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RESISTANCE OF WEST EUROPEAN ECOTYPE SPRING BARLEY TO NET BLOTCH

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Abstract

A total of 150 spring barley varieties and breeding lines of West European ecotype were tested in the field for resistance to net blotch (*Drechslera teres* (Sacc.) Shoem.). The experiment was conducted at the Lithuanian Institute of Agriculture in 2007. Selection of varieties for the experiment was based on their disease resistance, recorded in field resistance screenings in previous year. The field trial was arranged in 3 treatments: inoculated by spreading chopped barley straw between the rows, inoculated by spraying suspension of net blotch mycelium and conidia, and control treatment without artificial inoculation. Only barley inoculated using straw showed higher net blotch infection level, while artificial infection by spraying inoculum suspension was not effective and did not increase net blotch infection compared to control treatment. About 50 varieties with net blotch resistance level ranging from resistant/moderately resistant to susceptible were chosen for agro-biological trait evaluation. Increased level of infection had significant impact on spike length, number of spikelets and number of grains in a spike. No significant differences were found in the number of shoots and unproductive spikelets.

Key words: net blotch, spring barley, disease resistance.

Introduction

Barley (*Hordeum vulgare* L.) is an intensively cultivated cereal crop worldwide. It is one of the most widely grown cereal crops in Lithuania: the total area of spring barley in 2007 was 365.3 thousand ha (36.3% of all cereals). The most important and widespread disease of barley is net blotch, caused by phytopathogenic fungus *Drechslera teres* (Sacc) Shoem. Financial losses to this foliar pathogen result from both yield reduction, ranging from 15% to 35% /Khan, 1987; Steffenson et al., 1991/ and diminished grain quality. Both the seeds and leaves of barley can be infected by *D. teres*, and it can also persist in straw. First symptoms of net blotch usually appear when seedlings reach tillering stage. Two types of leaf symptoms are associated with the net blotch disease: the net type, caused by *D. teres* f. *teres*, which causes horizontal and vertical crisscrossed dark brown venation that can turn chlorotic, and the spot type, caused by *D. teres* f. *maculata*, which causes dark brown circular or elliptical spots surrounded by chlorosis /Smedegard-Petersen, 1977/. Both pathogens reduce yield. In recent years it has been considered undesirable to control the disease by fungicide spraying. Therefore, the search for new resistance sources and introduction of new germplasm sources into breeding programs as well as net blotch virulence and variability studies became an important research field. Within the barley genome, loci controlling net blotch resistance have been identified on every chromosome. While several studies have located quantitative trait loci (QTL) associated with resistance /Steffenson et al., 1996; Raman et al., 2003/, a number of single, major genes controlling resistance have been identified, with several mapped /Chelkowski et al., 2003; Friesen et al., 2006; Manninen et al., 2006/. However, none of them can confer durable resistance to net blotch. Studies of the occurrence and distribution of different virulence types of *D. teres* and barley germplasm screenings for net blotch resistance are essential to identify useful sources of resistance and assist in the development of future barley breeding strategies. The large variation in net blotch resistance is observed among barley germplasm, but range among European commercial cultivars of spring barley is rather in various degrees of susceptibility /Jonsson, 2001/.

The aim of this study was identification of resistant varieties and evaluation of increased net blotch infection effect on various agro-biological traits of spring barley.

Materials and Methods

A total of 150 West European ecotype spring barley varieties and breeding lines representing a wide range of reaction to net blotch were selected for field test. The selection of varieties for the experiment was based on their net blotch resistance, recorded in field screenings in previous year. The experiment was conducted at the Lithuanian Institute of Agriculture, in 2007. The field trial was arranged in 3 treatments. The first – barley was inoculated by spreading chopped barley straw between the rows. The straw for inoculations was collected in 2006 from the fields of barley, very susceptible to net blotch. The second – barley was sprayed with net blotch mycelium and conidia suspension, and the third was control treatment, with no artificial inoculation. Each treatment consisted of 3 replications, the varieties and breeding lines were randomly placed in each replicate. Each variety was sown in two rows, length of the row 1 meter, 2 grams of seed sown in a row. Several scorings for the disease reaction were made visually. The first scoring was made before inoculation, when seedlings reached BBCH 20–29 stage. Only the score made after plant heading was used. A 1 to 9 score scale, based on percentage of leaf area covered by necrosis and chlorosis, was used: 1 – 0%, 2 – 0.1%, 3 – 1%, 4 – 5%, 5 – 10%, 6 – 20%, 7 – 40%, 8 – 60%, 9 – 80 to 100%. 46 varieties with net blotch resistance level ranging from resistant/moderately resistant to susceptible were chosen for agro-biological trait evaluation, and 20 plants were collected of each of them. Shoot number, spike number and length, number of spikelets, number of grains per spike and average weight per spike were assessed.

The summer of the year 2007 was humid, except for droughty period at the beginning of June, the average amount of precipitation was higher or the same as long-term average (98.2–52.2 mm in May, 61.5–61.3 in June). The temperature was 1–2^{o} C higher than long-term average.

Results and Discussion

Net blotch infection rate and yield damage it causes depends both on host resistance and weather conditions during the growing season. In the summer 2007 the weather conditions were quite favourable for net blotch – it was rather cool and rainy, except for the first ten days of June when it was dry (Figure 1).

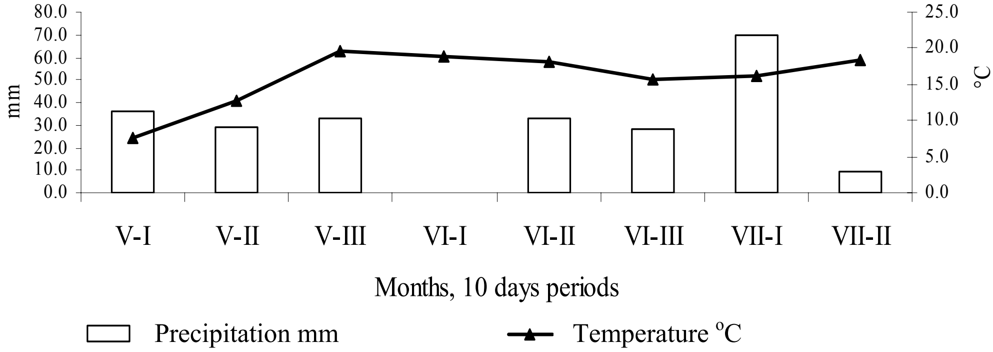

Figure 1. Weather conditions during the spring barley growing season of the year 2007 in Dotnuva

Net blotch infection level in the treatment inoculated with straw was 1–3 scores higher compared to the control treatment (Figure 2). Chopped straw as supplementary source of net blotch inoculum proved to be more effective than spraying with mycelium suspension. Varieties inoculated by spraying did not show any significant increase in net blotch level, thus the data obtained from plant analysis of that treatment are not presented here. The failure to increase net blotch infection level by spraying mycelium probably was caused by insufficient amount of inoculum: the spraying was done only once, while chopped straw supplied inoculum permanently.

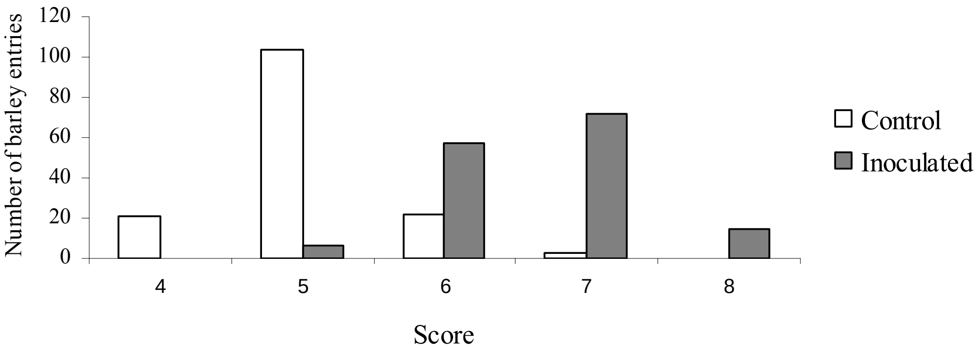

Figure 2. The distribution of barley genotypes in resistance categories in the uninoculated control and in the treatment inoculated with barley straw

As summer of last year was very favourable for rapid net blotch spreading and development, high levels of infection were reported all across Lithuania. Considering that, infection scorings in the control treatment are relatively low. This could have been caused by high number of different genotypes growing in a small area. The origin of barley entries used in the experiment is presented in Figure 3.

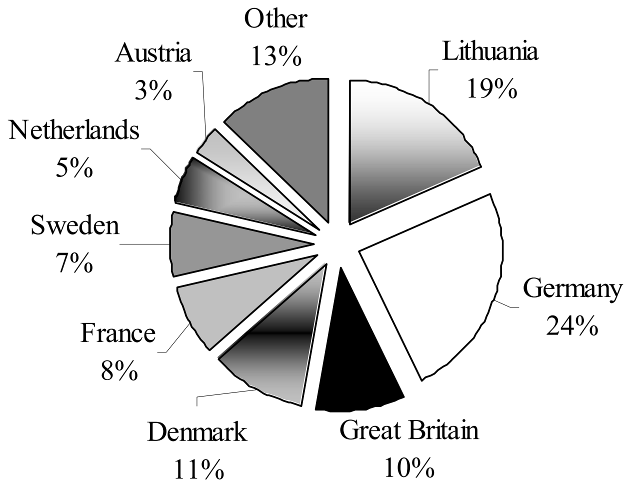

Figure 3. The origin of barley varieties used in the experiment

In general, differences in resistance level between the varieties originating from different countries are not greater than between the varieties originating from the same country. According to Jorgensen /Jorgensen et al., 2000/, the same varieties can sometimes show substantial differences in resistance level when different pathogen populations are used. This indicates that the local pathogen population may differ in composition and that a successful breeding effort requires the use of a pathogen population composed of several or many local subpopulations.

Statistical analysis of data obtained showed that in most cases investigated there were significant differences in spike length, number of spikelets and number of grains in the spike between artificially inoculated and not inoculated treatments (Table). 10 out of 46 barley varieties, that were chosen for agro-biological trait evaluation, did not show significant differences in any trait investigated, and 9 showed significant differences only in spike length but not in the number of spikelets or grains per spike. Varieties that exhibited the greatest differences are presented in Table. Varieties ʽChantal', ʽCicero', ʽHenley', ʽVivendi' and breeding line LIA 8451-6 exhibited the greatest reduction in all three traits. All of them were susceptible to net blotch and scored 7–8 in artificially inoculated trial.

There are several experiments showing that net blotch infection suppresses plant height and reduces yield mainly due to 1000 grain weight reduction, but has no effect on spike number /Robinson, 2000/. In our experiment we have not established any significant changes in spike number either, but the number of spikelets and grains was reduced in many cases.

Table. Mean values of spike length, number of spikelets per spike and number of grains per spike of selected barley genotypes

Variety	Country of origin	Spike length cm		No. of spikelets per spike		No. of grains per spike	
		Control	Straw inoculation	Control	Straw inoculation	Control	Straw inoculation
Auksiniai 3	LTU	8.8*	7.9*	25.6*	23.7*	23.5	22.6
Golf	FRA	10.0*	8.9*	27.1*	25.1*	26.4*	23.1*
Luokė	LTU	8.9*	8.1*	26.3**	23.8**	24.3*	22.1*
Meltan	SWE	8.3**	7.3**	23.2**	20.3**	22.1**	19.2**
Hanka	DEU	9.0*	8.2*	25.8**	23.5**	24.5**	22.4**
Chantal	DEU	8.8**	7.2**	25.8**	21.6**	25.0**	20.5**
Prosa	AUT	6.9	6.3	24.7**	21.1**	23.3**	20.2**
Forester	GBR	8.3	7.7	24.3**	21.1**	23.9**	20.0**
Cicero	DNK	10.0**	7.9**	26.1**	20.7**	25.1**	20.3**
Henley	DEU	9.8**	8.3**	26.9**	22.9**	26.6**	22.0**
8976-b	FIN	9.6	8.7	26.3**	23.6**	26.4*	23.3*
Cebeco 0367	NLD	9.3	8.4	26.6**	23.3**	25.9**	22.5**
Poet	DNK	7.7	7.1	23.1**	19.9**	22.3**	19.8**
Jenuva	DEU	8.5*	7.5*	24.8**	22.5**	24.2*	22.0*
Vivendi	DEU	9.3**	7.0**	24.4**	19.4**	23.3**	19.3**
Sj 0202	DNK	8.9*	7.9*	24.9**	21.2**	23.8**	20.5**
Quench	GBR	8.9**	7.5**	26.0**	22.4**	24.6**	21.1**
Conchita	DEU	7.8	7.1	22.4**	19.3**	21.2*	19.0*
LIA 8301-6	LTU	8.1	7.6	24.8*	22.8*	24.0**	21.7**
LIA 8451-6	LTU	9.0**	7.3**	25.7**	21.1**	24.3**	20.5**

* $P<0.05$; ** $P<0.01$

Conclusions

Artificial inoculation by spreading barley straw was more effective than spraying with mycelium suspension and increased level of net blotch infection. Therefore it can be helpful in field trials to detect most resistant barley genotypes that can be used in further breeding programmes.

Increased level of infection had significant impact on spike length, number of spikelets and number of grains in the spike in most cases. No significant differences were found in the number of shoots, number of spikes and number of unproductive spikelets.

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