作物学报 2007 33 (2): 242-249 ISSN: 0496-3490 CN: 11-1809/S

研究论文

CIMMYT新型人工合成小麦Pina和Pinb基因等位变异

李根英[1,2,3],夏先春[2],张明[2],张勇[2],何中虎[2,4,*],孙其信[1]

1中国农业大学农学与生物技术学院，北京100094 2中国农业科学院作物科学研究所，国家小麦改良中心/国家农作物基因资源与基因改良重大科学工程，北京100081 3山东省农业科学院作物研究所，山东济南250001 4国际玉米小麦改良中心CIMMYT中国办事处，北京100081

收稿日期 2006-4-30 修回日期 网络版发布日期 2007-1-17 接受日期 2006-6-13

摘要 六倍体人工合成小麦由硬粒小麦（*Triticum turgidum subsp.* durum）与粗山羊草（*Aegilops tauschii* Coss.）杂交产生,是研究小麦进化过程中基因变异的重要材料。以国际玉米小麦改良中心（CIMMYT）提供的57份由野生二粒小麦（*T. turgidum* subsp. *dicoccoides*）与粗山羊草杂交产生的新型人工合成六倍体小麦为材料，用单籽粒特性测定仪和*Pina*、*Pinb*特异性PCR引物对其籽粒硬度变异以及控制籽粒硬度的主效基因*Pina*和*Pinb*的分布情况进行了研究。结果表明，这些材料的SKCS硬度值变异较大，从10.5到42.6，其中15~30的占78%。共有*Pina-D1a*、*Pina-D1c*、*Pinb-D1h*和*Pinb-D1j* 4种等位变异型，基因型为*Pina-D1a/Pinb-D1j*的8个，占14%；基因型为*Pina-D1c/Pinb-D1h*的49个，占86%。方差分析表明，基因型*Pina-D1a/Pinb-D1j*与*Pina-D1c/Pinb-D1h*对籽粒硬度的影响差异不显著，但父本粗山羊草和母本野生二粒小麦以及二者间的互作对籽粒硬度有显著影响，说明除*Pina*和*Pinb*外，还有其他微效基因影响籽粒硬度的形成。

关键词 野生二粒小麦 粗山羊草 人工合成小麦 Pina和Pinb 籽粒硬度

分类号

Allelic Variations of Puroindoline a and Puroindoline b Genes in New Type of Synthetic Hexaploid Wheats from CIMMYT

LI Gen-Ying[123],XIA Xian-Chun[2],ZHANG Ming[2],ZHANG Yong[2],HE Zhong-Hu[24*],SUN Qi-Xin[1]

1 College of Agronomy and Biotechnology, China Agricultural University, Beijing 100094; 2National Wheat Improvement Center/Institute of Crop Sciences/The National Key Facility for Crop Gene Resources and Genetic Improvement, Chinese Academy of Agricultural Sciences, Beijing 100081; 3 Crop Research Institute, Shandong Academy of Agricultural Sciences, Jinan 250100, Shandong; 4CIMMYT China Office, Beijing 100081, China

Abstract *Triticum dicoccoides* and *Aegilops tauschii* are important germplasm resources of rich genetic variability for improvement of hexaploid wheat (T. *aestivum*). This variability can be accessed by utilizing synthetic hexaploid wheat lines with genomes from *Ae. tauschii* and *T. dicoccoides*. Two methods can be employed to incorporate Triticum dicoccoides and Aegilops tauschii genes into a hexaploid wheat. One is the direct cross method of hybridization between *Ae. tauschii* and hexaploid wheat, another is an indirect method of synthetic hexaploids by crossing tetraploid wheat with *Ae. tauschii*. Genes from tetraploid wheat and Aegilops tauschii are then available via direct crossing of synthetic hexaploids to *T. aestivum*. The CIMMYT (International Maize and Wheat Improvement Center) has produced two types of synthetic hexaploids. One is the progeny of *T. turgidum* ssp. *durum* crossing with *Ae. tauschii*, another is the new type synthetic wheat which produced by crossing Triticum dicoccoides with Aegilops tauschii.
Grain hardness is a major factor influencing the end-use quality. Genes for grain hardness in common wheat reside on Ha locus of chromosome 5DS. The wild-type alleles (*Pina-D1a*, *Pinb-D1a*) determine soft endosperm, while the hard phenotypes result from mutations in either Pina or Pinb. In order to understand the evolution of genes for grain hardness, studies have focused on the wild relatives of common wheat, particularly on *Ae. tauschii*, the supposed donor of the D genome in common wheat. Puroindoline a in Ae. tauschii contained 99.3% amino acid sequence homology to the wheat cultivar ‘Penawawa’ and 90.5% amino acid sequence homology in puroindoline b. Among 50 *Ae. tauschii* accessions, four alleles of puroindoline a and four alleles of puroindoline b were identified, encoding two and three different proteins, respectively. However, the effect that these sequence polymorphisms may have on kernel texture is unknown, as no test method of texture has been developed for *Ae. tauschii*. The incorporation of *Ae. tauschii* into synthetic hexaploid facilitates the analysis of puroindoline sequence polymorphism and other genetic effects on kernel texture, using testing methods designed for hexaploid wheat, such as the Perten single kernel characterization system (SKCS). Analysis of synthetic hexaploid can also facilitate the analysis of the effect of the A and B genomes, contributed by the tetraploid wheat parent on kernel texture. Studies on *Ae. tauschii* and synthetic hexaploid wheat derived from hybridization of *T. turgidum* ssp. *durum* with *Ae. tauschii* demonstrated a number of novel Pina and Pinb sequences. However, none of these Pina and Pinb mutations produced a hard endosperm texture in synthetic wheat. To further understand the mechanism of grain hardness formation in *Ae. tauschii* and synthetic wheat, a t

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otal of 57 new type synthetic hexaploid lines derived from the crosses *T. dicoccoides*×Ae.tauschii were employed to evaluate the SKCS hardness and detect puroindoline alleles using gene specific PCR primers. Four allelic variations of Pina and Pinb were identified, i.e., Pina-D1a, *Pina-D1c*, *Pinb-D1h*, and *Pinb-D1j*. Eight lines were *Pina-D1a/Pinb-D1j* types, accounting for 14%, and 49 were *Pina-D1c/Pinb-D1h* types, accounting for 86%. Kernel texture differed significantly among the synthetic hexaploid lines, ranging from 10.5 to 42.6, with significant difference among the parental types, *T. dicoccoides* or *Ae. tauschii*. The interactions between parental genotypes had also a significant influence on kernel texture. These results indicated that there might be some genes besides Ha locus associated with the kernel texture.

Key words Triticum dicoccoides Aegilops tauschii Synthetic hexaploid wheat Pina and Pinb alleles Kernel texture

DOI:

通讯作者 何中虎 zhhe@public3.bta.net.cn