

Identification, characterization and mapping of a new leaf rust (*Puccinia triticina*) resistance gene in spring wheat (*Triticum aestivum*)

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Introduction

- Leaf rust is the most common and widespread disease that affects wheat³ with average yield reductions between 5-15%⁴ and epidemic losses of upwards of 65%⁵
- Annual western Canadian losses estimated at \$88 million from 2001 – 2005⁶
- 60+ leaf rust resistance genes identified to date, most of which confer race specific resistance
- A series of near-isogenic wheat lines were developed in a Thatcher background, each with a single leaf rust resistance gene used for: world-wide virulence surveys, genetic studies of resistance genes, and host/parasite interaction experiments (Dr. Peter Dyck, Cereal Research Centre, AAFC, Winnipeg, Canada)
- After 2000, TDBG, a predominant race of leaf rust demonstrated avirulence to some lines of the Tc-*Lr1* near isogenic line (NIL) in a characteristic mesothetic infection type
- The Tc-*Lr1* NIL (RL6003) was demonstrated to contain an additional resistance gene in some lines which segregated independently of *Lr1*, this gene was temporarily designated *LrCen*
- TDBG also demonstrates avirulence to the Tc-*Lr14a* and Tc-*Lr20* NILs as well as Little Club, thought to be a universally susceptible cultivar
- A doubled haploid population of Tc-*LrCen*/Sumai3-*Lr34* was developed to further study this gene
- Preliminary phenotypic data on a diverse set of Canadian wheat lines indicate this gene may be widely distributed within the Canadian hard red spring wheat germplasm

Objectives

- To phenotypically characterize the leaf rust resistance gene, *LrCen*, derived from the Tc-*Lr1* NIL
- To map the leaf rust resistance gene and identify usable markers for marker assisted selection
- Perform allelism testing with *Lr14a* (7B), *Lr20* (7A) and Little Club
- Determine the distribution of *LrCen* within Canadian hard red spring wheat (CWRS) germplasm

References

¹FAOSTAT, 2012. <http://faostat.fao.org/site/339/default.aspx>; ²Oelke LM, Kolmer JA (2005) *Phytopath.* 95:773-778; ³Chu CG, Friesen TL, Xu SS, Farris JD, Kolmer JA (2009) *Theor Appl Genet.* 119:263-269; ⁴Singh A, Pallavi JK, Gupta P, Prabhu KV (2011) *Plant Breeding* 130:31-34; ⁵McCallum BD, Fecht T, Chong J (2007) *Aus J of Ag Res* 58:639-647; ⁶McCallum BD, Hiebert C (2012) *PAG XX*, January 14-19, 2012, San Diego, CA;

Materials and Methods

1. Phenotypic characterization of Tc-*LrCen* X Sumai3-*Lr34* DH population.



Figure 1. Phenotypic reactions observed on seedlings from the Tc-*LrCen*/Sumai3-*Lr34* doubled haploid population inoculated with leaf rust race TDBG, avirulent to *LrCen*.

2. Mapping process

Marker association

- Illumina Infinium[®] 90K SNP array
- Filter SNP markers - GenomeStudio[®]
- Initial two-point linkage

BLAST

- Wheat survey sequence
- Putative chr. locations for SNPs

Confirm and map location

- Chr.-specific SSR markers
- Map using MapDisto[®]

3. In progress...

Allelism test

- *LrCen* X *Lr20*
- *LrCen* X *Lr14a*
- *LrCen* X Little Club
- Little Club X *Lr20*
- *Lr14a* X *Lr20*
- *Lr14a* X Little Club

Distribution of *LrCen*

- Track in CWRS
- Develop KASPas SNP markers using the sequences from the linked Infinium markers
- Phenotype a panel of CWRS wheat varieties with race TDBG

Results

Table 1. Phenotypic segregation of *LrCen* within the Tc-*LrCen*/Sumai3-*Lr34* DH population inoculated with race TDBG.

Resistant lines	Susceptible lines	Expected ratio	P-value
108	84	1:1	0.081

Results

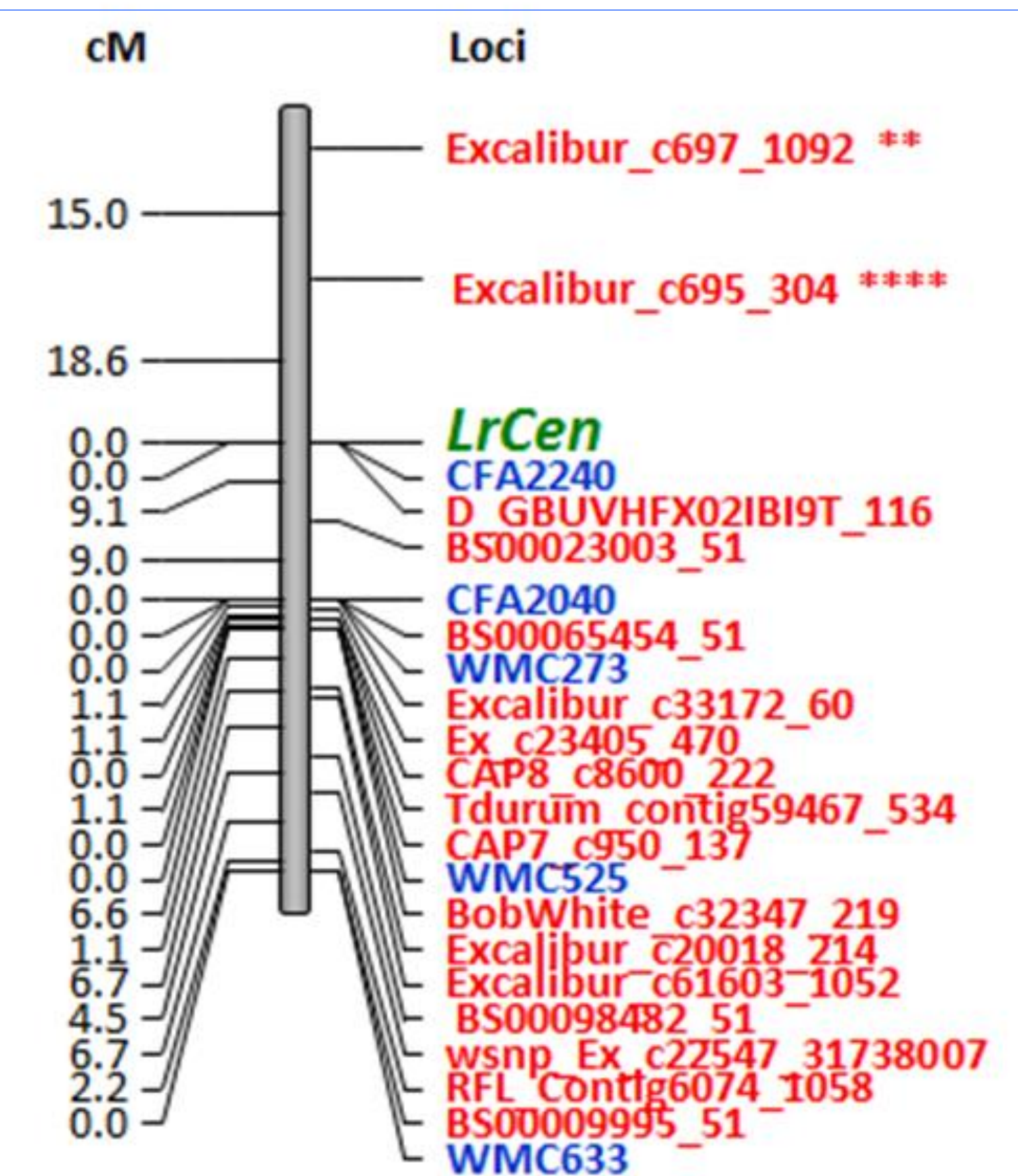


Figure 2. Preliminary linkage map created using MapDisto for SNP and SSR markers linked to *LrCen*.

Table 2. BLAST results for 133 linked SNP (Illumina Infinium assay) marker sequences against the Wheat Survey Sequence to determine the best putative chromosome location.

BLAST match order for 7AL	Number of SNPs	Percent of linked SNPs
Best match	101	76%
Second best match	14	11%
Third or worse match	15	11%
No match	3	2%

Preliminary Conclusions

- Preliminary marker data indicate a putative map location for *LrCen* on the long arm of chromosome 7A.
- The Tc-*Lr20* NIL appears to carry two genes, one of which appears to be *LrCen*. The relationship between these genes will be examined in future work.
- Preliminary phenotypic infection data with race TDBG indicate *LrCen* is widely distributed within the Canadian hard red spring wheat germplasm.

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