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杂交水稻专题

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前沿资讯

1．院士团队揭示水稻株型调控新机制

简介：近日，以万建民院士领衔的中国农业科学院作物科学研究所作物功能基因组研究创新团队克隆了水稻株型调控新基因DHT1，并对其调控水稻分蘖的分子机制进行了深入解析，揭示了其通过调控独脚金内酯受体基因D14的转录和剪接来调控水稻分蘖的新通路。6月7日，相关研究成果在线发表于《植物细胞（The Plant Cell）》上。据介绍，水稻株型是决定水稻产量的重要因素，独脚金内酯是近年发现的调控株型的新型植物激素，它的作用包括抑制水稻分蘖、促进株高和根系生长。已有研究虽明确了独脚金内酯信号传递的主要遗传通路，但对该通路基因的转录和剪接调控机制仍然不了解。万建民院士团队以一个矮杆多分蘖的水稻突变体dht1为材料，通过图位克隆的方法鉴定了DHT1基因编码一个新的单子叶植物特有的核不均一性核糖核蛋白，该蛋白参与调节大量基因的前体信使核糖核酸（包括独脚金内酯受体基因D14）的内含子剪接。dht1突变导致D14前体mRNA转录和剪接受阻，减少D14蛋白，阻碍了独脚金内酯的信号传递，最终导致独脚金内酯信号通路的抑制因子D53蛋白积累，促进了分蘖。研究揭示了通过调控独脚金内酯受体基因D14的转录和剪接来调控水稻分蘖的新通路，为水稻株型改良提供了新启示。

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2．成功研发高效代理引导基因编辑器并在水稻中率先实现多基因精准编辑

简介：近日，中国农业科学院作物科学研究所作物精准育种技术创新团队，成功研发出高效代理引导基因编辑器PE3-HS、PE3-AS和PE3-DS，并率先在水稻中实现多个基因同时精准编辑，进一步拓展了引导编辑系统在农作物多基因聚合育种中的应用。5月25日，相关成果在线发表在《分子植物（Molecular Plant）》杂志上。据夏兰琴介绍，引导编辑系统（PE）能够在不存在DNA双链断裂缺口和DNA供体修复模板的情况下，实现小片段靶向插入、删除和所有类型的单碱基自由转换和颠换，为农作物基因组精准编辑提供了有效工具，将极大提高农作物定向育种效率。但是，目前已报道的植物引导编辑存在编辑效率低、靶点依赖性强，且仅限于单个基因的引导编辑。针对上述问题，研发团队在前期研究基础上，进一步优化PE3引导编辑系统，分别建立了基于潮霉素抗性基因的代理引导基因编辑器PE3-HS、基于双草醚抗性基因的代理引导基因编辑器PE3-AS、基于潮霉素抗性基因和双草醚抗性基因的双代理引导基因编辑器PE3-DS。研究人员分别利用上述3种代理引导基因编辑器对水稻内源 OsSPL14 、 OsDHDPS 和 OsNR2 基因进行编辑，分别获得了 OsSPL14 、OsDHDPS 和 OsNR2 基因精准编辑的水稻植株。与对照（PE3）相比，PE3-HS 和PE3-AS编辑器将基因精准编辑效率提高了约2-14倍，双代理PE3-DS编辑器将精准编辑效率最高可提高约50倍，表明代理引导基因编辑器的研发和应用可显著提高植物引导编辑效率，大大节约了劳力和物力。在此基础上，该研究利用双代理PE3-DS编辑器对不同内源基因组合： OsSPL14 和 OsDHDPS 、 OsSPL14 和 OsEPSPS 、 OsSPL14 和 OsVQ25 、 OsSPL14 和 OsCYP71A1 、 OsDHDPS 和 OsVQ25 同时进行精

准编辑（或精准编辑/基因敲除），获得了多个内源基因同时精准编辑（或精准编辑/基因敲除）的水稻新材料。代理引导基因编辑器的开发和利用，为作物多基因精准编辑提供了有效工具，有望在水稻等农作物中一代实现多个优异等位基因聚合，大大加快育种进程。

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学术文献

1. Characterization and fine mapping of RTMS10, a semi-dominant reverse thermo-sensitive genic male sterile locus in rice(水稻半显性逆温敏核不育基因座RTMS10的特性及精细定位)

简介: The discovery and application of environment-sensitive genic male sterile (EGMS) rice germplasm provide an easy method for hybrid rice breeding and have made great contributions to hybrid rice production. Typically, the photoperiod- and thermosensitive GMS (P/TGMS) lines utilized in two-line hybrid systems are male sterile under long day or/and high temperature but fertile under short day or/and low temperature conditions. However, YannongS (YnS), a reverse TGMS (rTGMS) line, is sterile under low temperature (29 degrees C) and fertile under high temperature (29.5 degrees C). Here, we report a genetic study on the rTGMS trait in YnS. Interestingly, the F1 plants of the cross between YnS and a cultivar, L422, were male sterile at 22 degrees C and completely fertile at 27 degrees C. Moreover, the segregation ratio of fertile and sterile individuals in YnS/L422 F2 populations changed from 1:3.05 to 2.95:1 when the ambient temperature increased, showing that the rTGMS trait exhibits semidominance in YnS. We further found a locus on chromosome 10, termed RTMS10, which controls the rTGMS trait in YnS. We then finely mapped RTMS10 to a -68 kb interval between markers ID13116 and ID1318 by YnS/L422 BC6F2 populations. A near iso-genic line (NIL) NL1 from the BC6F3 generation was developed and the pollen of NL1 became abnormal from the meiosis stage under low temperature. In summary, we identified an rTGMS locus, RTMS10, and provided co-segregated markers, which could help to accelerate molecular breeding of rTGMS lines and better understand the rTGMS trait in rice.

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2. Detection and Dynamic Variation Characteristics of Rice Nitrogen Status after Anthesis Based on the RGB Color Index(基于RGB颜色指数的水稻花后氮素状况检测及动态变化特征)

简介：We aimed to elucidate the color changes of rice leaves after anthesis and create an algorithm for monitoring the nitrogen contents of rice leaves and of the whole plant. Hence, we aimed to provide a theoretical basis for the precise management of rice nitrogen fertilizer and the research and development of digital image nutrition monitoring equipment and reference. We selected the leaf colors of the main stems of four major rice varieties promoted in production, including Huaidao 5 (late-maturing medium japonica rice), Yangjing 4227 (early maturing late japonica rice), Changyou 5 (late japonica hybrid rice), and Yongyou 8 (late japonica hybrid rice). Under different nitrogen levels, the leaf R, G, and B values of the four rice varieties at different stages after anthesis, the dynamic changes in RGB normalized values, the correlations between RGB normalized values and leaf SPAD values, the leaf nitrogen content and whole plant nitrogen content, and the nitrogen prediction model were studied. The research results demonstrate the following: (1) regardless of nitrogen levels, the leaf of R, G, B, NRI, NGI and NBI of different rice varieties after anthesis followed the order, G > R > B. R, G, NRI, NGI, and days after heading could be fitted according to a logarithmic equation, y = ae(bx) (0.726 <= R-2 <= 0.992); B, NBI, and days after heading could be fitted using a linear equation, y = a + bx (0.863 <= R-2 <= 0.992). Both fitting effects were significant (except NGI). (2) A quadratic function (Y = -1296.192x(2) + 539.419x - 10.914; Y = -1173.104x(2) + 527.073x - 12.993) was adopted to construct a monitoring model for the NBI and SPAD values of japonica rice and hybrid japonica rice leaves after anthesis and the R-2 values were 0.902 and 0.838, respectively. Exponential functions (Y = 5.698e(7.261x); Y = 3.371e(9.326x)) were employed to construct monitoring models of leaf nitrogen content, and the R-2 values were 0.833 and 0.706, respectively. Exponential functions (Y = 5.145e(4.9143x); Y = 3.966e(5.364x)) were also used to construct a monitoring model for the nitrogen content of the whole plant, and the R-2 values were 0.737 and 0.511, respectively. The results obtained from prediction tests by using Determination Coefficient (R-2), Relative Percent Deviation (RPD), and Root Mean Square Error (RMSE) showed that it was feasible, accurate, and efficient to use a scanner for measuring the nitrogen content of rice.

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3. Geographic variation in the yield formation of single-season high-yielding hybrid rice in southern China（华南地区单季高产杂交水稻产量形成的地理变异）

简介：Environmental conditions greatly affect the growth of rice. To investigate the geographic differences in yield formation of single-season high-yielding hybrid rice in southern China, experiments were conducted in 2017 and 2018 in the upper and middle-lower reaches of the Yangtze River with 10-30 main locally planted high-yielding hybrid cultivars used as materials. Compared with rice planted in the middle-lower reaches of the Yangtze River, rice planted in the upper reaches has a longer tillering duration, higher accumulated temperature (>= 10 degrees C) during tillering period, but lower accumulated

temperature and solar radiation from initial booting to maturity. Yield traits comparison between the upper and the middle-lower reaches of Yangtze River showed that the former had 48.1% more panicles per unit area while the latter had 46.4% more grains per panicle; the rice yield in the former was positively correlated with the seed setting rate and the dry matter accumulation before heading, while the latter was positively correlated with grains per panicle and dry matter accumulation from booting to maturity. Comparison of the same variety Tianyouhuazhan planted in different regions showed there was a significant positive correlation between panicle number and the duration of and accumulated temperature during the tillering period (r=0.982**, r=0.993**, respectively), and between grains per panicle and accumulated solar radiation during booting period (r=0.952*). In the upper reaches of the Yangtze River, more than 90% of cultivars with an yield of greater than 11 t ha(-1) had an effective panicle number of 250-340 m(-2), and there was a significant negative correlation between seed setting rate and grains per panicle; therefore, the high-yielding rice production in these regions with a long effective tillering period (40 d) should choose varieties with moderate grains per panicle, adopt crop managements such as good fertilizer and water measures during vegetative growth period to ensure a certain number of effective panicles, and to increase the dry matter accumulation before heading. While in regions with a short effective tillering period (<20 d) but good sunshine conditions during the reproductive growth period, such as the middle-lower reaches of the Yangtze River, high-yielding rice production should choose cultivars with large panicles, adopt good water and fertilizer managements during the reproductive growth period to ensure the formation of large panicles and the increase of dry matter accumulation after heading.

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