2022年第23期总156期

杂交水稻专题

本期导读

前沿资讯

学术文献

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2022年6月6日

前沿资讯

1．院士团队在水稻耐低氮和耐盐碱遗传育种领域取得新进展

简介：水稻耐低氮和耐盐碱是多基因控制的复杂性状。研究水稻应对低氮和盐碱环境的关键基因及其调控网络，对于培育耐低氮耐盐碱水稻品种具有重要科学意义和应用价值。近日，国际著名期刊Plant Journal和New Phytologist发表了万建民院士团队在水稻耐低氮和耐盐碱遗传育种领域的研究新进展。在水稻耐低氮方面，他们通过QTL mapping 和GWAS破译植物耐低氮性状的遗传变异，鉴定了一个与氮利用效率（NUE，Nitrogen Use Efficiency）相关的籽粒发育基因OsGS1;1，揭示了水稻氮同化基因GS1;1自然变异和促进籽粒发育的分子机制（Alternative splicing of OsGS1;1 affects nitrogen-use efficiency, grain development, and amylose content in rice, Plant Journal, 2022 doi: 10.1111/tpj.15768）。研究发现该基因通过可变剪切产生两种转录本，均可编码具有活性的谷氨酰胺合成酶。其高活性转录本OsGS1;1b的过表达可提高NUE，促进籽粒发育，为低氮条件下高产优质水稻育种提供新途径。在水稻耐盐碱方面，已知植物盐害包括离子胁迫、渗透胁迫和氧化胁迫。其中离子胁迫是由植物细胞内盐离子的毒性作用引起的。他们鉴定了水稻盐敏感突变体shs1，克隆了编码微管蛋白OsTUB1的SHS1基因，阐明了微管蛋白在盐胁迫中稳定离子平衡的作用机制(OsTUB1 confers salt-insensitivity by interacting with Kinesin13A to stabilize microtubule and ion transporter in rice, New Phytologist 2022 doi:10.1111/nph.18282)。研究发现OsTUB1/OsKinesin13A在盐胁迫下可以稳定钠离子转运蛋白OsHKT1;5，进而维持离子平衡，保护水稻免受盐胁迫毒害。

来源：南京农业大学

发布日期:2022-05-31

全文链接:

http://agri.ckcest.cn/file1/M00/10/05/CsgkOGKYfkWAdjTCAALGhiGFH28674.pdf

2．万建民院士团队发现调控稻米直链淀粉含量的新基因

简介：近日，南京农业大学万建民院士团队在Plant Biotechnology Journal在线发表了题为“Du13 encodes a C2H2 zinc-finger protein that regulates Wxb pre-mRNA splicing and microRNA biogenesis in rice endosperm”的研究论文。直链淀粉含量是稻米蒸煮食味品质的主要决定因素。Wx基因编码的淀粉颗粒结合淀粉合酶（GBSSI）在直链淀粉的合成中起关键作用。Wx基因有Wxa和Wxb两种等位变异，存在于籼稻中的Wxa比在粳稻中的Wxb具有更强的转录活性，导致籼稻具有更高的直链淀粉含量。而Du11基因可调控Wxb基因的剪接和转录效率，du11突变体通常表现暗胚乳表型和更低的直链淀粉含量及更好的食味品质。但Wxb剪接如何受不同Du11基因调控尚不清楚。该研究克隆了一个调控稻米直链淀粉含量的新基因Du13，该基因编码一个C2H2锌指蛋白，主要增强Wxb的剪接效率，该基因突变导致Wxb第1内含子的剪接效率急剧下降，从而导致GBSSI蛋白和活性显著降低，直链淀粉含量降低。随后研究发现，Du13突变还影响了胚乳内许多pre-mRNA的可变剪接，并降低了一些重要microRNA的丰度。这些microRNA的前体在du13胚乳中积累，说明Du13影响microRNA前体的加工。进一步研究发现Du13与microRNA加工所需的关键蛋白OsHYL1互作。该研究揭示了mRNA和microRNA加工之间的紧密联系，在单、双子叶植物中均是进化上保守的，并展现了Du13基因在改良水稻食味品质中的应

用价值。
来源：南京农业大学
发布日期:2022-05-31
全文链接:
http://agri.ckcest.cn/file1/M00/03/33/CsgkOYbvLSSAeWhKAAPw9OxWfM4464.pdf

3．专家揭示稻曲菌抑制水稻免疫的新机制

简介：近日，华中农业大学植物科学技术学院黄俊斌课题组在New Phytologist上在线发表题为“A secreted fungal effector suppresses rice immunity through host histone hypoacetylation”的研究论文。该研究从表观遗传水平揭示了稻曲菌效应蛋白操纵水稻组蛋白去乙酰化抑制寄主免疫的新机制。研究人员首先联合分析稻曲菌分泌组和转录组数据，选取19个侵染早期上调表达的候选分泌蛋白进行基因敲除，室内接种发现分泌蛋白UvSec117的基因敲除突变体致病力显著减弱。通过酵母分泌系统证明其信号肽具有分泌活性，信号肽缺失导致突变体致病力降低。进一步通过酵母双杂交库筛选到互作蛋白水稻组蛋白去乙酰化酶OsHDA701，采用Y2H、Co-IP、GST pull-down以及BiFC证明UvSec117与OsHDA701在细胞核和细胞质中互作。为明确OsHDA701在水稻中的抗感功能，在水稻中沉默OsHDA701基因，发现OsHDA701-RNAi 转基因水稻对稻曲病、稻瘟病和水稻白叶枯病的抗性增强，说明OsHDA701负调控水稻的广谱抗病性。进一步将UvSec117和OsHDA701进行共表达，通过荧光观察和Western blot证明OsHDA701在细胞核中含量明显增加，说明UvSec117可招募更多的OsHDA701蛋白进入细胞核。一系列体内、体外生化试验证明OsHDA701主要清除组蛋白H3K9乙酰化修饰，而UvSec117增强了OsHDA701的去乙酰化活性。在水稻中异源超表达UvSec117，35S-UvSec117转基因水稻对稻曲病、稻瘟病和白叶枯病更为感病，且转基因水稻中H3K9乙酰化修饰水平显著降低，表明UvSec117干扰了水稻H3K9乙酰化修饰。ChIP-seq鉴定发现35S-UvSec117转基因水稻中H3K9乙酰化修饰调控的靶基因数量显著减少，RT-qPCR和ChIP-PCR证明35S-UvSec117转基因水稻中H3K9乙酰化修饰调控的抗病相关基因表达量显著降低，说明UvSec117通过影响水稻组蛋白H3K9乙酰化修饰干扰抗病基因表达。综上，稻曲菌可分泌一种毒性效应蛋白UvSec117进入寄主细胞中，与水稻组蛋白去乙酰化酶OsHDA701靶向互作，通过UvSec117的核定位信号将大量的OsHDA701招募到细胞核，同时UvSec117与OsHDA701互作过程中可增强OsHDA701去乙酰化活性，从两方面降低水稻组蛋白H3K9乙酰化水平，进而干扰防御基因的激活和寄主免疫。这是第一个直接证据证实植物病原真菌效应蛋白靶向寄主组蛋白去乙酰化酶抑制植物免疫；在表观遗传水平揭示了稻曲菌乃至植物病原真菌中一种新的致病策略，拓宽了我们对病原菌抑制寄主免疫途径的认识。研究中获得的水稻广谱抗病性负调控因子OsHDA701，对于水稻抗病育种和分子设计改良具有重要的科学利用价值。
来源：华中农业大学
发布日期:2022-05-23
全文链接:
http://agri.ckcest.cn/file1/M00/03/33/CsgkOYbvMFKAZ102AAJ58SCPdnA368.pdf

学术文献

1．Identification of Heterotic Loci with Desirable Allelic Interaction

to Increase Yield in Rice(水稻等位基因互作优势位点的筛选)

简介：Heterosis denotes the superiority of a hybrid plant over its parents. The use of heterosis has contributed significantly to yield improvement in crops. However, the genetic and molecular bases on heterosis are not fully understood. A large number of heterotic loci were identified for 12 yield-related traits in one parental population of chromosome segment substitution lines (CSSLs) and two test populations, which were interconnected by CSSLs derived from two rice genome-sequenced cultivars, Nipponbare and Zhenshan 97. Seventy-five heterotic loci were identified in both homozygous background of Zhenshan 97 and heterogeneous background of an elite hybrid cultivar Shanyou 63. Among the detected loci, at least 11 were colocalized in the same regions encompassing previously reported heterosis-associated genes. Furthermore, a heterotic locus Ghd8(NIP) for yield advantage was verified using transgenic experiments. Various allelic interaction at Ghd8 exhibited different heterosis levels in hetero-allelic combinations of five near-isogenic lines that contain a particular allele. The significant overdominance effects from some hetero-allelic combinations were found to improve yield heterosis in hybrid cultivars. Our findings support the role of allelic interaction at heterotic loci in the improvement of yield potential, which will be helpful for dissecting the genetic basis of heterosis and provide an optional strategy for the allele replacement in molecular breeding programs in hybrid rice.

来源：RICE

发布日期:2021-11-26

全文链接:

http://agri.ckcest.cn/file1/M00/10/04/CsgkOGKV2naARi10AB7se1SNxkg645.pdf

2. Characteristics of Fertility Transition Response to the Cumulative Effective Low Temperature in a Two-Line Male Sterile Rice Cultivar(两系雄性不育水稻品种育性转换对累积有效低温的响应特征)

简介：Background Photo-thermo-sensitive genic male sterile (PTGMS) rice (Oryza sativa L.) is usually considered two-line male sterile rice because of its dual-purpose in two-line hybrid rice system: under short days and low temperatures, it is fertile and used for self-propagation, but under long days and high temperatures, it is sterile and used for hybrid seed production. Therefore, photoperiod and temperature conditions are extremely important for the fertility transition of two-line male sterile rice. In recent years, there have been frequent occurrences of abnormally low-temperature (ALT) resulting in failure of two-line hybrid rice seed production. The daily average temperature (DAT) during ALT events is sometimes higher than the critical sterility-inducing temperature (CSIT) of two-line male sterile rice, of which the night temperature is lower than the CSIT. DAT has been traditionally used as the single indicator of pollen fertility transition, but it is unknown why the fertility of two-line male sterile rice in seed production restored fertility under ALT conditions. Results For Hang93S (H93S), a newly released PTGMS line, we hypothesized fertility transition is determined mainly by the cumulative effective low temperature (ELT) and only a certain duration of low temperature is required every day during the fertility-sensitive period. This study simulated

ALTs where the DAT was higher than the CSIT while some segments of night temperature were lower than the CSIT. The results showed H93S exhibited a fertility transition to varying degrees. Moreover, fertility was restored under simulated ALT conditions and pollen fertility increased with increasing cumulative ELT, indicating that the fertility transition was affected primarily by the cumulative ELT. Results also indicated that pollen fertility increased as the number of treatment days increased. Conclusions The fertility transition is caused mainly by the cumulative ELT. In two-line male sterile rice breeding, the effects of day length, ALT at night, and continuous response days should be considered together. The present study provides new insight into fertility transition so breeders can more effectively utilize the two-line male sterile rice, H93S, in breeding programs.

来源：RICE
发布日期:2021-08-03
全文链接:
http://agri.ckcest.cn/file1/M00/03/32/CsgkOYbsiNOAB9xZAA4qRwU-RP8589.pdf