Lehr- und Forschungszentrum für Landwirtschaft
Raumberg-Gumpenstein

64. Tagung der Vereinigung der Pflanzenzüchter und Saatgutkaufleute Österreichs 2013, 69
ISBN: 978-3-902849-00-7

Association between anther-retention and Fusarium head blight susceptibility in wheat

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Abstract

Plant morphological and developmental traits play an important role in Fusarium resistance, such as plant height and the extent of anther-retention during flowering. We evaluated three series of wheat germplasm for Fusarium head blight (FHB) resistance in replicated and artificially spray-inoculated field trials during 2-3 seasons. FHB severity was evaluated using visual scorings at several dates after inoculation which were used to calculate the area under disease progress curve (AUDPC) as an integrated measure for FHB severity. The same lines were evaluated for the extent of anther retention. We counted in each plot 20 florets per line 4-6 days after main flowering for florets with at least one anther still trapped inside the floret and expressed this as % anther retention. Population I consisted of 192 winter wheat breeding lines and cultivars, mainly from France and Austria. Population II was a bi-parental mapping population of 171 F_6 recombinant inbred lines from the cross Capo×Arina. Population III was a doubled haploid population with 203 DH lines from the cross Hermann×Skalmeje.

All three populations showed quantitative variation for FHB severity and for percentage of anther retention. Both traits were highly heritable, with broad sense heritability coefficients H^2=0.77 and 0.86 for % anther-retention and H^2=0.85 and 0.82 for AUDPC in populations III and II, respectively. In all three populations % anther retention was significantly correlated with AUDPC (r=0.63-0.65).

In the Capo×Arina population a linkage map with SSR and DArT markers is available which allowed mapping of QTL for both traits. Among four medium effect QTL for FHB resistance mapping to chromosomes 6B (r^2=10.4), 4A (r^2=10.9), 2A (r^2=9.6) and 5A (r^2=8), two co-mapped with large effect QTL for anther retention on 6B (r^2=22.4), and 4A (r^2=18.8). In both cases the 'Arina' allele contributed to increased FHB resistance and to reduced anther retention.

The Hermann×Skalmeje population segregates at two major dwarfing genes: *Rht-B1* and *Rht-D1*. Both semi-dwarf alleles (*Rht-B1b* and *Rht-D1b*) had very similar effects on reducing height by 12-14 cm compared to the tall lines, but different associations with FHB severity and anther retention. Relative to lines with both tall alleles (*Rht-B1a*/*Rht-D1a*) on average lines with *Rht-B1b*/*Rht-D1a* showed moderately increased in FHB severity (+22%) and anther retention (+12%), while lines possessing *Rht-B1a*/*Rht-D1b* showed strongly increased FHB severity (+61%) and anther retention (+60%). Double dwarfs (*Rht-B1b*/*Rht-D1b*) were on average very short (-31 cm), and were highly FHB susceptible (+128%) and had a high degree of anther retention (+99%), relative to tall lines with *Rht-B1a*/*Rht-D1a*.

In summary, FHB severity is strongly associated with the trait anther-retention. We speculate that anthers are an easy to conquer nutritious tissue for Fusarium that stimulate fungal development and thus give Fusarium an advantage for penetrating the floret. We assume that anther extrusion is a passive resistance factor which is primarily relevant for type 1 resistance of wheat. Selection of lines with high degree of anther extrusion should result in a correlated selection response towards increased FHB resistance.

Keywords

Dwarfing genes, flowering, heritability, resistance mechanism, *Triticum aestivum*

Acknowledgments

We gratefully acknowledge Mike Taylor, Limagrain Seeds, for providing the Hermann×Skalmeje doubled haploid population.

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