nature portfolio

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Reporting Summary

Nature Portfolio wishes to improve the reproducibility of the work that we publish. This form provides structure for consistency and transparency in reporting. For further information on Nature Portfolio policies, see our Editorial Policies and the Editorial Policy Checklist.

Statistics

For all statistical analyses, confirm that the following items are present in the figure legend, table legend, main text, or Methods section.

n/a	Confirmed
☐	☒ The exact sample size (*n*) for each experimental group/condition, given as a discrete number and unit of measurement
☐	☒ A statement on whether measurements were taken from distinct samples or whether the same sample was measured repeatedly
☐	☒ The statistical test(s) used AND whether they are one- or two-sided *Only common tests should be described solely by name; describe more complex techniques in the Methods section.*
☒	☐ A description of all covariates tested
☒	☐ A description of any assumptions or corrections, such as tests of normality and adjustment for multiple comparisons
☐	☒ A full description of the statistical parameters including central tendency (e.g. means) or other basic estimates (e.g. regression coefficient) AND variation (e.g. standard deviation) or associated estimates of uncertainty (e.g. confidence intervals)
☐	☒ For null hypothesis testing, the test statistic (e.g. *F*, *t*, *r*) with confidence intervals, effect sizes, degrees of freedom and *P* value noted *Give P values as exact values whenever suitable.*
☒	☐ For Bayesian analysis, information on the choice of priors and Markov chain Monte Carlo settings
☒	☐ For hierarchical and complex designs, identification of the appropriate level for tests and full reporting of outcomes
☒	☐ Estimates of effect sizes (e.g. Cohen's *d*, Pearson's *r*), indicating how they were calculated

Our web collection on statistics for biologists contains articles on many of the points above.

Software and code

Policy information about availability of computer code

Data collection	For RNA-seq: Illumina Novaseq platform. For root system analysis: ScanMarker i800plus and RhizoPheno root analysis system (Zhejiang Top Cloud-agri Technology Company). For measure 15N fluxes: Isoprime 100 (Elementar, Germany). For measure IAA content: ESI-HPLC-MS/MS system. For LUC activity determination: Dual-LUC Reporter Assay System (Promega, Madison, WI, USA; E1960). For plant growth phenotype images: Canon EOS80D(W) Camera. For RT-qPCR: ABI QuantStudio6 FLEX Q6 Touch Real-Time PCR Detection System. For Western blotting: Tanon 5200 Chemiluminescent Imaging System. For immunoblotting visualization Tanon image GIS Semi-quantitative analysis. For Enzyme activity assay: Spectra Max iD5. For measure N content: Elemental analyzer (vario PYRO, Elementar, Germany). For gas exchange measurement: Li-6800 (Li-COR, Lincoln, America). For chlorophyll fluorescence measurement: FluorPen FP110-LM/D (Photon Systems Instrument, Czech). For leaf area measurement: Li-3000C (Li-COR, Lincoln, America).
Data analysis	For plotting and statistical analysis of biological data: Microsoft Excel 2019, SAS 9.2, SPSS 27 and GraphPad Prism 8.0.2. For qPCR analysis: ABI QuantStudio6 FLEX Q6 Manager was used. For RNA-seq analysis: Novogene.

For manuscripts utilizing custom algorithms or software that are central to the research but not yet described in published literature, software must be made available to editors and reviewers. We strongly encourage code deposition in a community repository (e.g. GitHub). See the Nature Portfolio guidelines for submitting code & software for further information.

Data

Policy information about availability of data

All manuscripts must include a data availability statement. This statement should provide the following information, where applicable:

- Accession codes, unique identifiers, or web links for publicly available datasets
- A description of any restrictions on data availability
- For clinical datasets or third party data, please ensure that the statement adheres to our policy

We have provided a full data availability statement in the manuscript: Raw RNA-seq data were deposited at the National Genomics Data Center, Genome Sequence Archive (GSA) (accession number PRJCA024327 [https://ngdc.cncb.ac.cn/gsa/s/Hz4L1U30]).

Research involving human participants, their data, or biological material

Policy information about studies with human participants or human data. See also policy information about sex, gender (identity/presentation), and sexual orientation and race, ethnicity and racism.

Reporting on sex and gender	N/A
Reporting on race, ethnicity, or other socially relevant groupings	N/A
Population characteristics	N/A
Recruitment	N/A
Ethics oversight	N/A

Note that full information on the approval of the study protocol must also be provided in the manuscript.

Field-specific reporting

Please select the one below that is the best fit for your research. If you are not sure, read the appropriate sections before making your selection.

☒ Life sciences ☐ Behavioural & social sciences ☐ Ecological, evolutionary & environmental sciences

For a reference copy of the document with all sections, see nature.com/documents/nr-reporting-summary-flat.pdf

Life sciences study design

All studies must disclose on these points even when the disclosure is negative.

Sample size	For the rice fields trials and hydroponic experiment, more than 3 samples for each genotype were randomly selected and used for quantification. For RT-qPCR, 3 biological repeats were sampled. The sample sizes and material amount were determined based on experimental trials to allow for confident statistical analyses.
Data exclusions	No data were excluded from our analyses.
Replication	All experiments were repeated at least three times, and similar results were obtained.
Randomization	Plants of equal initial size were randomly assigned to the treatment and control groups.
Blinding	Analysis were performed in a manner blinded to treatment assignment in all experiments.

Behavioural & social sciences study design

All studies must disclose on these points even when the disclosure is negative.

Study description	
Research sample	
Sampling strategy	

Data collection	
Timing	
Data exclusions	
Non-participation	
Randomization	

Ecological, evolutionary & environmental sciences study design

All studies must disclose on these points even when the disclosure is negative.

Study description	
Research sample	
Sampling strategy	
Data collection	
Timing and spatial scale	
Data exclusions	
Reproducibility	
Randomization	
Blinding	

Did the study involve field work? ☐ Yes ☐ No

Field work, collection and transport

Field conditions	
Location	
Access & import/export	
Disturbance	

Reporting for specific materials, systems and methods

We require information from authors about some types of materials, experimental systems and methods used in many studies. Here, indicate whether each material, system or method listed is relevant to your study. If you are not sure if a list item applies to your research, read the appropriate section before selecting a response.

Materials & experimental systems

n/a	Involved in the study
☐	☒ Antibodies
☒	☐ Eukaryotic cell lines
☒	☐ Palaeontology and archaeology
☒	☐ Animals and other organisms
☒	☐ Clinical data
☒	☐ Dual use research of concern
☐	☒ Plants

Methods

n/a	Involved in the study
☒	☐ ChIP-seq
☒	☐ Flow cytometry
☒	☐ MRI-based neuroimaging

Antibodies

Antibodies used

The information of the antibodies used in this study were showed below:
anti-HSP82, AbM51099-31-PU, Lot No. 2020032401. 1:5000 dilution;
anti-Rabbite IgG: Peroxidase-AffiniPure IgG (H+L), jackson (111-035-003). Dilution: 1:10000;
anti-Mouse IgG: Peroxidase-AffiniPure IgG (H+L), jackson (115-035-003). Dilution: 1:10000;
anti-DNR1 were generated by ABclonal, E12199. 1:5000 dilution;
anti-PsbA, Agrisera, AS05084. Dilution: 1:5000;
anti-PsaB Agrisera, AS10695. Dilution: 1:5000;
anti-RbcS Agrisera, AS07259. Dilution: 1:5000;
anti-RbcL Agrisera, AS03037. Dilution: 1:5000;
anti-SBPase Agrisera, AS152873. Dilution: 1:5000.

Validation

Anti-HSP82 antibody verification can be found on the manufacturers website (http://www.proteomics.org.cn/product/202.html);
Anti-Rabbite IgG antibody verification can be found on the manufacturers website (https://www.jacksonimmuno.com/catalog/products/111-035-003);
Anti-Mouse IgG antibody verification can be found on the manufacturers website (https://www.jacksonimmuno.com/catalog/products//115-035-003);
Anti-PsbA, Anti-PsaB, Anti-RbcS, Anti-RbcL and anti-SBPase antibody verifications can be found on the manufacturers website (https://www.agrisera.com/);
Anti-DNR1 antibody was previously validated in Zhang et al., 2021 (doi: 10.1093/plcell/koaa037).

Eukaryotic cell lines

Policy information about cell lines and Sex and Gender in Research

Cell line source(s)

Authentication

Mycoplasma contamination

Commonly misidentified lines
(See ICLAC register)

Palaeontology and Archaeology

Specimen provenance

Specimen deposition

Dating methods

☐ Tick this box to confirm that the raw and calibrated dates are available in the paper or in Supplementary Information.

Ethics oversight

Note that full information on the approval of the study protocol must also be provided in the manuscript.

Animals and other research organisms

Policy information about studies involving animals; ARRIVE guidelines recommended for reporting animal research, and Sex and Gender in Research

Laboratory animals

Wild animals

Reporting on sex

Field-collected samples

Ethics oversight

Note that full information on the approval of the study protocol must also be provided in the manuscript.

Clinical data

Policy information about clinical studies

All manuscripts should comply with the ICMJE guidelines for publication of clinical research and a completed CONSORT checklist must be included with all submissions.

Clinical trial registration	
Study protocol	
Data collection	
Outcomes	

Dual use research of concern

Policy information about dual use research of concern

Hazards

Could the accidental, deliberate or reckless misuse of agents or technologies generated in the work, or the application of information presented in the manuscript, pose a threat to:

No	Yes	
☒	☐	Public health
☒	☐	National security
☒	☐	Crops and/or livestock
☒	☐	Ecosystems
☒	☐	Any other significant area

Experiments of concern

Does the work involve any of these experiments of concern:

No	Yes	
☒	☐	Demonstrate how to render a vaccine ineffective
☒	☐	Confer resistance to therapeutically useful antibiotics or antiviral agents
☒	☐	Enhance the virulence of a pathogen or render a nonpathogen virulent
☒	☐	Increase transmissibility of a pathogen
☒	☐	Alter the host range of a pathogen
☒	☐	Enable evasion of diagnostic/detection modalities
☒	☐	Enable the weaponization of a biological agent or toxin
☒	☐	Any other potentially harmful combination of experiments and agents

Plants

Seed stocks	The seeds involved in this study are all stored in the Ding's laboratory.
Novel plant genotypes	A near-isogenic line (NIL) in the HJX74 background that carries the japonica DNR1 allele from IRAP9, generated by crossing with HJX74 for at least 8 generation. The dnr1 mutation was generated by SRISPR/Cas9, which resulted in a 2-bp deletion in the second exon of DNR1 and therefore likely to disrupt its normal gene function.
Authentication	Using qPCR and western-bloting to vertify the DNR1 loss of function mutation.

ChIP-seq

Data deposition

☐ Confirm that both raw and final processed data have been deposited in a public database such as GEO.

☐ Confirm that you have deposited or provided access to graph files (e.g. BED files) for the called peaks.

Data access links
May remain private before publication.

Files in database submission

Genome browser session
(e.g. UCSC)

Methodology

Replicates

Sequencing depth

Antibodies

Peak calling parameters

Data quality

Software

Flow Cytometry

Plots

Confirm that:

☐ The axis labels state the marker and fluorochrome used (e.g. CD4-FITC).

☐ The axis scales are clearly visible. Include numbers along axes only for bottom left plot of group (a 'group' is an analysis of identical markers).

☐ All plots are contour plots with outliers or pseudocolor plots.

☐ A numerical value for number of cells or percentage (with statistics) is provided.

Methodology

Sample preparation

Instrument

Software

Cell population abundance

Gating strategy

☐ Tick this box to confirm that a figure exemplifying the gating strategy is provided in the Supplementary Information.

Magnetic resonance imaging

Experimental design

Design type

Design specifications

Behavioral performance measures

Acquisition

Imaging type(s)

Field strength

Sequence & imaging parameters

Area of acquisition

Diffusion MRI ☐ Used ☐ Not used

Preprocessing

Preprocessing software

Normalization

Normalization template

Noise and artifact removal

Volume censoring

Statistical modeling & inference

Model type and settings

Effect(s) tested

Specify type of analysis: ☐ Whole brain ☐ ROI-based ☐ Both

Statistic type for inference

(See Eklund et al. 2016)

Correction

Models & analysis

n/a	Involved in the study
☐	☐ Functional and/or effective connectivity
☐	☐ Graph analysis
☐	☐ Multivariate modeling or predictive analysis

Functional and/or effective connectivity

Graph analysis

Multivariate modeling and predictive analysis