m^{-2} s^{-1})	SPAD (nmol chl. cm^{-2})
MTU 1010	22.24 ± 1.76 ^{c}	0.331 ± 0.023 ^{d}	238 ± 14.52 ^{bc}	13.6 ± 1.02 ^{c}	47.01 ± 3.41 ^{b}
Rasi	21.22 ± 1.44 ^{de}	0.323 ± 0.021 ^{e}	231 ± 12.34 ^{cd}	13.1 ± 1.07 ^{cd}	45.42 ± 4.22 ^{c}
Nagina 22	19.68 ± 1.51 ^{e}	0.317 ± 0.022 ^{f}	227 ± 14.28 ^{d}	12.7 ± 1.09 ^{d}	43.81 ± 3.82 ^{d}
BPT 5402	22.09 ± 1.13 ^{cd}	0.328 ± 0.024 ^{de}	235 ± 11.93 ^{c}	13.5 ± 1.01 ^{c}	46.62 ± 3.39 ^{bc}
Pusa 44	23.11 ± 1.56 ^{b}	0.344 ± 0.026 ^{b}	245 ± 13.32 ^{b}	14.2 ± 1.05 ^{b}	48.11 ± 4.21 ^{ab}
Nidhi	21.57 ± 2.23 ^{d}	0.324 ± 0.021 ^{e}	230 ± 12.37 ^{cd}	13.2 ± 1.02 ^{cd}	45.74 ± 2.97 ^{c}
Panvel	24.21 ± 2.12 ^{a}	0.352 ± 0.031 ^{a}	252 ± 15.78 ^{a}	15.6 ± 1.12 ^{a}	49.54 ± 3.65 ^{a}
CR Dhan 310	22.94 ± 2.45 ^{bc}	0.339 ± 0.025 ^{c}	243 ± 16.22 ^{bc}	14.3 ± 1.11 ^{b}	47.47 ± 4.11 ^{b}
CR Dhan 311	22.92 ± 1.53 ^{bc}	0.337 ± 0.028 ^{cd}	241 ± 12.71 ^{bc}	13.8 ± 1.10 ^{bc}	47.29 ± 4.23 ^{b}
Taipe 309	21.98 ± 2.03 ^{cd}	0.326 ± 0.024 ^{de}	232 ± 13.15 ^{c}	13.3 ± 1.06 ^{cd}	46.36 ± 3.74 ^{bc}

Note: Result data are the mean ± SE and the different letters indicate statistically significant differences among cultivars in Tukey comparisons ($P < 0.05$). P_n = net photosynthetic rate; g_s = stomatal conductance; C_i = intercellular CO2 rate; T_r = transpiration rate; and SPAD = soil and plant analyzer development.

Supplementary Table S3. Coefficient and yield of photochemical and non-photochemical quenching of photosystem II of the ten rice cultivars in the screening experiment

Cultivars	qN	qP	qL	Y(NO)	Y(NPQ)
MTU 1010	0.024 ± 0.006 ^{ab}	0.781 ± 0.045 ^{e}	0.415 ±0.039 ^{e}	0.367 ± 0.021 ^{a}	0.008 ± 0.002 ^{a}
Rasi	0.016 ± 0.003 ^{bc}	0.931 ± 0.076 ^{a}	0.737 ± 0.048 ^{a}	0.259 ± 0.019 ^{e}	0.003 ± 0.001 ^{c}
Nagina 22	0.025 ± 0.007 ^{a}	0.813 ± 0.037 ^{d}	0.479 ± 0.021 ^{d}	0.352 ± 0.034 ^{b}	0.007 ± 0.003 ^{ab}
BPT 5402	0.014 ± 0.003 ^{c}	0.900 ± 0.068 ^{b}	0.643 ± 0.031 ^{b}	0.276 ± 0.021 ^{de}	0.003 ± 0.001 ^{c}
Pusa 44	0.019 ± 0.005 ^{b}	0.896 ± 0.043 ^{bc}	0.621 ± 0.033 ^{bc}	0.270 ± 0.018 ^{de}	0.004 ± 0.001 ^{bc}
Nidhi	0.018 ± 0.004 ^{b}	0.839 ± 0.039 ^{cd}	0.512 ± 0.027 ^{c}	0.326 ± 0.032 ^{bc}	0.005 ± 0.002 ^{b}
Panvel	0.012 ± 0.002 ^{cd}	0.853 ± 0.044 ^{c}	0.515 ± 0.026 ^{c}	0.300 ± 0.027 ^{cd}	0.003 ± 0.001 ^{c}
CR Dhan 310	0.013 ± 0.003 ^{cd}	0.847 ± 0.048 ^{c}	0.517 ± 0.036 ^{c}	0.314 ± 0.024 ^{c}	0.003 ± 0.001 ^{c}
CR Dhan 311	0.024 ± 0.007 ^{ab}	0.781 ± 0.033 ^{e}	0.415 ± 0.026 ^{e}	0.367 ± 0.031 ^{a}	0.008 ± 0.003 ^{a}
Taipe 309	0.007 ± 0.002 ^{e}	0.891 ± 0.041 ^{bc}	0.620 ± 0.038 ^{bc}	0.285 ± 0.022 ^{d}	0.002 ± 0.001 ^{cd}

Note: Result data are the mean ± SE and the different letters indicate statistically significant differences among cultivars in Tukey comparisons ($P < 0.05$). qN = Coefficient of non-photochemical fluorescence quenching; qP and qL = Coefficient of photochemical fluorescence quenching; Y(NO) = Quantum yield of non-regulated fluorescence emission; and Y(NPQ) = Quantum yield non-photochemical fluorescence quenching.

Supplementary Table S4. Rubisco enzyme activity, Rubisco protein content and, the soluble protein content of leaves of ten rice cultivars in the screening experiment

Cultivars	Rubisco enzyme activity ($nmol^{-1}$ g^{-1} FW)	Rubisco protein content (mg cm^{-1} FW)	Soluble protein content (mg g^{-1} FW)
MTU 1010	209.13 ± 9.22 ^{bc}	0.138 ± 0.021 ^{cd}	29.22 ± 3.42 ^{c}
Rasi	189.71 ± 7.54 ^{e}	0.132 ± 0.023 ^{de}	23.56 ± 2.99 ^{de}
Nagina 22	187.65 ± 7.11 ^{e}	0.129 ± 0.016 ^{e}	21.79 ± 2.89 ^{e}
BPT 5402	197.55 ± 5.93 ^{d}	0.136 ± 0.023 ^{d}	27.55 ± 3.67 ^{cd}
Pusa 44	211.36 ± 6.27 ^{b}	0.145 ± 0.022 ^{b}	30.12 ± 4.57 ^{b}
Nidhi	193.81 ± 5.48 ^{de}	0.131 ± 0.019 ^{e}	24.68 ± 3.22 ^{d}
Panvel	224.62 ± 7.89 ^{a}	0.148 ± 0.026 ^{a}	33.57 ± 4.12 ^{a}
CR Dhan 310	203.72 ± 6.93 ^{c}	0.142 ± 0.021 ^{c}	28.44 ± 3.25 ^{cd}
CR Dhan 311	205.28 ± 6.22 ^{c}	0.141 ± 0.024 ^{c}	29.12 ± 3.71 ^{c}
Taipe 309	195.47 ± 5.14 ^{de}	0.134 ± 0.022 ^{de}	24.11 ± 3.00 ^{d}

Note: Result data are the mean ± SE (FW = fresh weight) and the different letters indicate statistically significant differences among cultivars in Tukey comparisons ($P < 0.05$).

Supplementary Table S5. Leaf nitrogen, phosphorus, and sulphur contents of the ten rice cultivars grown at the low-NPS supply

Cultivars	Leaf N content (mg g^{-1} DW)	Leaf P content (mg g^{-1} DW)	Leaf S content (mg g^{-1} DW)
MTU 1010	4.20 ± 0.13 ^{c}	2.05 ± 0.11 ^{bc}	2.91 ± 0.22 ^{ab}
Rasi	3.92 ± 0.14 ^{e}	1.72 ± 0.09 ^{de}	2.65 ± 0.18 ^{c}
Nagina 22	3.12 ± 0.09 ^{f}	1.61 ± 0.07 ^{e}	2.24 ± 0.15 ^{d}
BPT 5402	4.16 ± 0.12 ^{cd}	1.84 ± 0.10 ^{d}	2.72 ± 0.16 ^{bc}
Pusa 44	4.44 ± 0.11 ^{b}	2.12 ± 0.12 ^{b}	2.83 ± 0.19 ^{b}
Nidhi	4.10 ± 0.13 ^{d}	1.81 ± 0.11 ^{d}	2.66 ± 0.14 ^{c}
Panvel	4.60 ± 0.16 ^{a}	2.33 ± 0.14 ^{a}	3.04 ± 0.21 ^{a}
CR Dhan 310	4.32 ± 0.11 ^{bc}	1.95 ± 0.10 ^{c}	2.80 ± 0.20 ^{b}
CR Dhan 311	4.28 ± 0.13 ^{bc}	1.92 ± 0.11 ^{c}	2.81 ± 0.17 ^{b}
Taipe 309	4.11 ± 0.10 ^{d}	1.80 ± 0.12 ^{d}	2.61 ± 0.11 ^{c}

Note: Result data are the mean ± SE (DW = dry weight) and the different letters indicate statistically significant differences among cultivars in Tukey comparisons ($P < 0.05$). N = nitrogen; P = phosphorus; and S = sulphur.

Supplementary Table S6. Analysis of variance (3-way ANOVA) of gas-exchange, chlorophyll fluorescence, biochemical, and plant growth traits of the rice cultivars grown under two N levels

Traits	C	T	GS	C × T	C × GS	T × GS	C × T × GS	R^2
P_n	9.56*	35.66***	28.92**	29.34**	24.75*	52.61**	1.63*	69.74%
g_s	6.89*	47.84**	31.22*	31.87*	27.62*	42.57*	0.78^{ns}	58.47%
C_i	10.22**	43.53**	35.21*	33.26*	29.44^{ns}	39.56*	0.81^{ns}	48.34%
SPAD	8.12*	35.69*	51.22**	27.54*	42.33*	39.46*	1.52^{ns}	55.49%
F_v/F_m	3.16*	14.86***	23.41**	11.45**	12.32*	17.13*	1.77*	49.83%
Φ_{PSII}	2.67**	16.47**	10.56*	9.86*	7.94*	13.52*	1.66*	55.38%
ETR	21.24**	32.45**	18.74*	24.33*	19.52*	14.22*	1.92*	63.77%
qP	4.55*	28.94**	21.44*	14.57*	7.66^{ns}	11.87*	0.89^{ns}	52.62%
NPQ	7.23*	31.66***	22.91**	21.37**	14.11*	25.47**	1.97*	58.43%
Shoot length	15.78**	42.57***	37.58**	25.48**	21.18*	28.35**	2.33*	65.21%
Leaf area	8.67*	41.32**	29.69*	26.47*	17.88*	29.45*	0.85^{ns}	51.36%
Plant biomass	7.84*	22.43**	31.65**	17.86*	19.72*	23.19*	1.93*	49.71%
Rubisco enzyme activity	12.28*	37.64***	35.48**	21.17*	20.83*	25.66*	2.76*	62.57%
Rubisco protein content	5.42*	25.49**	19.63*	18.38*	12.55^{ns}	18.82*	0.71^{ns}	38.95%
Soluble protein content	10.33*	31.53**	22.47*	19.77*	15.92*	23.41*	0.79^{ns}	44.95%
Leaf N content	6.43*	42.58***	19.62**	24.81**	12.48*	17.99*	1.83*	47.82%

Note: The values in each column represents *F*-value and asterisks denotes the significant differences at *$P < 0.05$, **$P < 0.01$ and ***$P < 0.001$. C = cultivars; T = treatment; and ns = not significant.

Supplementary Table S7. Analysis of variance (2-way ANOVA) of total tillers per hill, agronomic traits, N uptake efficiency, N use efficiency

Traits	C	T	C × T	R^2
Total tillers per hill	17.48***	35.73***	2.14*	64.82%
Panicles per hill	9.39**	43.82***	2.73*	71.36%
Panicle length	12.23**	52.14**	1.92*	56.38%
Grains per panicle	23.45**	46.71***	2.67*	49.63%
1000gains weight	6.26*	50.42**	1.18^{ns}	43.85%
Panicle per meter square	12.66**	34.85***	2.88*	51.28%
Grain yield	22.59***	44.84***	1.85*	48.52%
N uptake efficiency	9.78**	47.16***	1.86*	53.47%
N utilization efficiency	15.87**	45.93***	2.21*	67.19%
N use efficiency	13.54**	42.19***	2.01*	62.33%

Note: The values in each column represents *F*-value and asterisks denotes the significant differences at **P* < 0.05, ***P* < 0.01 and ****P* < 0.001. C = cultivars; T = treatment; and ns = not significant.

Supplementary Table S9. List of genes for validation with their forward and reverse primers

Accession number	Protein description	Gene name	Primers [F = Forward; R = Reverse]
Q7F2G3	Carbonic anhydrase	Os01g0639900	F 5´-TGGAGAACCTCAAGACCTAC-3´ R 5´-ACTGACGAACTGAACGGAC-3´
Q0DG05	Photosystem I reaction center subunit VI	PSAH	F 5´-AGGATGTTATGCTCTGCCTG-3´ R 5´-GCTGCTACTGCTGTTTTCTTG-3´
Q10HD0	Chlorophyll a-b binding protein, chloroplastic	RCABP89	F 5´-CACCACACACCACAAAAAAC-3´ R 5´-AGGTCCATACCAGATGCTC-3´
Q7XCK0	Glutathione S-transferase	GST	F 5´-CCTGTCTGTCAAACTGCTTTC-3´ R 5´-ACCTTCCTATTCATCTTCCCC-3´
P16081	Nitrate reductase [NADH] 1	NIA1	F 5´-CGAGTCCGACAACTACTACC-3´ R 5´-TCACCGAGTTCACGTTCAG-3´
Q5W6H5	Chlorophyll synthase, chloroplastic	CHLG	F 5´-ATGAAAGCAGCAATCGCC-3´ R 5´-GCAAAGTAGCAAAACGACCC-3´
Q0IU70	Nitrogen fixation protein, putative	Os11g07916	F 5´-ATGAAAGCAGCAATCGCC-3´ R 5´-GCAAAGTAGCAAAACGACCC-3´
Q6AUR2	Nitrogen regulatory protein P-II homolog	GLB	F 5´-TGAAAAGGCAAGAACAGGAG-3´ R 5´-CATCATCACTAATCAACAGGGG-3´
Q0JG75	Photosystem II reaction center PSB28 protein	PSB28	F 5´-TTTTTCTCCTTTTTTCCCCCTC-3´ R 5´-GCACACACCAAACAACTCATC-3´
P93431	RuBisCO activase	RCA	F 5´-GATGTAACACACAGAGTGCC-3´ R 5´-ACCACCAATCTCTTCTACCC-3´
Q10DV7	Actin-1 (as reference gene)	ACT1	F 5´-TGACAGGATGAGCAAGGAG-3´ R 5´-CAAAAAGAGAGAAACAAGCAGG-3´