

On the Cover: Boron is an essential element for plant growth, but for a long time, it was unknown how boron was delivered to the developing tissues. In this issue, the transporter, OsNIP3;1 is described that undertakes preferential distribution of boron to young leaves and panicles in rice. This image shows the tissue localization of OsNIP3;1 in rice node I. OsNIP3;1 is localized at the xylem transfer cell of enlarged vascular bundle and phloem region of diffuse vascular bundle of node I in rice. The red color in the image shows signal from OsNIP3;1 protein and the blue color is auto-fluorescence. Cover design by Naoki Yamaji.

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[^{OPEN}]Monitoring Polysaccharide Dynamics in the Plant Cell Wall.
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New technologies reveal the deposition and remodeling of plant cell wall polysaccharides and their impact on plant development. 2590

[^{OPEN}]Ethylene Exerts Species-Specific and Age-Dependent Control of Photosynthesis.
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Ethylene regulates many different aspects of photosynthesis in an age-dependent and species-specific manner. 2601

RESEARCH REPORT

The Transcriptional Coactivator ADA2b Recruits a Structural Maintenance Protein to Double-Strand Breaks during DNA Repair in Plants. *Jianbin Lai, Jieming Jiang, Qian Wu, Ning Mao, Danlu Han, Huan Hu, and Chengwei Yang*
ADA2b, a transcriptional coactivator, recruits SMC5, a chromosome structural maintenance protein, to double-strand DNA breaks in the plant DNA damage response. 2613

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RESEARCH ARTICLES

BIOCHEMISTRY AND METABOLISM

[^{OPEN}]Trehalose 6-Phosphate Regulates Photosynthesis and Assimilate Partitioning in Reproductive Tissue. *Maria Oszvald, Lucia F. Primavesi, Cara A. Griffiths, Jonathan Cohn, Shib Sankar Basu, Michael L. Nuccio, and Matthew J. Paul*

Decreased T6P in phloem cells of maize female reproductive tissue causes opposing changes in primary and secondary metabolism and a shift in assimilates within cobs in favor of florets, simultaneously increasing photosynthetic rate.

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Mycorrhiza-Triggered Transcriptomic and Metabolomic Networks Impinge on Herbivore Fitness. *Moritz Kaling, Anna Schmidt, Franco Moritz, Maaria Rosenkranz, Michael Witting, Karl Kasper, Dennis Janz, Philippe Schmitt-Kopplin, Jörg-Peter Schnitzler, and Andrea Polle*

*Ectomycorrhiza-induced systemic defenses in leaves involve aldoxime metabolism and improve poplar fitness by fending off the leaf herbivore *Chrysomela populi*.*

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The Citrus Transcription Factor CsMADS6 Modulates Carotenoid Metabolism by Directly Regulating Carotenogenic Genes. *Suwen Lu, Yin Zhang, Kaijie Zhu, Wei Yang, Junli Ye, Lijun Chai, Qiang Xu, and Xiuxin Deng*

*Citrus CsMADS6 coordinately and positively modulates carotenoid metabolism by directly regulating the expression of *LCYb1* and other carotenogenic genes, including *PSY*, *PDS*, and *CCD1*.*

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[^{OPEN}]Discovery, Biosynthesis and Stress-Related Accumulation of Dolabradiene-Derived Defenses in Maize. *Sibongile Mafu, Yezhang Ding, Katherine M. Murphy, Omar Yaacoobi, J. Bennett Addison, Qiang Wang, Zhouxin Shen, Steven P. Briggs, Jörg Bohlmann, Gabriel Castro-Falcon, Chambers C. Hughes, Mariam Betsiashvili, Alisa Huffaker, Eric A. Schmelz, and Philipp Zerbe*

This study describes a class of stress-related diterpenoids, termed dolabraloxins, in maize and identifies diterpene synthases and a cytochrome P450 involved in their biosynthesis.

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CELL BIOLOGY

Oxidation of Translation Factor EF-Tu Inhibits the Repair of Photosystem II. *Haruhiko Jimbo, Rayakorn Yutthanasirikul, Takanori Nagano, Toru Hisabori, Yukako Hihara, and Yoshitaka Nishiyama*

Oxidation of a cysteine residue in translation factor EF-Tu inhibits the synthesis of proteins that are essential for the repair of photosystem II, resulting in stimulation of photoinhibition.

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[^{OPEN}]A Genetic Network for Systemic RNA Silencing in Plants. *Weimei Chen, Xian Zhang, Yaya Fan, Bin Li, Eugene Ryabov, Nongnong Shi, Mei Zhao, Zhiming Yu, Cheng Qin, Qianqian Zheng, Pengcheng Zhang, Huizhong Wang, Stephen Jackson, Qi Cheng, Yule Liu, Philippe Gallusci, and Yiguo Hong*

A DCL2-dependent DCL genetic pathway is crucial for systemic PTGS in plants.

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ECOPHYSIOLOGY AND SUSTAINABILITY

[^{OPEN}]Comparative Analysis of Arabidopsis Ecotypes Reveals a Role for Brassinosteroids in Root Hydrotropism. *Rui Miao, Meng Wang, Wei Yuan, Yan Ren, Ying Li, Na Zhang, Jianhua Zhang, Herbert J. Kronzucker, and Weifeng Xu*

The inhibition of brassinosteroid biosynthesis via mutation or pharmacological approaches reduces root hydrotropic responses and H⁺ efflux in Arabidopsis.

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GENES, DEVELOPMENT AND EVOLUTION

MYB52 Negatively Regulates Pectin Demethylesterification in Seed Coat Mucilage.

Dachuan Shi, Angyan Ren, Xianfeng Tang, Guang Qi, Zongchang Xu, Guohua Chai, Ruibo Hu, Gongke Zhou, and Yingzhen Kong

MYB52 is a transcriptional activator that represses pectin demethylesterification during seed coat mucilage maturation.

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[OPEN]ELIGULUM-A Regulates Lateral Branch and Leaf Development in Barley. Ron J. Okagaki, Allison Haaning, Hatice Bilgic, Shane Heinen, Arnis Druka, Micha Bayer, Robbie Waugh, and Gary J. Muehlbauer

The barley ELIGULUM-A gene regulates lateral branch development and acts to establish the blade-sheath boundary during leaf development.

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[OPEN]The COMPASS-Like Complex Promotes Flowering and Panicle Branching in Rice. Pengfei Jiang, Shiliang Wang, Haiyang Jiang, Beijiu Cheng, Keqiang Wu, and Yong Ding

OsWDR5a and OsTrx1/SDG723 form the core components of the COMPASS-like complex to positively regulate the flowering time and panicle branching in rice.

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Multi-Omics Driven Assembly and Annotation of the Sandalwood (*Santalum album*) Genome.

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*Use of integrated genomic, transcriptomic, and proteomic approaches enhanced the quality of genome assembly and annotation for sandalwood (*Santalum album*).*

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[OPEN]Proliferation of Regulatory DNA Elements Derived from Transposable Elements in the Maize Genome. Hainan Zhao, Wenli Zhang, Lifan Chen, Lei Wang, Alexandre P. Marand, Yufeng Wu, and Jiming Jiang

Characterization of open chromatin reveals wide spread occurrence of cis-regulatory DNA sequences derived from transposable elements in the maize genome.

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[OPEN]A Putative Protein O-Fucosyltransferase Facilitates Pollen Tube Penetration through the Stigma–Style Interface. Devin K. Smith, Danielle M. Jones, Jonathan B. R. Lau, Edward R. Cruz, Elizabeth Brown, Jeffrey F. Harper, and Ian S. Wallace

A putative protein O-fucosyltransferase in Arabidopsis facilitates pollen tube penetration through stigmatic tissue, suggesting that protein O-fucosylation events may play a role in plant reproduction.

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[OPEN]Extended Vernalization Regulates Inflorescence Fate in *Arabis alpina* by Stably Silencing PERPETUAL FLOWERING1. Ana Lazaro, Evelyn Obeng-Hinneh, and Maria C. Albani

PERPETUAL FLOWERING1 has a dual role regulating meristem fate after cold; it prevents flowering of new axillary branches and antagonizes inflorescence development.

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^[OPEN]SIAMESE-RELATED1 Is Regulated Posttranslationally and Participates in Repression of Leaf Growth under Moderate Drought. *Marieke Dubois, Katia Selden, Alexis Bediée, Gaëlle Rolland, Nicolas Baumberger, Sandra Noir, Lien Bach, Geneviève Lamy, Christine Granier, and Pascal Genschik*

The CDK inhibitory protein SMR1 is regulated by protein turnover under favorable conditions and is induced by ethylene to fine-tune cell cycle arrest under drought. 2834

Transcriptional Roadmap to Seasonal Variation in Wood Formation of Norway Spruce. *Soile Jokipii-Lukkari, Nicolas Delhomme, Bastian Schiffthaler, Chanaka Mannapperuma, Jakob Prestele, Ove Nilsson, Nathaniel R. Street, and Hannele Tuominen*

Seasonal wood transcriptomes of Norway spruce suggest mechanisms underlying specific aspects of gymnosperm wood biology, such as latewood formation, lignin biosynthesis, and tracheid longevity. 2851

Jasmonate Negatively Regulates Stomatal Development in Arabidopsis Cotyledons. *Xiao Han, Yanru Hu, Gensong Zhang, Yanjuan Jiang, Xiaolan Chen, and Diqiu Yu*

Jasmonate and MYC transcription factors negatively regulate stomatal development in Arabidopsis cotyledons. 2871

^[OPEN]Subcellular Compartmentation of Alternatively Spliced Transcripts Defines SERINE/ARGININE-RICH PROTEIN30 Expression. *Lisa Hartmann, Theresa Wießner, and Andreas Wachter*

Differential compartmentation and translation of alternatively spliced transcripts adjusts expression of the splicing regulator SR30 to ambient light conditions in Arabidopsis thaliana. 2886

SELF-PRUNING Acts Synergistically with DIAGEOTROPICA to Guide Auxin Responses and Proper Growth Form. *William B. Silva, Mateus H. Vicente, Jessenia M. Robledo, Diego S. Reartes, Renata C. Ferrari, Ricardo Bianchetti, Wagner L. Araújo, Luciano Freschi, Lázaro E. P. Peres, and Agustin Zsögön*

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VASCULAR PLANT ONE-ZINC FINGER1 (VOZ1) and VOZ2 Interact with CONSTANS and Promote Photoperiodic Flowering Transition. *Sushil Kumar, Pratibha Choudhary, Mansi Gupta, and Utpal Nath*

The Arabidopsis VOZ proteins interact physically with CONSTANS to modulate its function and promote photoperiod-dependent flowering. 2917

MEMBRANES, TRANSPORT AND BIOENERGETICS

^[OPEN]The Ribosome-Bound Protein Pam68 Promotes Insertion of Chlorophyll into the CP47 Subunit of Photosystem II. *Lenka Bučinská, Éva Kiss, Peter Koník, Jana Knoppová, Josef Komenda, and Roman Sobotka*

The production of the CP47 subunit of Photosystem II requires the Pam68 protein that binds to ribosomes in the vicinity of the SecY translocon and most likely promotes chlorophyll loading into the CP47 polypeptide chain. 2931

[OPEN]The Phosphate Fast-Responsive Genes *PECP1* and *PPsPase1* Affect Phosphocholine and Phosphoethanolamine Content. Mohamed Hanchi, Marie-Christine Thibaud, Bertrand Légeret, Keiko Kuwata, Nathalie Pochon, Fred Beisson, Aiqin Cao, Laura Cuyas, Pascale David, Peter Doerner, Ali Ferjani, Fan Lai, Yonghua Li-Beisson, Jérôme Mutterer, Michel Philibert, Kashchandra G. Raghothama, Corinne Rivasseau, David Secco, James Whelan, Laurent Nussaume, and Hélène Javot

Intense induction of PPsPase1 and PECP1 phosphatases impacts phosphocholine and phosphoethanolamine content in Arabidopsis.

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SIGNALING AND RESPONSE

[OPEN]Two B-Box Proteins Regulate Photomorphogenesis by Oppositely Modulating HY5 through their Diverse C-Terminal Domains. Nikhil Job, Premachandran Yadukrishnan, Katharina Bursch, Sourav Datta, and Henrik Johansson

The contrasting roles of BBX21 and BBX24 in photomorphogenesis arise through their different C-terminal regions and how they alter HY5 function at the post-transcriptional level.

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[OPEN]The Glucose Sensor MdHXX1 Phosphorylates a Tonoplast Na⁺/H⁺ Exchanger to Improve Salt Tolerance. Mei-Hong Sun, Qi-Jun Ma, Da-Gang Hu, Xiao-Ping Zhu, Chun-Xiang You, Huai-Rui Shu, and Yu-Jin Hao

MdHXX1 is involved in glucose-mediated improvement of tolerance to high salinity by interacting with and phosphorylating the tonoplast Na⁺/H⁺ exchanger MdNHX1.

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BRASSINOSTEROID-SIGNALING KINASE1 Phosphorylates MAPKKK5 to Regulate Immunity in Arabidopsis. Haojie Yan, Yaofei Zhao, Hua Shi, Juan Li, Yingchun Wang, and Dingzhong Tang

The Arabidopsis receptor-like cytoplasmic kinase BSK1 phosphorylates MAPKKK5 to regulate plant defense responses.

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[OPEN]The MtDMI2-MtPUB2 Negative Feedback Loop Plays a Role in Nodulation Homeostasis. Jiaying Liu, Jie Deng, Fugui Zhu, Yuan Li, Zheng Lu, Peibin Qin, Tao Wang, and Jiangli Dong

MtPUB2 and MtDMI2 form a negative feedback loop that regulates nodulation homeostasis in the Medicago truncatula/Sinorhizobium meliloti symbiosis.

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[OPEN]Plastid Translation Elongation Factor Tu Is Prone to Heat-Induced Aggregation Despite Its Critical Role in Plant Heat Tolerance. Xifeng Li, Chong Cai, Zhe Wang, Baofang Fan, Cheng Zhu, and Zhixiang Chen

Despite its critical roles in plant heat stress responses, plastid translation factor EF-Tu rapidly becomes insoluble at high temperatures, which leads to its inactivation.

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[OPEN]Different Modes of Negative Regulation of Plant Immunity by Calmodulin-Related Genes. You Lu, William Truman, Xiaotong Liu, Gerit Bethke, Man Zhou, Chad L. Myers, Fumiaki Katagiri, and Jane Glazebrook

The Arabidopsis CBP60a and two CALMODULIN-LIKE (CML) genes negatively regulate plant immunity, with the CML genes affecting amplitude and CBP60a controlling duration.

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[OPEN]STRESS INDUCED FACTOR 2, a Leucine-Rich Repeat Kinase Regulates Basal Plant Pathogen Defense. Ning Yuan, Shuangrong Yuan, Zhigang Li, Man Zhou, Peipei Wu, Qian Hu, Venugopal Mendu, Liangjiang Wang, and Hong Luo

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Time-Course Transcriptomics Analysis Reveals Key Responses of Submerged Deepwater Rice to Flooding. Anzu Minami, Kenji Yano, Rico Gamuyao, Keisuke Nagai, Takeshi Kuroha, Madoka Ayano, Masanari Nakamori, Masaya Koike, Yuma Kondo, Yoko Niimi, Keiko Kuwata, Takamasa Suzuki, Tetsuya Higashiyama, Yumiko Takebayashi, Mikiko Kojima, Hitoshi Sakakibara, Atsushi Toyoda, Asao Fujiyama, Nori Kurata, Motoyuki Ashikari, and Stefan Reuscher

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Modulation of Plant Salicylic Acid-Associated Immune Responses via Glycosylation of Dihydroxybenzoic Acids. Xu-xu Huang, Guo-qing Zhu, Qian Liu, Lu Chen, Yan-jie Li, and Bing-kai Hou

The glycosyltransferase UGT76D1 catalyzes the glycosylation of dihydroxybenzoic acids and modulates plant salicylic acid homeostasis and immune responses. 3103

[OPEN]3'-Phosphoadenosine 5'-Phosphate Accumulation Delays the Circadian System. Suzanne Litthauer, Kai Xun Chan, and Matthew Alan Jones

Accumulation of the stress-induced metabolite PAP delays the circadian system in Arabidopsis thaliana. 3120

SYSTEMS AND SYNTHETIC BIOLOGY

[OPEN]Synthetic MicroProteins: Versatile Tools for Posttranslational Regulation of Target Proteins. Ulla Dolde, Vandasue Rodrigues, Daniel Straub, Kaushal Kumar Bhati, Sukwon Choi, Seong Wook Yang, and Stephan Wenkel

A synthetic microProtein approach unravels modes of posttranslational regulation of a wide range of protein families in Arabidopsis. 3136

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Arabidopsis MYC Transcription Factors Are the Target of Hormonal Salicylic Acid/Jasmonic Acid Cross Talk in Response to *Pieris brassicae* Egg Extract. Schmiesing A., Emonet A., Gouhier-Darimont C., and Reymond P.

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