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2022年8月22日

前沿资讯

1．专家团队发现一新型水稻细胞质雄性不育和育性恢复系统

简介：2022年8月15日，华中农业大学张启发院士和欧阳亦聃教授团队联合中国种子集团生命科学技术中心周发松研究员在美国国家科学院院刊（PNAS）在线发表了题为Fujian cytoplasmic male sterility and the fertility restorer gene OsRf19 provide a promising breeding system for hybrid rice的最新成果。该研究克隆了水稻CMS-FA型细胞质雄性不育的不育基因FA182和恢复基因OsRf19，初步解析了OsRf19恢复育性的机理，并通过育种应用证明了水稻CMS-FA/OsRf19系统具有重要的育种应用价值。CMS-FA/OsRf19是由福建农林大学王乃元教授发现和建立的杂交稻育种体系，其雄性不育性来自于福建的野生稻，为孢子体不育，败育性彻底，单基因恢复且恢复力强。王乃元教授已用这个体系培育出多个优良杂交稻组合。以此为基础，本文发表的研究工作克隆了雄性不育基因和恢复基因，并进行了作用机理分析。为了找到导致雄性不育的细胞质基因，研究人员对不育系的线粒体基因组进行了测序，通过与多个水稻线粒体基因组进行比对分析，发现了一个部分序列与高粱线粒体基因组序列同源的嵌合基因FA182，将其转化水稻导致雄性不育，该基因还可抑制大肠杆菌的生长。研究人员通过遗传分析将恢复基因OsRf19定位在水稻第10染色体上35 kb的范围内，并在这个区间内预测到四个编码PPR类蛋白的基因，随后通过遗传转化和CRISPR/Cas9突变证实了OsRf19控制水稻CMS-FA的育性恢复。进一步研究表明恢复基因OsRF19蛋白通过剪切不育基因FA182的转录本以极大地降低其含量从而恢复育性；在花药中恢复基因OsRf19能够降低不育基因90%的转录本含量。研究人员利用多个已测序的野生稻和栽培稻的基因组数据进行了OsRf19的演化分析，发现OsRf19为一个PPR基因簇成员，与已经克隆的水稻恢复基因Rf1a/Rf5来自于一个共同的祖先。为展示CMS-FA/OsRf19系统的应用前景，该研究用CMS-FA不育胞质和OsRf19恢复基因培育了多个不育系和恢复系，配制了杂交稻组合。田间试验表明所配制的杂交稻具有优良的农艺性状和产量表现。该研究所展示的单个基因OsRf19能完全恢复不育系的育性这一结果，为杂交稻的培育提供了理论基础和基因资源，具有重要的应用前景。

来源：华中农业大学

发布日期:2022-08-17

全文链接:

http://agri.ckcest.cn/file1/M00/10/0D/CsgkOGL96ZSATxwPAAI2OgSLGOo334.pdf

2．专家团队揭示水稻广谱抗病性与生长平衡机制

简介：8月16日，中国农业科学院植物保护研究所作物病原生物功能基因组研究创新团队和作物科学研究所作物精准育种技术创新团队合作在细胞子刊《细胞通讯》(Cell Reports)上发表了题为“A VQ-motif-containing protein fine-tunes rice immunity and growth by a hierarchical regulatory mechanism”的研究论文。该研究报道了VQ蛋白OsVQ25通过OsPUB73-OsVQ25-OsWRKY53层级调节机制平衡水稻广谱抗病性和生长的分子机制。水稻是我国重要的粮食作物，由稻瘟菌(Magnaporthe oryzae)和白叶枯菌(Xanthomonas oryzae pv . oryzae)侵染引起的稻瘟病和白叶枯病是严重影响水稻生产的重要真菌性和细菌性病害。挖掘水稻广谱抗病功能基因并解析其分子机制，对培育水稻抗病新品种和开发病害防控新策略具有重要意义。缬氨酸-谷氨酰胺

(Valine-glutamine, VQ)蛋白是一类含有保守VQ基序（FxxhVQxhTG）结构的蛋白家族。已有研究表明VQ蛋白在植物免疫反应中发挥重要作用，然而VQ蛋白调控植物抗病的分子机制还不清楚。本研究发现水稻OsVQ25蛋白与水稻U-box类型E3泛素连接酶OsPUB73和转录因子OsWRKY53相互作用平衡水稻广谱抗病性和生长。一方面，OsVQ25是OsPUB73泛素化的底物，OsPUB73通过26S蛋白酶体途径促进OsVQ25的降解从而正向调控水稻对稻瘟菌及白叶枯菌的抗性 。 另一方面，OsVQ25与水稻抗性和生长调控因子OsWRKY53相互作用并抑制其转录活性，从而平衡水稻抗病性与生长发育。遗传分析表明，敲除 OsVQ25 能够增强水稻对两种病原菌的广谱抗性，但不影响水稻的其它主要农艺性状，说明OsVQ25有望成为水稻抗病性改良的优异基因。总之，本研究揭示了OsPUB73-OsVQ25-OsWRKY53模块平衡水稻广谱抗病性和生长的层级调控机制，为培育广谱抗病水稻品种提供了重要理论基础和候选基因。

来源：中国农业科学院植物保护研究所

发布日期:2022-08-17

全文链接:

http://agri.ckcest.cn/file1/M00/03/3B/CsgkOYdUmSiAU_AnAAQ3oOzkEKY816.pdf

学术文献

1. Heat Stress During Gametogenesis Irreversibly Damages Female Reproductive Organ in Rice(水稻配子发生过程中的热胁迫对雌性生殖器官造成不可逆的损害)

简介：Heat stress during gametogenesis leads to spikelet sterility. To ascertain the role of female reproductive organ (pistil), two rice genotypes N22 and IR64 with contrasting heat stress responses were exposed to control (30 degrees C) and heat stress (38 degrees C and 40 degrees C) during megasporogenesis. Anatomical observations of ovule revealed greater disappearance of megaspore mother cell and nuclei at early stages, and during later stages mature embryo sac without female germ unit, improper positioning of nuclei, and shrunken embryo sac was observed in the sensitive IR64. Under heat stress, a decrease in sugar and starch, increase in H2O2 and malondialdehyde with lower antioxidant enzyme activities were recorded in pistils of both N22 and IR64. Lower accumulation of TCA cycle metabolites and amino acids were noticed in IR64 pistils under heat stress at gametogenesis, whereas N22 exhibited favorable metabolite profiles. At heading, however, N22 pistils had higher carbohydrate accumulation and better ROS homeostasis, suggesting higher recovery after heat stress exposure. In summary, the results indicate that heat stress during megasporogenesis leads to irreversible anatomical and physiological changes in pistil and alters metabolic signatures leading to increased spikelet sterility in rice. Mechanisms identified for enhanced heat tolerance in pistil can help in developing rice varieties that are better adapted to future hotter climate.

来源：RICE

发布日期:2022-06-28

全文链接:

http://agri.ckcest.cn/file1/M00/03/3B/CsgkOYdUbDmAZpzMACM67RVt8E0303.pdf

2. Thermo-Sensitive Genic Male Sterile Lines of Neo-Tetraploid Rice Developed through Gene Editing Technology Revealed High Levels of Hybrid Vigor(通过基因编辑技术开发的新四倍体水稻温敏核不育系显示出高水平的杂交活力)

简介：Neo-tetraploid rice, which developed from the progenies of autotetraploid hybrid by our research group, is a useful germplasm with high fertility and strong heterosis when they crossed with other autotetraploid rice lines. The CRISPR/Cas9-mediated TMS5 gene editing system has been widely used in diploid rice, but there are few reports in tetraploid rice. Here, we used CRISPR/Cas9 technology to edit the TMS5 gene, which is a temperature sensitive gene controlling the fertility in diploid rice, in neo-tetraploid rice to develop male sterile lines. Two mutant lines, H2s and H3s, were developed from the gene editing and displayed characteristics of thermo-sensitive genic male sterility. The daily mean temperatures of 23 degrees C to 26 degrees C were found to be critical for sterility (restrictive temperature) in H2s and H3s under both controlled (growth chambers) and natural growing conditions (field). Cytological observation showed the anther dysplasia appeared later in H2s and H3s than that of the TMS5 mutant of diploid rice (E285s) under the same conditions. Then these mutant lines, H2s and H3s, were crossed with tetraploid rice to generate F-1 hybrids, which exhibited obvious advantages for effective number of panicles, total grains and seed setting. The high levels of hybrids heterosis were maintained for several generations that can save seed cost. Our research provides an effective way of developing thermo-sensitive genic male sterility (TGMS) lines of tetraploid rice using gene editing, which will accelerate the utilization of polyploid heterosis.

来源：PLANTS-BASEL

发布日期:2022-05-24

全文链接:

http://agri.ckcest.cn/file1/M00/10/0D/CsgkOGL9vSGAXzMzAB53Fs_PNDQ120.pdf

3. Contrasting Characteristics of Lodging Resistance in Two Super-Rice Hybrids Differing in Harvest Index(两个收获指数不同的超级稻杂交种抗倒伏特性对比)

简介：The "super rice" breeding program in China has been successful in developing high-yielding hybrids, including few with high harvest index values. However, there is limited information on the relationship between lodging resistance and harvest index, and the mechanisms underlying the relationship in super-rice hybrids. In this study, a two-year field experiment was conducted to compare lodging resistance and its related traits between two super rice hybrids differing in harvest index, i.e., Guiliangyou 2 (G2) with a high harvest index and Y-liangyou 1 (Y1) with a typical harvest index of modern high-yielding rice varieties. Results showed that compared to Y1, G2 was lower in plant height due to its lower aboveground N uptake, and its higher stem breaking resistance (i.e., lower stem breaking index) resulted from a lower stem height at its center of gravity. Consequently, G2 had a

higher lodging resistance (i.e., lower plant lodging index) than Y1. This study suggests that developing super-rice hybrids with high harvest index values is a possible way to achieve both high grain yield and strong lodging resistance in rice.

来源：PHYTON-INTERNATIONAL JOURNAL OF EXPERIMENTAL BOTANY
发布日期:2021-10-17
全文链接:
http://agri.ckcest.cn/file1/M00/10/0D/CsgkOGL9uoCAZcx-AAclZ39QGhk019.pdf