

Identification of candidate genes for resistance to mildew diseases in pea

Mishi Vachev¹, Kumar Garg¹, Ana Campa², Juan Jose Ferreira Fernandez², Kara Boyd¹, Alba Pacheco Moreno¹, Sanu Arora¹



¹John Innes Centre; ²Regional Agrifood Research and Development Service (SERIDA), Spain



The Problem

Pea (*Pisum sativum*) is an economically important crop that suffers from several biotic stresses, including downy mildew, caused by *Peronospora viciae*, and powdery mildew, caused by *Erysiphe pisi*. These diseases can cause yield losses of up to 75%¹ and 80%², respectively.

Only one resistance locus conferring downy mildew resistance in pea, *Rpv*³, has been mapped to date. For powdery mildew, the resistance genes *er1*, *er2* and *Er3*² have been described but additional sources of resistance are needed.



Downy mildew (top) sporulation on the underside of the leaf. Powdery mildew (bottom) white lesions throughout the plant.

Objective

Identify **loci conferring resistance** to downy and powdery mildew and evaluate **candidate genes**.

Methods

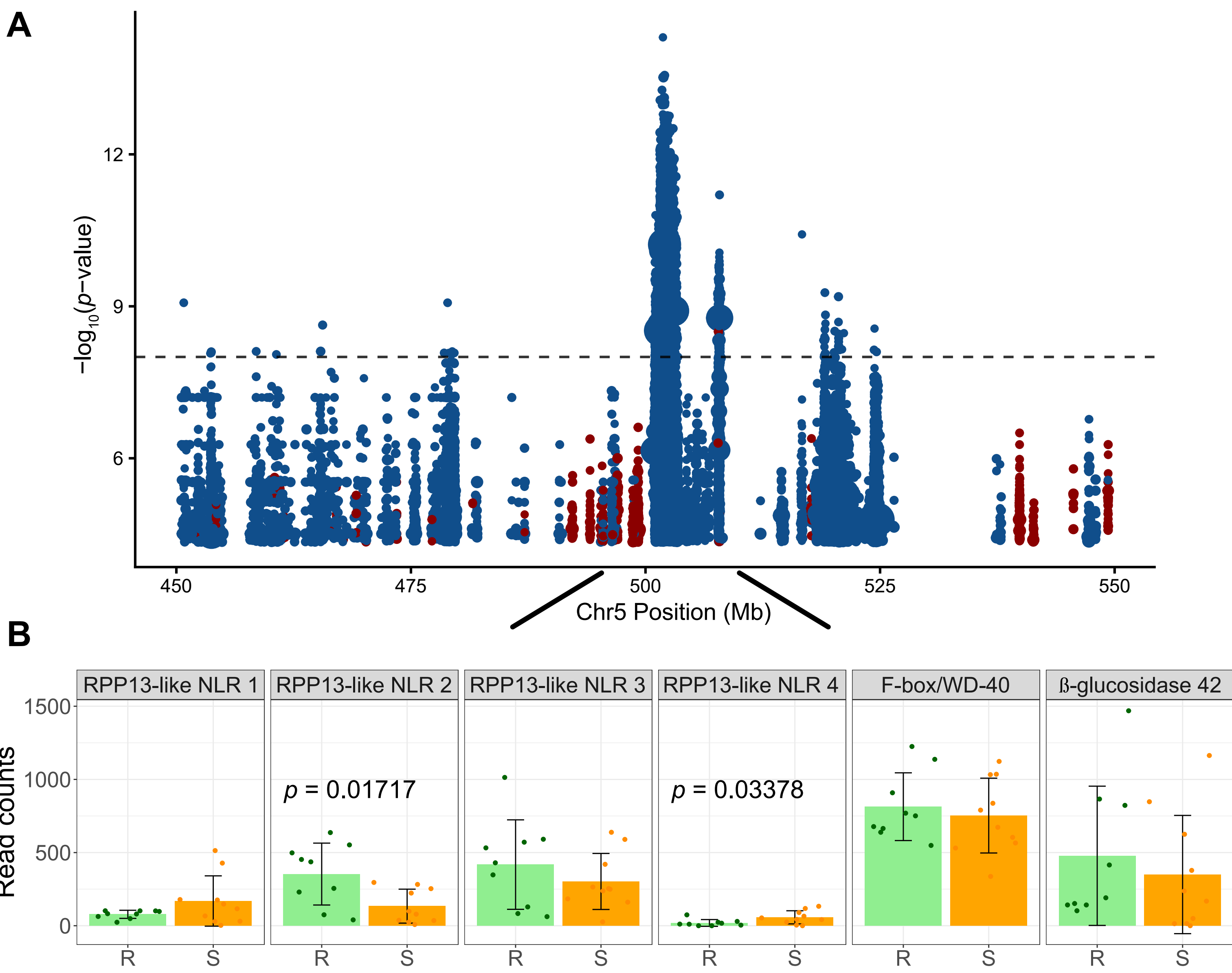
A panel of 243 diverse pea lines were screened for resistance to a race 1 downy mildew isolate in 2023 in a controlled environment by NIAB, and a panel of 262 lines were screened for resistance to powdery mildew in 2025 in a field trial by SERIDA.

Resistance was mapped using short-read sequences of the two panels⁴ and *k*-mer GWAS⁵. *k*-mers were mapped onto two genomes from resistant lines.

Expression of candidate genes was evaluated in 10 resistant and 10 susceptible lines using short-read RNAseq data, featureCounts⁶, and DESeq2⁷.

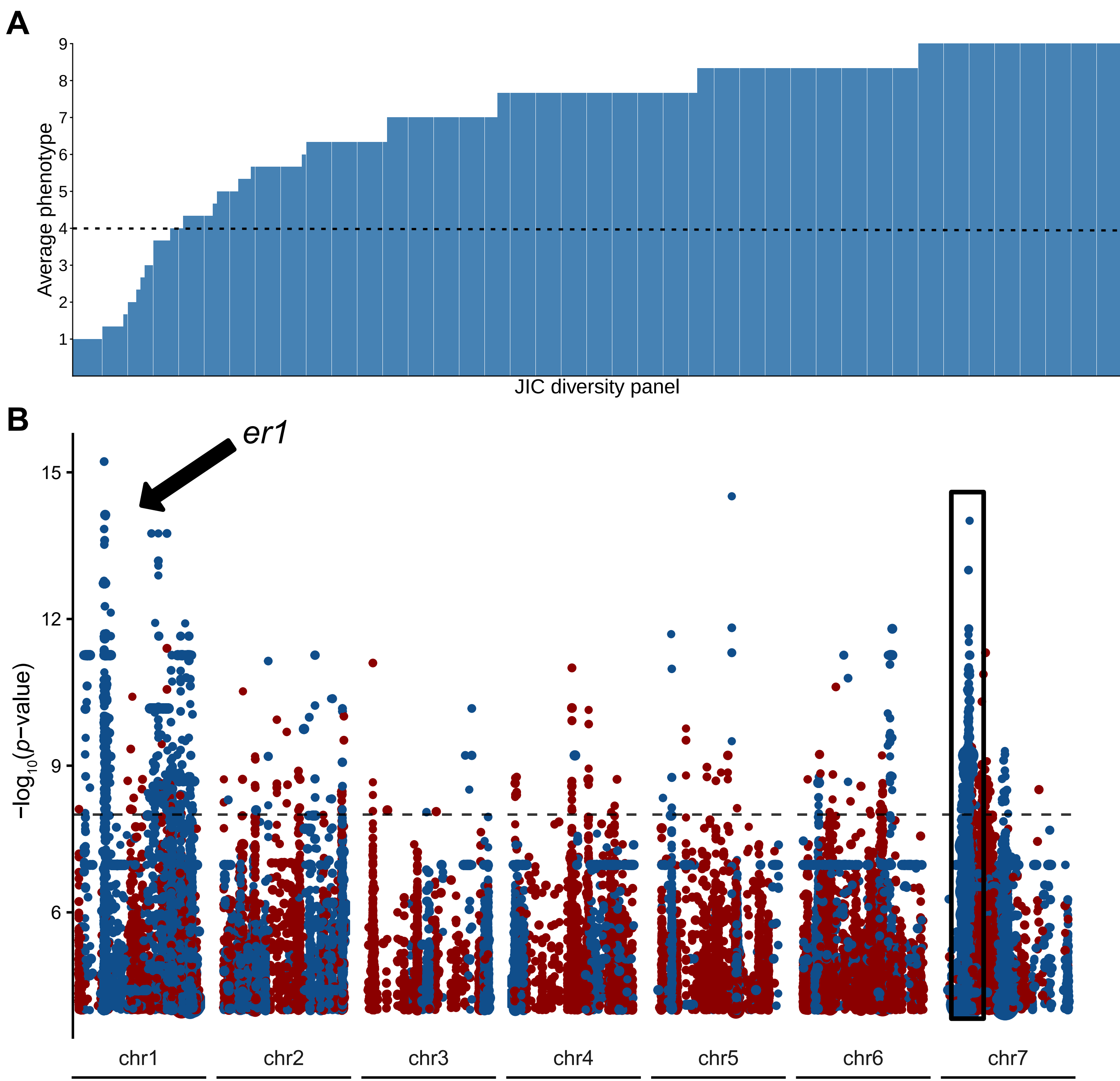
RESULTS

Resistance to downy mildew is conferred by a novel locus on chr5



(A) A novel 5Mb locus for resistance to a race 1 downy mildew isolate was identified on chromosome 5 with *k*-mer GWAS. **(B)** This region contains six genes associated with resistance: four RPP13-like CC-type NLRs, a F-box/WD-40 protein, and a β -glucosidase. Expression under basal conditions was assessed in 10 resistant and 10 susceptible lines. RPP13-like NLR 1 was significantly more expressed in resistant lines, whereas RPP13-like NLR 4, with missing LRR domains, was more significantly expressed in susceptible lines.

Resistance to powdery mildew is conferred by a 0.7 Mb locus on chr7



(A) The majority of lines were highly susceptible to powdery mildew in the 2025 SERIDA field trial. Dashed line is resistance cutoff score of 4. **(B)** Resistance was mapped to a novel region on chromosome 7 spanning 0.7 Mb, which contains two genes not typically associated with resistance: a 3β -hydroxysteroid dehydrogenase/decarboxylase and a chloroplastic hydroxyacylglutathione hydrolase 2. The previously identified powdery mildew resistance locus *er1* was also mapped on chromosome 1.

Conclusions

A 5 Mb locus on chromosome 5 confers **resistance** to a race 1 isolate of **downy mildew**, and contains three **RPP13-like NLR** candidate genes. One NLR is **more significantly expressed** in resistant lines.

A majority of the panel is **highly susceptible** to powdery mildew. A **0.7 Mb locus on chromosome 7** confers resistance to **powdery mildew**, although no resistance genes were identified.

Next steps

Validate the RPP13-like NLR downy mildew **candidate genes** with virus-induced **gene silencing** (VIGS) and **transient expression**.

Screen a select panel of lines for powdery mildew resistance in a **controlled environment**, and re-map the locus. Design predictive **markers** for the chromosome 7 locus for marker-assisted **selection of resistant lines** by breeders.

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