Identification of partial resistance to powdery mildew in synthetic hexaploid wheat

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Introduction

Hexaploid bread wheat (*Triticum aestivum*, 2n = 6x = 42, AABBDD) originated from the spontaneous hybridization of tetraploid *T. turgidum* (2n = 4x = 28, AABB) with diploid *Aegilops tauschii* (2n = 2x = 14, DD) some 10 000 years ago. The genetic diversity of the D-genome of bread wheat is low, although a huge genetic diversity is present among wild populations of *Ae. taushcii*. A way to tap into this gene pool for breeding is the creation of synthetic hexaploid amphiploids by hybridization of elite durum wheats with diverse accessions of *Ae. tauschii* (Mujeeb-Kazi et al. 2008).

Here we report on the assessment of partial resistance to powdery mildew in a set of 448 primary synthetic wheat lines from CIMMYT.

Preliminary screening

In 2005, the whole collection was screened in unreplicated trials at two locations in south-eastern Norway (Ås and Hamar) together with the partially resistant and moderately susceptible checks 'Naxos' and 'MS273-150'.

66 lines with with powdery mildew severities less than 'MS273-150' in both trials were selected for further study.

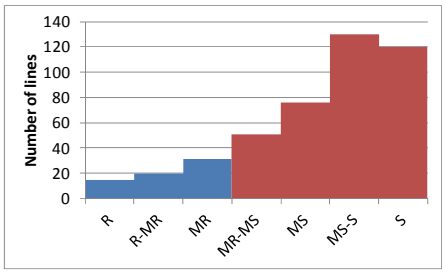

Fig. 1. Frequency distribution of powdery mildew severity classes for the entire set of 448 synthetics. Selected lines for further testing are indicated in blue.

Multi-environment testing

The reduced set of 66 lines was tested in replicated and randomized field trials under high disease pressure over three field seasons in Ås and Hamar in South-Eastern Norway (2006, 2007, 2008), Stjørdal in central Norway (2008) and Changins in Switzerland (2007).

Since the local powdery mildew pathogen populations at these locations are known to differ in their virulence composition, stable levels of low disease severity across environments can be taken as an indication of possible race non-specific and durable partial resistance (Lillemo et al. 2010).

Table 1. Mean powdery mildew severities (% diseased leaf area) across environments for the most promising lines with partial resistance that did not show environment-specific interactions or immunity in any environment.

		Ås			Hamar			Stjørdal	Changins	
Line	Name	2006	2007	2008	2006	2007	2008	2008	2007	Mean
173	68.111/R//WRD/3/FGO/4/RABI/5/*Ae.tauschii* (905)	4	3	8	5	3	2	8	15	**5.7**
400	CROC_1/*Ae.tauschii* (362)	5	-	10	5	4	5	5	15	**6.2**
280	GAN/*Ae.tauschii* (897)	13	2	3	8	2	10	2	15	**6.6**
222	GAN/*Ae.tauschii* (257)	20	2	3	20	3	2	5	3	**7.1**
144	CROC_1/*Ae.tauschii* (662)	5	7	8	10	5	10	10	10	**8.0**
140	CPI/GEDIZ/3/GOO//JO69/CRA/4/*Ae.tauschii* (633)	8	9	10	13	3	8	13	5	**8.3**
277	SNIPE/YAV79//DACK/TEAL/3/*Ae.tauschii* (877)	-	9	15	10	3	15	9	11	**10.9**
316	AJAIA/*Ae.tauschii* (330)	10	15	8	25	2	8	10	20	**12.1**
264	SCOOP_1/*Ae.tauschii* (662)	30	10	18	25	2	13	13	13	**15.2**
251	BOTNO/*Ae.tauschii* (617)	23	4	13	40	5	18	15	25	**17.6**
114	DOY1/*Ae.tauschii* (446)	35	13	25	30	8	18	13	20	**20.0**
379	CETA/*Ae.tauschii* (256)	35	18	15	30	9	33	10	20	**21.1**
276	CETA/*Ae.tauschii* (796)	30	15	33	15	13	15	33	20	**21.6**
377	DOY1/*Ae.tauschii* (255)	35	25	30	30	5	28	18	15	**23.1**
311	RASCON/*Ae.tauschii* (312)	35	28	15	40	10	15	11	33	**23.2**
447	DOY1/*Ae.tauschii* (1030)	40	10	20	35	20	25	20	20	**23.8**
58	CPI/GEDIZ/3/GOO//JO69/CRA/4/*Ae.tauschii* (223)	-	10	25	50	5	20	25	30	**23.9**
Check	Saar (moderately resistant)	6	12	7	10	13	20	13	20	**12.5**
Check	Naxos (moderately resistant)	10	8	5	23	9	15	8	15	**11.6**
Check	MS273-150 (moderately susceptible)	48	40	40	68	40	40	40	25	**42.2**
Check	Avocet (susceptible)	80	60	80	95	83	87	67	50	**75.4**

Fig. 2. Hillplot testing of powdery mildew resistance

Data analysis

The multi-environment powdery mildew data was subjected to Median Polish in order to identify environment-specific interactions. A total of 14 lines showed lower or higher than expected disease severities in at least one environment, which were likely caused by race-specific interactions. A further 22 lines showed immunity (disease severity of 0 or 1) in single environments also indicating race-specific resistance, while 13 lines turned out to have disease severities close to the level of the moderately susceptible check 'MS273-150'.

The 17 most promising lines with partial and potentially race non-specific resistance are listed in Table 1.

Source of the resistance

In the field trials at Ås, Hamar and Stjørdal in 2008, the durum wheat parents of 48 synthetic wheat lines were also included for comparison. 31 lines showed significantly lower severities than their durum wheat parents, indicating that resistance was contributed by *Ae. tauschii*. Only two lines were more susceptible than their durum wheat parents while for the rest of the lines the differences were not significant.

None of the lines listed in Table 1 had higher severities than their durum wheat parents.

Discussion

While most of the synthetic wheat lines from CIMMYT were susceptible to powdery mildew (Fig. 1) some lines demonstrated high levels of resistance. The majority of these lines showed indications of race-specificity, but a subset of lines was identified with promising partial and potentially durable resistance (Table 1).

Synthetic wheat lines from this study are currently being used as crossing parents to diversify powdery mildew resistance in Swiss and Norwegian breeding programs.

Further work should be done to reveal the nature of resistance in these lines in order to predict the potential durability and usefulness in resistance breeding.

References:

Lillemo M, Singh RP, van Ginkel M (2010) Identification of stable resistance to powdery mildew in wheat based on parametric and nonparametric methods. Crop Sci 50:478-485

Mujeeb-Kazi A, Gul A, Farooq M, Rizwan S, Ahmad I (2008) Rebirth of synthetic hexaploids with global implications for wheat improvement. Australian Journal of Agricultural Research 59:391-398