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SCREENING RESULTS OF DIVERSE SPRING BARLEY (*HORDEUM VULGARE* L.)
VARIETIES AND BREEDING LINES FOR RESISTANCE
TO FUSARIUM HEAD BLIGHT

ABSTRACT

Fusarium head blight (FHB, scab) is a widespread disease of cereals, including barley (*Hordeum vulgare* L.), causing substantial yield and quality loss. Varieties with resistance provide the greatest potential for reducing FHB. In the present study, we adapted cut-spike method for screening FHB severity among 126 spring barley genotypes. The collection consisted of Latvian varieties and perspective breeding lines and foreign varieties with specific quality traits important for food purposes and resistance to several diseases. Screening was repeated for two years, 2008 and 2009. Differences between genotypes in FHB resistance were observed. Two years data showed that genotype has a significant effect on FHB resistance ($p < 0.001$) and genotype effect on resistance was 41.6%. Differences between FHB resistance of accessions of contrasting morphological traits and origin were tested. Only significant difference were found between covered and hulless barley. There was no significant correlation between plant height and FHB severity and between flowering date and FHB severity, but significant positive correlation ($r = 0.672$, $p \leq 0.05$) were found between days from snowing to maturity and FHB severity. Together 15 genotypes (all with Latvian origin) on this study showed average FHB severity lower than 10%.

Key words: *Fusarium culmorum*, *Hordeum vulgare*, FHB resistance

INTRODUCTION

Fusarium Head Blight (FHB, scab) is a widespread disease of cereals including barley (*Hordeum vulgare* L.), which infects spikes and reduces grain yield and quality. In addition FHB is a significant threat to food and feed chains because certain species of fungi that are involved in the disease may produce mycotoxins in the infected grains.

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Together 17 species can cause FHB (Parry *et al.*, 1995 Audenaert *et al.* 2009) the most important ones are *Fusarium graminearum*, *F. culmorum*, *F. avenaceum* and *F. poae*, which can produce a range of mycotoxins (Bottalico and Perrone, 2002).

In Europe, FHB is caused by at least four species of *Fusarium*: *F. graminearum*, *F. culmorum*, *F. avenaceum* and *F. poae* and by *Microdochium nivale* (Ioos *et al.*, 2004; Browne and Cooke, 2005). *Fusarium graminearum* particularly grows at warm regions whereas *F. culmorum*, *F. poae*, *F. avenaceum* and *M. nivale* tend to dominate in cooler regions such as Scandinavia and the UK (Parry *et al.* 1995; Waalwijk *et al.*, 2003; Xu *et al.* 2005).

Genetic resistance offers the greatest potential for reducing FHB. The genetics and expression of resistance to FHB in barley is complex. Difficulties to accurately measure *Fusarium* resistance have been reported (Yoshida *et al.*, 2005).

Several agronomic and morphological traits are associated with FHB resistance in barley such as late heading, plant height, lax spike, and two-rowed spike (Steffenson *et al.*, 1996; Urrea *et al.*, 2002; Yoshida *et al.*, 2005; Buerstmayr *et al.* 2004).

There are differences between studies in relation between late heading and FHB resistance; most of authors mention that resistance is linked to late heading, but Wingbermuehle *et al.* (2004) has found that in general, late heading is not associated with disease resistance, and correlation between late heading and FHB resistance could be due to the host escaping infection by the pathogen.

Modelling of field data suggests that FHB development is greatly affected by temperature and free moisture (De Wolf *et al.* 2003; Moschini and Fortugno, 1996; Rossi *et al.*, 2001). The risk of FHB infection is higher in the time around flowering (Buerstmayr *et al.*, 2004).

The aim of the study was to adapt FHB severity screening method useful for breeding purposes, to screen various spring barley genotypes with Latvian and foreign origin as well as to select the most resistant ones for using as parents in breeding.

MATERIAL AND METHOD

126 spring barley genotypes were selected for study and the collection consisted of Latvian varieties and perspective breeding lines and foreign varieties with specific quality traits important for food purposes and resistance to several diseases. Collection consisted of 117 two-row and 9 six-row genotypes; 91 covered and 35 hulless barley accessions; 104 accessions were with Latvian origin (80 breeding lines and 34 cultivars) and 22 foreign cultivars.

The plants were grown in field conditions in 2.3 m² plots. 3 spikes were used from every genotype; each spike has been taken as a replicate. Susceptible variety 'Fontana' and resistant variety 'Fredrickson' were used as a checks (Buerstmayr *et al.*, 2004).

The cut spike inoculation method adapted from Takeda (2004) was applied. At the flowering time, spikes were detached from the plants at the second internode from the top, and put in humidity chamber with air humidifier. Air humidifier was filled two times a day and it kept working 5 hours after filling.

The barley accessions were tested during two seasons (2008 and 2009). There was difference in time of inoculation between years. In 2009 all genotypes were infected in 2nd of July, but 2008 inoculation was done from 26th of June to 8th of July depending on flowering time.

The average air temperature in time period of inoculation was 15.2 °C (2008) and 16.4 °C (2009), and maximum temperature in was 24.2 °C (2008) and 27°C (2009).

The suspension of conidia was made from dry *Fusarium culmorum* infested grains (produced by Prophyta, Germany). 5 grams of infection material was incubated in 1l of water for one hour, and then filtered. The final spore concentration for inoculation was 1x10⁵ conidiospores per litre. Inoculations were carried out in the evening. Temperature and light in the chamber was not controlled and depended from the outdoor conditions.

In each spike the percentage of visibly infected spikelets was scored according to a linear 0 to 100% scale 8 days after inoculation to measure FHB severity.

The number of days from sowing to flowering and maturity was recorded in the field trial. At the beginning of grain ripening, plant height was measured from the soil surface to the top of the heads (5 measurements per plot), excluding awns.

RESULTS AND DISCUSSION

Differences between genotypes in FHB resistance were observed. There was significant though low correlation ($r=0.268$; $r_{0.05}=0.175$) of FHB severity between the years. Two years data showed that genotype has a significant effect on FHB resistance ($p<0.001$). Genotype effect on resistance was 41.6%.

Differences between FHB resistance of accessions of contrasting morphological traits and origin were tested. Two-row accessions tended to be less diseased, but there were no significant differences between six-row and two-row genotypes. But in most of other studies correlation between row type and FHB resistance was found (Steffenson *et al.*, 1996, Buerstmayr *et al.*, 2004), only Yoshida *et al.* (2005) mention that the effect of row type is

unstable and low, and resistance is more related to flowering type than to row type. Need to admit, that in our study mostly two rowed genotypes were used, 117 of tested 126 accessions were two-rowed.

In other studies a significant negative correlation between plant height and FHB severity have been reported (Buerstmayr *et al.*, 2004; Mesfin *et al.*, 2003; Urrea *et al.*, 2002) In this study there was no significant correlation between plant height and FHB severity. Other studies have shown that resistance usually is associated with agronomic and morphological traits such as late heading (Mesfin *et al.*, 2003; Urrea *et al.*, 2002; Steffenson *et al.*, 1996), on the other hand, in some studies (Buerstmayr *et al.*, 2004) no significant correlation between FHB severity and flowering were found. It is in agreement with our results where no significant correlation between days from sowing to flowering and FHB severity have been found. But significant positive correlation ($r=0.672$, $p\leq 0.05$) were found between days from sowing to maturity and FHB severity, earlier matured genotypes showed higher resistance.

Only significant difference between FHB resistance of accessions of contrasting morphological traits and origin were found between covered and hulless barley ($p= 0.04$); these differences have not been mentioned in publications before.

No significant differences between origin of genotype, and weather the accession is breeding line or variety were found to affect the severity of FHB.

As shown in Table1, 15 genotypes (all with Latvian origin) on this study showed average FHB severity lower than 10%, in that list are varieties 'Linga', 'Balga' and 'Rubiola' which have been bred in State Priekuli Plant Breeding Institute, and hulless barley breeding line PR-3528 which has been passed to variety registration trials.

Table1

Amount of FHB infected spikelets (%) of check varieties and the most resistant genotypes

Variety/ line	2008-2009		2008		2009	
	Average	St. dev.*	Average	St. dev.**	Average	St. dev.**
Fredrickson	11.8	10.0	18.9	12.2	4.8	4.9
Fontana	38.9	3.9	36.1	15.3	41.6	18.4
7978 77-39	1.3	1.9	0.0	0.0	2.7	2.5
Rasa	4.5	2.1	3.0	1.7	6.0	7.9
Rūja	4.8	1.2	4.0	1.7	5.7	1.2
Linga	5.3	5.2	1.7	2.9	9.0	6.6
12630 98-13	6.2	4.0	3.3	5.8	9.0	6.6
12733 00-50	6.2	0.7	6.7	7.6	5.7	8.1
PR-3528	6.3	0.5	6.7	7.6	6.0	7.9
L-2985.1	6.5	5.9	2.3	2.5	10.7	8.1
7186 76-19	7.2	6.4	2.7	3.8	11.7	2.9
PR-3537	7.5	8.2	1.7	2.9	13.3	2.9
9016 83-48	8.2	1.2	7.3	6.8	9.0	6.6
Balga	9.2	8.2	3.3	2.9	15.0	5.0
Rubiola	9.5	10.1	2.3	4.0	16.7	10.4
PR-3438	9.8	7.3	4.7	5.0	15.0	5.0

* standard deviation between years; ** standard deviation between replications

CONCLUSIONS

1. Genotype has a significant effect on FHB resistance.
2. There is significant difference between FHB resistance between covered and hulless barley.
3. No significant differences between origin of genotype, row types and weather the accession is breeding line or variety were found to affect the severity of FHB.
4. No significant correlation between plant height, flowering date and FHB severity were found.
5. 15 genotypes (all with Latvian origin) with FHB severity lower than 10% were found.

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