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杂交水稻专题

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前沿资讯

1．研究揭示植物营养生长的表观遗传协同调控新机制

简介：近日，中国农业科学院生物技术研究所玉米功能基因组团队解析了植物高光效和高产等多重发育程序的表观遗传协同调控分子机理，首次揭示了真核生物中不同的表观遗传修饰间的互作关系和功能，为研究植物生长发育、环境适应性及高产稳产作物培育提供了新的方向。相关研究成果发表在《前沿科学（Advanced Science）》上。植物的营养生长受多重发育程序的调控，并直接影响种子发育和作物产量。但植物响应环境、平衡复杂的发育程序以维持营养生长阶段能量积累和快速生长的分子机制目前尚不清楚。该研究发现植物特异蛋白EMF1能调控RNA甲基化和组蛋白修饰在全基因组水平上的协作关系，在植物营养生长阶段可同时作为抑制子和激活子调控特定的开花、种子发育以及叶绿体发育和光合作用等关键下游靶基因转录。两个不同的作用方式精确调控了植物正常的营养生长，促进了植物的光合作用，从而为植物生殖生长和种子的形成积累了能量。该研究不仅为植物表观遗传和基因组学相关研究提供了重要数据资源，而且深入揭示了RNA甲基化在染色质表观修饰可塑性的贡献，并为复杂的表观调控网络在作物高光效、高产等基因转录调控中的作用提供了新认知。

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2．教授团队揭示水稻吸收重金属铅的分子机制

简介：近日，南京农业大学资环学院赵方杰教授团队在《Environmental Science & Technology》在线发表了题为“OsNRAMP5 is a major transporter for lead uptake in rice”的研究论文，揭示了水稻根系膜转运蛋白OsNRAMP5参与对有毒重金属铅（Pb）吸收的新功能。铅是毒性最强的重金属元素之一，且在环境中分布广泛，被联合国世界卫生组织列为影响人类公共健康的十大污染物之一。过量Pb暴露会对人体健康造成一系列不良影响。此外，Pb是一种神经毒素，过量暴露可导致儿童认知发育迟缓，智力下降。食物是人体Pb暴露的主要来源之一，其中，大米对膳食Pb摄入贡献较大。种植在未受污染土壤的水稻籽粒Pb含量通常较低，但人为活动（如采矿、金属冶炼和大气沉降等）造成的土壤污染会增加水稻籽粒中Pb的积累。水稻根系如何吸收Pb的分子机制迄今尚不清楚。NRAMP（自然抗性相关巨噬细胞蛋白）家族是一类具有转运过度金属离子活性的膜蛋白。前期研究表明OsNRAMP5是水稻吸收锰(Mn)和镉(Cd)的主要转运蛋白，但OsNRAMP5是否也转运Pb尚不清楚。赵方杰团队首先采用酵母异源表达OsNRAMP5基因，发现表达该基因的酵母细胞Pb的吸收增加，对Pb的敏感性增强。进一步采用CRISPR/Cas9编辑敲除水稻OsNRAMP5基因，发现突变体根系对Pb的吸收和地上部Pb的积累大幅度下降。吸收动力学实验结果表明，OsNRAMP5基因敲除突变体根系Pb的最大吸收速率（Vmax）比野生型下降了70%（图1）。在水培条件下，提高营养液Mn浓度显著抑制水稻根系对Pb的吸收，说明Mn对Pb的吸收有竞争效应。种植在Pb污染的水稻土中，OsNRAMP5基因敲除突变体籽粒和秸秆Pb含量比野生型分别降低了50%和70%。研究结果表明，OsNRAMP5除了对Mn和Cd吸收发挥重要作用外，还是水稻吸收Pb的主要转运蛋白。该研究首次揭示了水稻根系吸收Pb的分子机制，为阻控作物Pb的吸收、提升农产品安全提供了理论依据。

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学术文献

1. Foliar Diseases and the Associated Fungi in Rice Cultivated in Kenya(肯尼亚种植的水稻叶片病害及其相关真菌)

简介：We conducted a survey to assess the occurrence and severity of rice blast and brown spot diseases on popular cultivars grown in the Busia, Kirinyaga, and Kisumu counties of Kenya in 2019. Working with agricultural extension workers within rice production areas, we interviewed farmers (n = 89) regarding their preferred cultivars and their awareness of blast disease, as this was the major focus of our research. We scored the symptoms of blast and brown spot and assessed the lodging, plant height, and maturity of the crops (days after planting). Furthermore, we collected leaf and neck tissues for the assessment of the prevailing fungal populations. We used specific DNA primers to screen for the prevalence of the causal pathogens of blast, Magnaporthe oryzae, and brown spot, Cochliobolus miyabeanus, on asymptomatic and symptomatic leaf samples. We also conducted fungal isolations and PCR-sequencing to identify the fungal species in these tissues. Busia and Kisumu had a higher diversity of cultivars compared to Kirinyaga. The aromatic Pishori (NIBAM 11) was preferred and widely grown for commercial purposes in Kirinyaga, where 86% of Kenyan rice is produced. NIBAM108 (IR2793-80-1) and BW196 (NIBAM 109) were moderately resistant to blast, while NIBAM110 (ITA310) and Vietnam were susceptible. All the cultivars were susceptible to brown spot except for KEH10005 (Arize Tej Gold), a commercial hybrid cultivar. We also identified diverse pathogenic and non-pathogenic fungi, with a high incidence of Nigrospora oryzae, in the rice fields of Kirinyaga. There was a marginal correlation between disease severity/incidence and the occurrence of causal pathogens. This study provides evidence of the need to strengthen pathogen surveillance through retraining agricultural extension agents and to breed for blast and brown spot resistance in popular rice cultivars in Kenya.
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2. Characteristics of Population Quality and Rice Quality of Semi-Waxy japonica Rice Varieties with Different Grain Yields(不同产量半糯粳稻品种群体品质和稻米品质特征)

简介：A primary focus of rice breeding and production is the optimization of yield and quality. Currently, semi-waxy japonica rice is widely planted in the middle and lower reaches

of the Yangtze River due to its good eating quality and strong reputation among consumers. However, little information is yet available on grain yield formation and rice quality characteristics of these semi-waxy japonica rice varieties with different grain yields. In this study, three high-yielding (HGY) semi-waxy japonica rice varieties and three low-yielding (LGY) semi waxy japonica rice varieties were compared for population quality and rice quality in 2018 and 2019. The average values of spikelet per panicle, 1000-grain weight, and total spikelet number of the HGY varieties were significantly higher than those of the LGY varieties, while the panicle number and filled grain rate showed the opposite. Compared with the LGY varieties, the HGY varieties had a larger leaf area index at each growth stage, with a larger high efficient leaf area composed of a larger leaf length and width and smaller leaf angles of the top three leaves, as well as a greater single stem-sheath weight, more total dry matter accumulation, and longer growth duration from elongating to maturity. There were significant differences in rice quality between the HGY and LGY varieties. Compared with the LGY varieties, the head milled rice rate of the HGY varieties decreased significantly, and the chalky kernel rate and chalkiness degree increased significantly. Due to the low protein content, high peak viscosity, trough viscosity, and final viscosity and breakdown, as well as low setback, consistence, and pasting temperature of the HGY varieties, their taste values were significantly better than those of the LGY varieties. These results suggest that the HGY varieties could achieve a synergistic improvement of grain yield and eating quality, but the milling quality and appearance quality require further improvement.

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3. Improvement of Upland Rice Variety by Pyramiding Drought Tolerance QTL with Two Major Blast Resistance Genes for Sustainable Rice Production(利用两个主要抗稻瘟病基因聚合抗旱QTL改良旱稻品种)

简介：Varalu is an early maturing rice variety widely grown in the rainfed ecosystem preferred for its grain type and cooking quality. However, the yield of Varalu is substantially low since it is being affected by reproductive drought stress along with the blast disease. The genetic improvement of Varalu was done by introgressing a major yield QTL, qDTY(12.1), along with two major blast resistance genes i.e. Pi54 and Pi1 through marker-assisted backcross breeding. Both traits were transferred till BC2 generation and intercrossing was followed to pyramid the two traits. Stringent foreground selection was carried out using linked markers as well as peak markers (RM28099, RM28130, RM511 and RM28163) for the targeted QTL (qDTY(12.1)), RM206 for Pi54 and RM224 for Pi1. Extensive background selection was done using genome-wide SSR markers. Six best lines (MSM-36, MSM-49, MSM-53, MSM-57, MSM-60 and MSM-63) having qDTY(12.1) and two blast resistance genes in homozygous condition with recurrent parent genome of 95.0%-96.5% having minimal linkage drag of about 0.1 to 0.7 Mb were identified. These lines showed yield

advantage under drought stress as well as irrigated conditions. MSM-36 showed better performance in the national coordinated trials conducted across India, which indicated that improved lines of Varalu expected to replace Varalu and may have an important role in sustaining rice production. The present study demonstrated the successful marker-assisted pyramiding strategy for introgression of genes/QTLs conferring biotic stress resistance and yield under abiotic stress in rice.

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