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Evaluation of barley disease development depending on varieties

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Abstract. Resistance against diseases is one of the key factors for plant varieties used in organic farming systems. Official variety trials in a certified organic field were inspected during 2004–2008 in the Research and Study farm "Vecauce"of LLU.

Net blotch (caused by *Pyrenophora teres*) and mildew (caused by *Blumeria graminis* f. sp. *hordei*) were the most significant diseases in spring barley. Rust (caused by *Puccinia hordei* (syn. *P. anomala*) was observed very seldom and leaf scald (caused by *Rhynchosporium secalis*) was noted only in 2008 for a new breeding line, G 131.

The incidence of net blotch fluctuated from 0–100% depending on year and variety, but the incidence of mildew was 3–100%. The incidence of barley rust did not exceed 29% (severity only 0.7%).

The obtained data gave general information about the spectrum of diseases, but they are inconsistent and are seriously influenced by meteorological conditions: artificial inoculation is necessary for better variety selection, especially for organic farming.

Key words: barley, variety testing, diseases, organic farming

INTRODUCTION

Organic farming has spread rapidly in Latvia since 1998, the total certified land area having increased from 1426 ha in 1998 to 151,505 ha in 2007. Currently, 6% of the total agricultural land is certified organic. Areas sown with small grain cereals occupy 25% of total certified organic land; barley is a primary cereal crop.

Selection of the appropriate variety is one of the key factors for successful organic farming. Although organic farmers primarily use varieties which were selected for conventional farming, varieties with special traits are necessary (Leistrumaitė & Razbadauskienė, 2008).

Resistance against diseases (including specific and non-specific resistance, tolerance) is one of the key factors for plant varieties used in organic farming systems (Lammerts van Bueren, 2002). One way to establish the level of partial resistances is determination of disease development under field conditions (Liatukas & Leistrumaite, 2007)

An important problem for barley in organic farming is infection with loose smut (*Ustilago nuda*). The regulations for seed production in organic farming are the same as in conventional farming, but chemical seed treatment is not allowed. Three varieties were included in the Latvian Plant Variety Catalogue as suitable for organic farming

before 2009 (‘Abava’, ‘Kristaps’, ‘Rasa’) and another two will be included in 2009 (‘G-131’ and ‘Rubiola’) (Latvian Plant…, 2009). Only one barley variety bred specially for organic farming (‘Rubiola’) has been proved by DNA analysis to resist loose smut (Legzdina et al., 2008). Other Latvian local varieties (e.g. ‘Abava’ and ‘Idumeja’) flower with closed flowers; their infection level with loose smut is usually low (Legzdina et al., 2005).

Except for variety ‘Rubiola’, true disease resistance has not been determined in Latvia (except resistance of variety ‘Rubiola’ against loose smut). The aim of the investigations is to determine the response of Latvian varieties to the most important barley diseases under field conditions.

MATERIALS AND METHODS

Official spring barley variety trials along with some additionally sown varieties grown in a certified organic field were inspected during 2004–2008 in Research and Study farm “Vecauce”of LLU. The plot size was 12.5–25 m^2, and varieties were arranged randomly in 4 replications. During the trial years a total of 10 varieties and new breeding lines (all bred in Latvia) were inspected: ‘Rasa’ and ‘Rubiola’ (previously line PR-2797) - 2004–2008; ‘Abava’ and ‘Idumeja’ - 2004–2006, 2008; ‘Sencis’, ‘Ruja’ and ‘Malva‘- 2004–2006; ‘PR-2544’ – 2004; ‘Kristaps’ - 2006–2007; ‘G-131’- 2007–2008. The standard variety was ‘Abava’ during 2004-2005 and ‘Rasa’ in 2006–2008. The seed used corresponded to the demands of category B. Each year, barley was sown on the earliest possible date; 400 germinable seeds per 1 m^2 were used. Harrowing for weed control was used in the tillering stage. Soil characteristics were as follows: sod-gleysolic clay loam soil, organic matter 19–34 g kg^{-1}, pH_{KCl} 6.8–7.5, P_2O_5 41-91 mg kg^{-1}, K_2O 60–115 mg kg^{-1}. Crop rotation was exactly executed and the pre-crop was potato in 2004–2007; due to heavy infestation with potato leaf beetle (*Leptinotarsa decemlineata*), it was changed to rye in 2008.

All spikes in every plot were inspected for loose smut during heading, but for leaf diseases 100 (25 from each replicate) leaves from each variety were collected during milk ripeness. The incidence and severity of diseases were determined.

Meteorological conditions differed each year. In 2004 weather conditions were very favourable for the development of diseases; in 2005 atmospheric temperatures were similar to long term averages, but low rainfall was received; 2006 was uncommonly hot and dry throughout the season; 2007, on average, was a good year as to air temperatures and moisture conditions; low rainfall was observed only in June, but 2008 was the worst of all trial years: spring was extremely dry in the organic field due to narrow local conditions; seedling emergence and development was not uniform, and heavy infestation with aphids (*Aphis* spp.) was observed.

Data were statistically processed using analysis of variance.

RESULTS AND DISCUSSION

For characterisation of trial conditions, average yields are shown in Table 1. Grain yields obtained during trial years averaged from 3.52 t ha^{-1} in 2008 to 5.44 t ha^{-1} in 2004. During 2005–2007 grain yields were similar, approximately 5 t ha^{-1}.

Table 1. Barley grain yields depending on variety and trial year (2004–2008).

Variety	100% clean grain yield at 14% moisture				
	2004	2005	2006	2007	2008
'Abava'	5.01	4.71	5.31	x	4.27
'Sencis'	5.36	5.20	5.56	x	x
'Ruja'	5.71	5.14	4.96	x	x
'Rasa'	5.53	4.80	4.89	4.51	3.68
'Malva'	5.49	5.46	5.43	x	x
'Idumeja'	5.36	4.24	5.50	x	2,52
' PR-2797' ('Rubiola')	5.64	5.14	4.74	4.87	4.08
'PR-2544'	5.38	x	x	x	x
'Kristaps'	x	x	4.54	5.46	x
'G-131'	x	x	x	4.93	3.04
$RS_{0,05}$	0.48	0.60	0.50	0.41	0.46

Yield level was mainly determined by meteorological conditions and the worst were observed in 2008, when in addition to heavy aphid infestation, high mildew incidence was noted.

Net blotch (caused by *Pyrenophora teres*) and mildew (caused by *Blumeria graminis* f. sp. *hordei*) were the most significant diseases in spring barley. Barley rust (caused by *Puccinia hordei* (syn. *P. anomala*) was observed seldom and leaf scald (caused by *Rhynchosporium secalis*) was noted only in 2008 for a new breeding line, G 131.

The incidence of net blotch fluctuated from 0–100% depending on year and variety. Severity of net blotch depending on varieties during 2004–2006 was shown in Fig.1. Statistical analysis confirmed significant differences between varieties ($F_{fact} > F_{crit}$). Results were controversial, because the influence of the year is visible, but response of varieties differed very sharply.

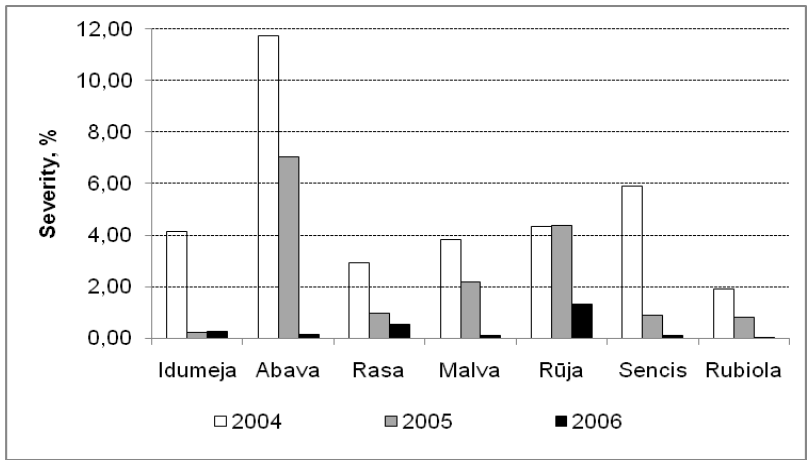

Fig. 1. Severity of net blotch depending on varieties and years.

Mildew was a very important disease in 2005 and 2008 (Fig. 2 and Fig. 4), the severity of diseases achieving more than 20% in some cases. The distinction of mildew severity depending on varieties were statistically significant ($F_{fact} > F_{crit}$,) in all years. Nevertheless, it is impossible to select more a resistant variety, because results differed with year.

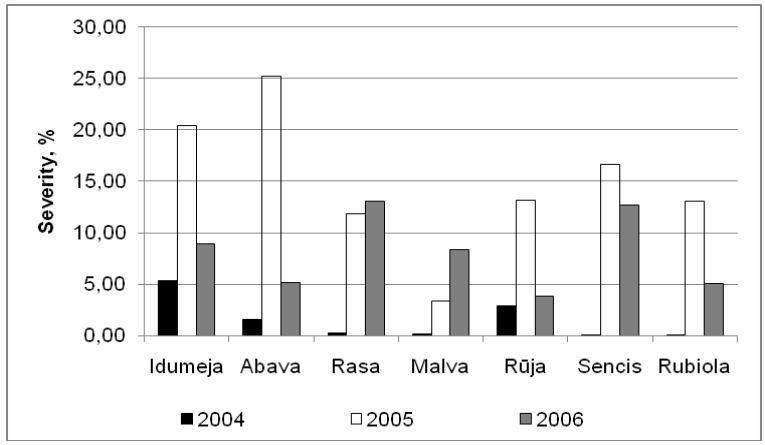

Fig. 2. Severity of mildew depending on year and variety.

Barley rust is a sporadically important disease. Observation of barley rust incidence clearly showed the insufficiency of field data (Fig. 3), because development of rust fluctuated depending on year and varieties. Nevertheless, field data showed susceptibility of some varieties; it is especially significant for 'Rasa', which is a standard variety for organic farming.

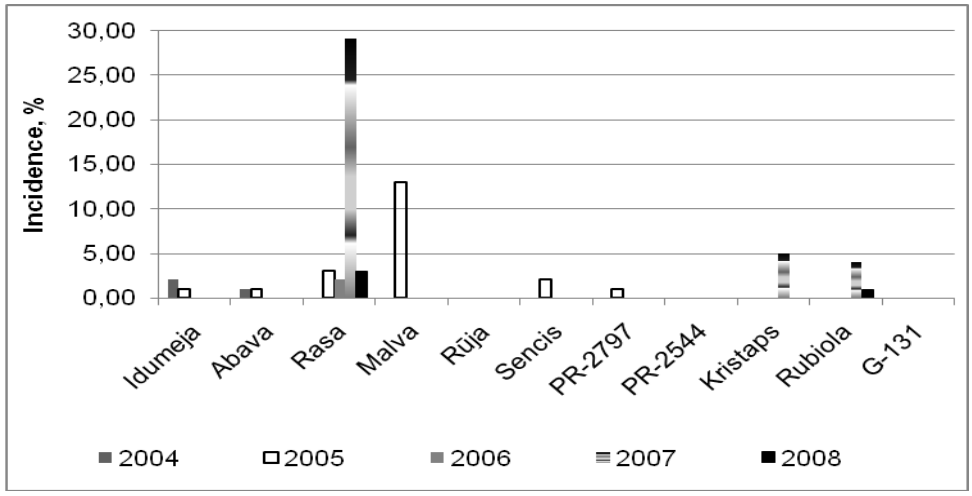

Fig. 3. Barley rust incidence depending on year and variety.

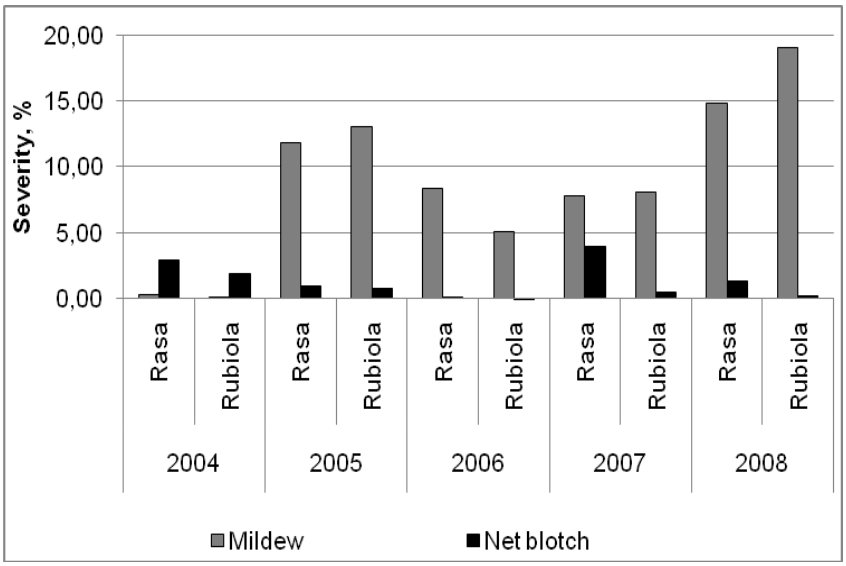

Fig. 4. Severity of net blotch and mildew depending on year and variety.

The influence of meteorological conditions and other factors in each year on the severity of diseases was demonstrated by the varieties 'Rasa' and 'Rubiola' (Fig. 4). Severity of net blotch fluctuated from 0–2.95 %, but differences of mildew severity were sharper. Net blotch is a seed- and splash-borne disease: meteorological conditions influence disease development very substantially.

High severity of mildew was observed in years with different meteorological conditions: for example, the summer of 2008 was extremely dry, but the summer of 2005 was normal if compared with long term average data. The causal agent of mildew *Blumeria graminis* is a biotrophic pathogen; in this case resistance of each variety is especially significant. Field observations did not provide a complete picture of variety resistance; the severity of mildew fluctuated from 0.27% tol 14.82%. Lack of investigations related to races of pathogens is one possible reason for these inconsistent results.

Higher mildew severity was observed in years which were not preferable for net blotch. A possible reason could be competitiveness between pathogens. Strong competitiveness between biotrophic and necrotrophic pathogens was observed in wheat (Weber et al., 2007).

Varieties 'Rasa' and 'Rubiola' showed high susceptibility to mildew and could be a problem in organic farming.

Loose smut is a very important disease of barley, especially in organic farming. All tested varieties showed good resistance against this disease (Table 2). Loose smut was not detected for varieties 'Rasa', 'Kristaps' and 'Rubiola'. Field data confirmed true resistance against loose smut for variety 'Rubiola'.

Table 2. Incidence of loose smut during trial years.

Variety	Incidence of loose smut during trial years, spikes per 1 m^2				
	2004	2005	2006	2007	2008
'Abava'	0.01	0	0	x	0
'Sencis'	0.28	0	0.075	x	x
'Ruja'	0.14	0	0	x	x
'Rasa'	0	0	0	0	0
'Malva'	0.16	0	0.075	x	x
'Idumeja'	0.13	0	0	x	0
' PR-2797' ('Rubiola')	0	0	0	0	0
'PR-2544'	0.88	x	x	x	x
'Kristaps'	x	x	0	0	x
'G-131'	x	x	x	0.01	0

CONCLUSIONS

Our obtained results showed that field investigations were not sufficient for determination of true resistance against causal agents of most significant barley diseases. Nevertheless, field data are necessary for full characterization of varieties. The field data indicate the most harmful tendencies of new varieties and allow making conclusions about variety tolerance against diseases. Tolerance should be the most significant trait of varieties used in organic farming.

Two varietes,,'Rubiola' which was especially bred for organic farming and variety 'Rasa' showed good resistance against loose smut, but both were heavily infected by *Blumeria graminis* when conditions for disease development were appropriate.

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