Mapping resistance gene to leaf rust in wheat line KS91WGRC11 using quantitative bulked segregant analysis and DArT platform

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ABSTRACT

Leaf rust caused by Puccinia triticinia is one of the most devastating foliar diseases of wheat. Major leaf rust resistance gene Lr42 identified on chromosome 1D of T. tauschii was transferred to common wheat line KS91WGRC11 (= Century’3/T. tauschii TA2450, T. tauschii TA2450) (Kansas State University, Manhattan, KS, USA). Recently, using molecular markers resistance gene Lr42 was located on chromosome 2D. According to our preliminary mapping neither 1D nor 2D harbor resistance gene to leaf rust in line KSWGRC11. Based upon novel marker technology DArT (Diversity Arrays Technology) and quantitative bulked segregant analysis we can conclude that resistance is conditioned by a gene located on chromosome 3D. However, this notion has to be confirmed in further mapping experiments.

Keywords: DNA markers, Puccinia triticinia, resistance locus, Triticum aestivum

INTRODUCTION

Leaf rust (Puccinia triticina Erks.) is one of the most important foliar diseases of wheat (Triticum aestivum L.) worldwide. High genetic variability of the pathogen prompts breeders to stack few major resistance genes into a single cultivar. To effectively manipulate resistance genes, tightly linked molecular markers to resistance loci are required. Recently, a novel marker system called Diversity Arrays Technology (DArT) has been devised. Such system provides a practical and cost-effective whole-genome fingerprinting tool without the requirement of DNA sequence information comparing to other DNA markers (Jacquoud et al. 2001).

Wild relative of common wheat T. tauschii (genomes DD, 2n = 14) is a valuable source of resistance genes. Major leaf rust resistance gene Lr42 identified in T. tauschii was transferred to common wheat line KS91WGRC11 (= Century’3/T. tauschii TA2450, T. tauschii TA2450) (Cox et al. 1994). According to monosomic analysis resistance in line KSWGRC11 was conditioned by single partially dominant gene located on chromosome 1D (Cox et al. 1994). Recently, this line was used as source of resistance to leaf rust in mapping experiments and a resistance locus (putative gene Lr42) was located on chromosome 1D (Sun and Bai 2007), but also on 2D (personal communication, Robert Bowden and Sukhwinder Singh, Department of Plant Pathology, Kansas State University, Manhattan KS 66506, USA).

The objective of our study was to clarify the location of Lr42 gene in wheat genome and mapping closely linked molecular markers suitable for marker assisted selection.

RESULTS AND DISCUSSION

Observed segregation ratio among F3 families (37 susceptible, 67 heterozygous and 30 resistant) indicated that resistance was controlled by a single dominant gene. We could establish genetic maps for chromosomes 1D and 2D, comprising 13 and 9 microsatellite markers, respectively. The order of markers on each chromosome...
was consistent with the consensus genetic map of wheat published by Somers et al. (2004). The resistance locus (putative Lr42) could not be placed reliably on neither of the two chromosomes. We report a successful application of BSA strategy coupled with scanning of wheat DNA samples with thousands of polymorphism-enriched clones. In our experiment, we identified 30 clones that differ significantly (over 50%) in allele frequency between bulks and parents (figure 1). Only 13 of these 30 clones have been mapped and 11 of them are located on chromosome 3D. The other two are mapped on chromosomes 1B and 7D.

Figure 1. DArT-BSA genome scan for leaf rust resistance gene in the Aristos/KSWGRC11 population.

DArT-BSA assay confirmed our previous finding that resistance to leaf rust in line KS91WGRC11 is probably not located on chromosome 1D or 2D, but on chromosome 3D. The same source of resistance was used in mapping experiments and tight linkage with DNA markers was identified on chromosomes 1D (Sun and Bai, 2007) and 2D (personal communication, Robert Bowden and Sukhwinder Singh). However, in the later case it is likely that the resistance gene mapped on 2DS is different from gene Lr42. We can only speculate on the reasons for discrepancy on the location of the resistance to leaf rust in line KS91WGRC11. It is likely that different genetic materials were evaluated and described in the above mapping experiments or different resistance genes were transferred to line KS91WGRC11 form T. tauschii. Interestingly, resistance gene to leaf rust Lr32 derived from T. tauschii is also located on chromosome 3D (Kerber 1987, 1987). Further genetic and molecular analyses are required to discover possible gene(s) contributing to leaf rust resistance in line KS91WGRC11. In the next step, we will try to map this resistance gene on chromosome 3D using microsatellite markers.

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REFERENCES