ISSN 1392-3196 / e-ISSN 2335-8947
Zemdirbyste-Agriculture, vol. 100, No. 3 (2013), p. 283–288
DOI 10.13080/z-a.2013.100.036

The susceptibility of pea (*Pisum sativum* L.) to ascochyta blight under Lithuanian conditions

Irena GAURILČIKIENĖ[1], Rūta ČESNULEVIČIENĖ[2]

[1]Institute of Agriculture, Lithuanian Research Centre for Agriculture and Forestry
Instituto 1, Akademija, Kėdainiai distr., Lithuania
E-mail: irenag@lzi.lt

[2]Perloja Experimental Station, Lithuanian Research Centre for Agriculture and Forestry
Sodo 12, Perloja, Varėna distr., Lithuania

Abstract

During the period 2008–2010, experiments were conducted to investigate the severity of ascochyta blight in the crops of semi-leafless field pea (*Pisum sativum* L.) cultivars 'Profi', 'Eiffel', 'Simona', 'Tinker', 'Mascara' and 'Pinochio' in different soil and climate conditions of Lithuania: 1) on a Southeast *Luvisol* (*LV*) in Perloja, 2) on a Middle Lowland's *Cambisol* (*CM*) in Dotnuva. The study was aimed to identify the susceptibility of various field pea cultivars to ascochyta blight under different agro-ecological conditions and to establish the effects of meteorological factors on the disease severity and to determine the composition of *Ascochyta* complex on pea plants.

In all experimental years, the values of area under disease progress curve (AUDPC) of ascochyta blight were higher in Perloja than in Dotnuva. Among the tested pea cultivars, 'Tinker' demonstrated the highest susceptibility to ascochyta blight, while 'Simona' and 'Pinochio' were less susceptible irrespective of the disease infection level. In Perloja, a significant moderate or strong correlation was identified between the AUDPC values of ascochyta blight and the amount of precipitation and sum of effective temperatures ($\sum \geq 5°C$) for all field pea cultivars tested. Due to the low severity of ascochyta blight in Dotnuva, the interaction among the same factors was markedly lower. The incidence of ascochyta blight on pods was significantly influenced by the amount of precipitation in the second half of the growing season in both experimental sites, while only in Perloja it was also significantly influenced by effective temperatures. The frequency of detection of pathogens of *Ascochyta* complex on pea plants was high at pea seedling stage, later, until flowering, the frequency of pathogen detection diminished, and during the flowering-grain formation stage it increased again. In Dotnuva, at seedling stage and during the growing season *Mycosphaerella pinodes* and *Phoma pinodella* pathogens prevailed in the *Ascochyta* complex, and at the end of the growing season, *Ascochyta pisi* was prevalent on pods. In Perloja, the relative density of *A. pisi* in the population of *Ascochyta* complex was low during the entire growing season.

Key words: ascochyta blight, *Ascochyta* complex, meteorological factors, *Pisum sativum*.

Introduction

The field pea (*Pisum sativum* L.) is valued for protein-rich grain and for being a good pre-crop. In Lithuania, over the last decade, the field pea production area has fluctuated from 7.4 thousand ha in 2003 to 27.0 thousand ha in 2011. The crop productivity varied significantly too: from 1.07 t ha^{-1} in 2006 to 2.0 t ha^{-1} in 2009. One of the reasons responsible for the low pea productivity is fungal diseases causing significant annual losses in grain yield (Garry et al., 1998; Beasse et al., 2000; Xue, 2000). More than 20 fungi species infesting pea crops have been established in various parts of the world. Ascochyta blight is widespread in all pea growing regions. Its causal agents are *Ascochyta pisi*, *Mycosphaerella pinodes*, *Phoma pinodella*, which are often referred to in literature as *Ascochyta* complex (Onfroy et al., 1999). These pathogens damage plant root, foot and aerial parts, pods and grains (Moussart et al., 1998; Bretag et al., 2006; Marcinkowska, 2008).

All three causal agents of ascochyta blight: *A. pisi*, *M. pinodes*, *P. pinodella* are transmitted through infected seed and plant residues in the soil. Each of these pathogens causes specific symptoms on plants: *A. pisi* commonly causes leaf and pod spotting, *M. pinodes* and *P. pinodella* cause foot and root rots, and on aerial plant parts - stem, leaf and pod spotting (Wallen, 1974). *A. pisi* symptoms are circular, tan coloured with a dark brown margin, which differ from the multiple brown-purple spots caused by *M. pinodes* and *P. pinodella* (Bretag et al., 2006; Chilvers et al., 2009). However, the symptoms of the latter causal agents on the aerial plant part are very similar and difficult to differentiate even with the aid of molecular techniques (Faris-Mokaiesh et al., 1996; Onfroy et al., 1999; Wang et al., 2000). *M. pinodes* and *P. pinodella* infection persists very well on pea residues in the soil; however, the expression of *A. pisi* saprotrophic properties is weaker, therefore seed infection is more important for the spread of this pathogen (Bretag et al., 2006). The conidia of all pathogens of *Ascochyta* complex are dispersed by rain-splash in a crop within a short distance; however, *M. pinodes* ascospores are also wind-dispersed. The disease progression in a crop is significantly influenced by the plant architecture of the pea varieties and plant morphological peculiarities: leaf area and distribution, internode length, branching, stem strength and height (Le May et al., 2008; Schoeny et al., 2008). In Canada, where the pea cultivation area totals 1.3 million hectares, the yield losses from the diseases caused by *Ascochyta* complex amount to 50% and in separate years to 70% (Wallen, 1974; Xue, 2003). In France, research evidence has shown that in 7 years out of 10 pea grain yield losses from ascochyta blight (*M. pinodes)* amounted to 20% (Beasse et al., 2000). Different pea pathogens differ in resistance to ascochyta blight; however, none of the existing varieties has exhibited complete resistance. Quantitative trait loci (QTL), influencing ascochyta blight resistance have been identified in a pea genome but molecular mechanism of resistance still has not been well ascertained (Onfroy et al., 1999; Wang et al., 2000; Timmerman-Vaughan et al., 2002; Prioul-Gervais et al., 2007). The susceptibility of Lithuania-grown pea cultivars to ascochyta blight is not known; moreover, there is no research evidence on this disease.

The current study was aimed: 1) to identify the susceptibility of various field pea cultivars to ascochyta blight under different agro-ecological conditions, 2) to establish the effect of meteorological factors on ascochyta blight infection and 3) to determine the composition of *Ascochyta* complex on pea plants.

Materials and methods

Determination of pea cultivar's susceptibility to ascochyta blight under different agro-ecological conditions. During the period 2008–2010, in different soil and climate conditions of Lithuania: 1) on Southeast's *Luvisol* (*LV*) in Perloja, 2) on Middle Lowland's *Cambisol* (*CM*) in Dotnuva, experiments were conducted to investigate the severity of ascochyta blight in the crops of semi-leafless field pea cv. 'Profi', 'Eiffel', 'Simona', 'Tinker', 'Mascara' and 'Pinochio'. In the crops of the same cultivars, research was done into the detection frequency of the pathogens of Ascochyta complex on plants at different stages of their ontogenesis. In both experimental sites (Perloja and Dotnuva), experiments were sown using the same untreated seed at a rate of 1 million viable seeds ha^{-1}, a conventional technology for pea cultivation for grain was employed. For all cultivars tested, 6 × 24 m observation plots were formed in 6 metre-wide bands, where from plant emergence to maturity, assessments of ascochyta blight severity were carried out periodically, every 14–18 days. For disease pressure assessment, three samples of 15 plants were formed from each cultivar's observation plot, phenological development stage was determined according to the BBCH scale (Weber, Bleiholder, 2001). Ascochyta blight severity on plants was estimated based on the disease-affected plant surface according to percentage scale, and ascochyta blight incidence on pods (percent of affected pods) was recorded (Sharma, 2004). The severity of ascochyta blight per season is expressed by the area under disease progress curve (AUDPC) value (Campbell, Madden, 1990).

Frequency of detection of pathogens of Ascochyta complex was investigated by cultivating fragments of plant parts on an oat agar medium (Dhingra, Sinclair, 1994; Roger, Tivoli, 1996 a). The pathogens of *Ascochyta* complex were identified according to the morphological traits typical of the colonies (Punithalingam, Holliday, 1972 a; b; Punithalingam, Gibson, 1976; Mathur, Kongsdal, 2003). Frequency of detection of *Ascochyta* complex pathogens and *A. pisi* relative density in *Ascochyta* complex were calculated (González et al., 1995).

Meteorological conditions. In 2008, in Dotnuva the sum of effective temperatures (∑ ≥ 5°C) was significantly higher than that in Perloja nearly throughout the whole growing season; however, the amount of rainfall was markedly higher in Perloja. In 2009, a slightly higher sum of effective temperatures since early spring was recorded in Dotnuva, while in summer months in Perloja. The year 2009 was distinguished by a droughty spring, especially in the Middle Lithuania zone. Later in the season, both experimental sites received a similar amount of rainfall, except for the downpour in Dotnuva, where 74 mm of rainfall fell within 4 hours on 23 June. In 2010, unlike in the previous year, there was more rainfall and rainy days in spring in Dotnuva; however, the first two ten-day periods of June and July were wetter in Perloja, except for third ten-day period of July when Dotnuva received as much as 101 mm more rainfall than Perloja. The effect of the meteorological factors – amount of precipitation (mm) and sum of effective temperatures (∑ ≥ 5°C) on the severity of ascochyta blight in field pea were estimated by a binary regression and correlation data analysis method.

Statistical analysis. The experimental data were processed by the analysis of variance method. The significant difference of data was estimated according to Fisher and Duncan criteria. The method of binary regression and correlation analysis of data was used to estimate the interaction between AUDPC of ascochyta blight and environmental factors. Statistical analysis was done using the statistical data processing software package *SELEKCIJA* (software *ANOVA*, *STAT*) (Tarakanovas, Raudonius, 2003).

Results and discussion

The susceptibility of pea cultivars to ascochyta blight. In 2008, in Perloja the first symptoms of ascochyta blight were spotted in the crops of cv. 'Tinker' and 'Mascara' at stem elongation stage (BBCH 33–35), the lowest ascochyta blight severity at maturity stage was recorded for cv. 'Simona'. In Dotnuva, ascochyta blight appeared much later, the first disease symptoms on 'Profi' and 'Pinochio' plants were spotted only at flowering stage (BBCH 63), while on 'Simona' the disease occurred as late as seed ripening stage (BBCH 85) (Table 1). In 2009, in Perloja, ascochyta blight started to spread in pea crops at the end of bud formation stage, and by the beginning of flowering (BBCH 61–62) the disease had already severely spread in the crops of all cultivars. That year, significantly highest disease severity was identified for 'Mascara' and 'Tinker', while the lowest severity was measured for 'Simona' and 'Pinochio'. In Dotnuva, in 2009, the severity of ascochyta blight was markedly lower than that in Perloja, and the disease manifested itself more severely only at seed ripening stage (BBCH 83). The plants of cv. 'Profi' were most severely affected (Table 1). In 2010, both in Perloja and Dotnuva, ascochyta blight started to spread early, the first disease symptoms in the crops of all cultivars were spotted at stem elongation stage (BBCH 36–37). The disease severity until beginning of flowering (BBCH 61) was low; later, at grain-formation stage

(BBCH 79), in Perloja ascochyta blight significantly more severely affected ‘Tinker’, while ‘Simona’ plants were least affected. In Dotnuva also the highest ascochyta blight severity was identified on ‘Tinker’ pea plants, the disease progressed more slowly in the crops of cv. ‘Pinochio’, ‘Mascara’ and ‘Simona’ (Table 1).

Table 1. The severity of ascochyta blight (%) on the field pea cultivars in Perloja and Dotnuva

Cultivar	Perloja					Dotnuva				
	2008									
BBCH	33–35*	51–55	65–69	75–77	84–85	52–55	61	63	75	85
‘Profi’	0 a	2.6 c	2.7 a	3.4 a	5.0 ab	0	0	0.07 c	0.3 bcd	4.6 b
‘Eiffel’	0 a	3.8 d	5.5 c	5.6 cd	5.8 ab	0	0	0 a	0.4 d	3.2 a
Simona	0 a	1.2 ab	3.0 a	3.3 a	3.8 a	0	0	0 a	0 a	2.5 a
‘Tinker’	4.6 c	5.1 e	3.0 a	6.0 cd	7.0 c	0	0	0 a	0.1 ab	3.5 a
‘Mascara’	2.3 b	1.8 bc	2.2 a	6.1 d	6.8 bc	0	0	0 a	0.07 a	1.9 a
‘Pinochio’	0 a	0.4 a	4.9 c	3.9 ab	4.3 a	0	0	0.03 ab	0.1 ab	2.7 a
	2009									
BBCH	36	51	61–62	79	84–85	51	61–62	71	77–79	83
‘Profi’	0	0	14.2 e	15.3 bc	15.9 ab	0	0.03 a	0.9 bc	2.6 c	13.2 c
‘Eiffel’	0	0	10.3 bc	15.5 c	16.0 abcd	0	0.2 a	0.7 abc	2.0 bc	6.2 a
‘Simona’	0	0	13.7 cde	14.7 abc	14.7 a	0	0.03 a	0.4 a	1.9 bc	3.8 a
‘Tinker’	0	0	10.0 bc	15.0 bc	17.0 bcd	0	0.2 a	0.6 abc	2.0 bc	7.3 abc
‘Mascara’	0	0	8.3 b	14.0 a	17.5 d	0	0.2 a	0.6 abc	0.8 a	6.1 a
‘Pinochio’	0	0	2.4 a	14.8 bc	14.8 a	0	0 a	0.9 c	1.5 abc	9.2 abc
	2010									
BBCH	36–37	54–55	61–63	79	84–85	36	39	61	79	84–85
‘Profi’	1.0 c	2.3 a	8.1 d	20.0 bc	30.8 b	1.6 b	2.3 c	2.7 a	4.7 cd	3.4 a
‘Eiffel’	0.7 b	5.0 cd	5.3 a	21.0 bc	31.4 bc	0.6 a	1.3 a	1.6 a	5.2 cd	3.9 a
‘Simona’	0.8 b	2.3 a	6.6 cd	18.5 a	24.3 a	0.9 a	1.1 a	3.1 a	3.1 ab	4.5 a
‘Tinker’	1.3 d	6.0 d	7.0 cd	28.0 c	40.2 d	6.0 c	2.7 c	7.3 b	5.8 d	5.0 b
‘Mascara’	0.03 a	2.1 a	6.1 ab	18.0 a	30.0 b	0.2 a	1.4 a	1.6 a	2.4 a	4.4 a
‘Pinochio’	0.1 a	3.0 ab	5.6 ab	26.0 bc	35.1 bc	0.7 a	1.3 a	1.5 a	1.9 a	3.9 a

Note. The values denoted by the same letter in the same site and year did not differ significantly ($P \leq 0.05$).

The disease severity was particularly significantly influenced by the experimental site’s agro-ecological conditions. In all experimental years, the AUDPC values of ascochyta blight were higher in Perloja than those in Dotnuva (Table 2). The AUDPC values of the disease were the highest for cv. ‘Tinker’ in Perloja and for ‘Profi’ in Dotnuva for two years out of three, while for ‘Simona’ these values were the lowest. The AUDPC values of ascochyta blight for the other cultivars tested varied markedly between years and experimental sites. The data of the experiments carried out for three years in different agro-climatic conditions showed ‘Tinker’ to be more susceptible to ascochyta blight, while cv. ‘Simona’ and ‘Pinochio’ were less susceptible.

Table 2. The area under disease progress curve (AUDPC) values of ascochyta blight on the field pea cultivars in Perloja and Dotnuva

Cultivar	Perloja			Dotnuva		
	2008	2009	2010	2008	2009	2010
‘Profi’	99 ab	271 c	455 ab	37 c	132 c	102 c
‘Eiffel’	152 cd	257 bc	463 ab	27 abc	70 ab	92 bc
‘Simona’	83 a	253 bc	385 a	19 a	48 a	90 bc
‘Tinker’	169 d	260 bc	601 d	27 abc	78 ab	175 d
‘Mascara’	133 bcd	251 bc	414 ab	15 a	59 ab	72 ab
‘Pinochio’	100 ab	216 a	516 bcd	21 a	91 b	65 a

Explanation under Table 1

The incidence of ascochyta blight on the pods of the pea cultivars tested was observed in all experimental years. In 2008, the pods of cv. ‘Simona’ and ‘Pinochio’ were free from ascochyta blight in both experimental sites (Table 3). In 2009, lower disease pressure was noted on the pods of ‘Pinochio’ (73.3%) in Perloja, in Dotnuva on the pods of ‘Tinker’ (66.7%). In 2010, in Perloja ascochyta blight incidence on pods was as high as 95.0–100%, in Dotnuva 70.0–95.0%.

The effect of the meteorological factors on the severity of ascochyta blight in field pea crops. A combination of three factors is necessary for the spread of fungal diseases: pathogen – host plant – favourable environmental conditions (Van der Plank, 1963). In our study, in both experimental sites (Perloja and Dotnuva) the first two factors were similar; however, there were annual differences in the meteorological conditions (air temperature, precipitation rate as well as the number of rainy days) between the sites (Dotnuva–Middle and Perloja–Southeast Lithuania). Because of the differences in the environmental parameters between the sites the incidence of pea ascochyta blight was uneven. To estimate the effects of the amount of precipitation and the sum of effective temperatures ($\sum \geq 5°C$) on the AUDPC values of ascochyta blight, a binary regression correlation analysis of data was conducted. A strong

Table 3. The incidence of ascochyta blight on pea pods (%) in Perloja and Dotnuva

Cultivar	Perloja			Dotnuva		
	2008	2009	2010	2008	2009	2010
‘Profi’	36.7 e	100 d	98.0 a	13.0 b	76.7 abcd	70.0 a
‘Eiffel’	20.0 c	100 d	98.2 a	20.0 c	80.0 abcd	75.0 a
‘Simona’	0 a	96.7 bcd	90.0 a	0 a	96.7 d	90.0 bcd
‘Tinker’	13.3 b	100 d	100 a	13.3 b	66.7 a	95.0 d
‘Mascara’	26.7 d	90.0 bc	96.7 a	33.3 d	93.3 bcd	80.0 ab
‘Pinochio’	0 a	73.3 a	95.0 a	0 a	70.0 ab	90.0 bcd

Explanation under Table 1

significant correlation ($P \leq 0.01$) was established among the AUDPC values of pea ascochyta blight and the sum of effective temperatures during the growing season and the amount of precipitation in the second half of the growing season for all pea cultivars in Perloja (Table 4). However, in Dotnuva, the correlation among the same factors was considerably weaker. A significant strong correlation between the AUDPC values of ascochyta blight and the amount of precipitation in the second half of the growing season was established only for ‘Profi’ and ‘Pinochio’. The correlation of the AUDPC values of ascochyta blight and the sum of effective temperatures was moderate for the same cultivars. In Dotnuva, in the crops of other cultivars, meteorological indicators correlated with ascochyta blight weakly or did not correlate at all. It is likely that such results were obtained because of the low severity of ascochyta blight in Dotnuva, compared with Perloja, where the disease severity was markedly higher. Ascochyta blight incidence on pods was significantly influenced both in Dotnuva and Perloja by the amount of precipitation in the second half of the growing season (from $r = 0.80$ to $r = 0.99$), and in Perloja also by effective temperatures, from $r = 0.70$ to $r = 0.87$.

Table 4. The correlation coefficients (r) among the area under disease progress curve (AUDPC) values of ascochyta blight and the amount of precipitation (mm) and the sum of effective temperatures ($\sum T \geq 5°C$) 2008–2010

Environmental indicators	Cultivar					
	‘Profi’	‘Eiffel’	‘Simona’	‘Tinker’	‘Mascara’	‘Pinochio’
r between AUDPC of ascochyta blight and environmental indicators						
Dotnuva						
Precipitation 21 04–31 05	0.40	0.10	0.44	0.01	0.14	0.19
Precipitation 01 06–21 07	0.90**	0.56	0.09	0.62	0.46	0.92**
∑T ≥ 5°C 21 04–31 05	0.54	0.46	0.44	0.55	0.55	0.73*
∑T ≥ 5°C 01 06–21 07	0.70*	0.32	0.29	0.28	0.10	0.55
Perloja						
Precipitation 21 04–31 05	0.66	0.68*	0.56	0.73*	0.63	0.71*
Precipitation 01 06–21 07	0.80**	0.79*	0.87**	0.69*	0.83**	0.73*
∑T ≥ 5°C 21 04–31 05	0.91**	0.99**	0.99**	0.94**	0.99**	0.96**
∑T ≥ 5°C 01 06–21 07	0.99**	0.99**	0.97**	0.96**	0.99**	0.97**
r between ascochyta blight severity on pods and environmental indicators						
Dotnuva						
Precipitation 01 06–31 07	0.84**	0.98**	0.97**	0.80*	0.96**	0.88**
∑T ≥ 5°C 01 06–31 07	0.47	0.48	0.49	0.43	0.46	0.47
Perloja						
Precipitation 01 06–31 07	0.99**	0.99**	0.99**	0.99**	0.97**	0.97**
∑T ≥ 5°C 01 06–31 07	0.73*	0.74*	0.70*	0.75*	0.78*	0.87**

Number of pairs: in 2008 n = 9, in 2009 n = 9, in 2010 n = 9; * – $P \leq 0.05$, **– $P \leq 0.01$

The conidia of the pathogens of *Ascochyta* complex are dispersed by rain-splash onto other plants horizontally and upwards to the newly emerging plant parts (Roger, Tivoli, 1996 b; Schoeny et al., 2008). A minimum wet period of 2 h is required for the germination of *M. pinodes* conidia at temperatures from 15°C to 30°C. The pathogenic conidia that have been dispersed to newly emerging plant parts can survive dry periods of up to 21 days and can successfully germinate after the rain. Roger et al. (1999) indicated that ascochyta blight infection was severe in each case when plants were returned to wet conditions after a period of dryness. Setti et al. (2008) reported that lengthening of the duration of wet period increased ascochyta blight severity in the crops of all pea varieties tested. Moreover, the authors maintain that a 48-hour period of uninterrupted wetness on plants in the crops susceptible to ascochyta blight stipulated the outbreak of infection and is an indicator for use of fungicides.

Frequency of detection of the pathogens of Ascochyta complex on field peas. Pathogens of the *Ascochyta* complex were abundantly detected on pea seedlings in both experimental sites. It is likely that the major source of pathogens isolated at an early growth stage was seed-borne infection. All pathogens of the *Ascochyta* complex are seed-borne; *M. pinodes* and *P. pinodella* can cause root and foot rots, while first symptoms of *A. pisi* appear on a stemlet above the first leaves (Bretag et al., 2006). Later, with rapid growth of plants, until flowering stage, the frequency of detection of pathogens of *Ascochyta* complex diminished, and during flowering-grain formation stage the detection frequency rapidly increased until maturity stage (Table 5).

Both in Dotnuva and Perloja, the frequency of pathogen detection on individual varieties varied appreciably at different growth stages. For the similarity of cultural indications of *Mycosphaerella pinodes* and *Phoma pinodella*, these pathogens were not separated and

Table 5. The frequency of detection of *Ascochyta* complex and the relative density of *A. pisi* in *Ascochyta* complex on pea plants of six cultivars at different plant growth stages (BBCH) in Dotnuva and Perloja (standard deviation rate is given)

Year / site	BBCH					On pods
	13	36–37	51–55	61–62	77–79	(BBCH 83)
Frequency of detection (%) of *Ascochyta* complex						
2009 / Dotnuva	39.3 ± 15.1	48.6 ± 21.9	19.4 ± 11.1	29.5 ± 13.7	48.3 ± 14.0	64.4 ± 7.7
2009 / Perloja	13.3 ± 7.3	–	–	65.0 ± 15.7	70.5 ± 8.2	–
2010 / Dotnuva	68.7 ± 14.2	57.8 ± 23.7	29.3 ± 12.5	68.0 ± 8.0	64.0 ± 9.3	44.1 ± 31.3
2010 / Perloja	35.7 ± 17.9	51.2 ± 19.6	26.0 ± 18.2	24.8 ± 10.6	29.3 ± 18.9	63.6 ± 24.4
Relative density (%) of *A. pisi* in *Ascochyta* complex						
2009 / Dotnuva	2.8 ± 1.8	1.3 ± 1.2	2.3 ± 1.6	2.8 ± 2.7	14.0 ± 10.9	68.1 ± 10.8
2009 / Perloja	13.9 ± 9.0	–	–	12.2 ± 5.6	0	–
2010 / Dotnuva	0	43.5 ± 13.6	11.2 ± 7.0	19.5 ± 4.5	24.0 ± 9.6	72.8 ± 10.5
2010 / Perloja	19.2 ± 9.7	19.2 ± 6.8	12.3 ± 5.9	0	0	0

relative density in *Ascochyta* complex only for *Ascochyta pisi* was calculated. In Dotnuva, at seedling stage and during the growing season *M. pinodes* and *P. pinodella* patogens prevailed in the *Ascochyta* complex, and at the end of the growing season, *A. pisi* was prevalent on pods. In Perloja, the relative density of *A. pisi* in the population of *Ascochyta* complex was low during the entire growing season. Until grain-formation stage, only solitary isolates of *A. pisi* were detected. At maturity stage, the highest relative density of this pathogen in the *Ascochyta* complex was identified on the stems of 'Tinker' and 'Mascara'. There was found no consistent relationship between the frequency of detection of pathogens and pea cultivar.

Conclusions

1. The pea cv. 'Tinker' demonstrated the highest susceptibility to ascochyta blight, while 'Simona' and 'Pinochio' were less susceptible irrespective of the ascochyta blight infection level.

2. In Perloja, a significant moderate or strong correlation was identified between the area under disease progress curve (AUDPC) values of pea ascochyta blight and the amount of precipitation and sum of effective temperatures ($\sum T \geq 5°C$) for all field pea cultivars tested. Due to the low severity of ascochyta blight in Dotnuva, the interaction among the same factors was markedly lower. The incidence of ascochyta blight on pods was significantly influenced by the amount of precipitation in the second half of the growing season (from $r = 0.80$ to $r = 0.98$ and $r = 0.97$ to $r = 0.99$ for individual cultivars, respectively) in both experimental sites, while only in Perloja it was also significantly influenced by effective temperatures (from $r = 0.70$ to $r = 0.87$).

3. The frequency of detection of pathogens of *Ascochyta* complex was high at pea seedling stage, later, until flowering, the frequency of pathogen detection diminished, and during the flowering–grain formation stage it increased again. The pods of all varieties were severely infected with the pathogens of *Ascochyta* complex, among which *A. pisi* took the dominant position in Dotnuva; however, in Perloja the complex of *Mycosphaerella pinodes* and *Phoma pinodella* previled.

Acknowledgements

The paper presents research findings, obtained through the long-term research programme "Harmful organisms in agro and forest ecosystems" implemented by Lithuanian Research Centre for Agriculture and Forestry.

Received 31 12 2012
Accepted 15 05 2013

References

Beasse C., Ney B., Tivoli B. 2000. A simple model of pea (*Pisum sativum*) growth affected by *Mycosphaerella pinodes*. Plant Pathology, 49: 187–200

Bretag T. W., Keane P. J., Price T. V. 2006. The epidemiology and control of *Ascochyta* blight in field peas: a review. Australian Journal of Agricultural Research, 57 (8): 883–902 http://dx.doi.org/10.1071/AR05222

Campbell C. L., Madden L. V. 1990. Temporal analysis of epidemics. I. Description and comparison of diseases progress curves. Campbell C. L., Madden L. V. (eds). Introduction to Plant Disease Epidemiology, p. 161–202

Chilvers M. I., Rogers J. D., Dugan F. M., Stewart J. E., Chen W., Peever T. L. 2009. *Didymella pisi* sp. nov., the teleomorph of *Ascochyta pisi*. Mycological Research, 113: 391–400 http://dx.doi.org/10.1016/j.mycres.2008.11.017

Dhingra O. D., Sinclair J. B. 1994. Basic plant pathology methods

Faris-Mokaiesh S., Boccara M., Denis J.-B., Derrien A., Spire D. 1996. Differentiation of the *Ascochyta complex* fungi of pea by biochemical and molecular markers. Current Genetics, 29 (2): 182–190 http://dx.doi.org/10.1007/BF02221583

Garry G., Jeuffroy M. H., Ney B., Tivoli B. 1998. Effects of Ascochyta blight (*Mycosphaerella pinodes*) on the photosynthesizing leaf area and the photosynthetic efficiency of the green leaf area of dried-pea. Plant Pathology, 47: 473–479 http://dx.doi.org/10.1046/j.1365-3059.1998.00259.x

González H. H. L., Resnik S. L., Boca R. T., Marasas W. F. O. 1995. Mycoflora of Argentinean corn harvested in the main production area in 1990. Mycopathologia, 130: 29–36 http://dx.doi.org/10.1007/BF01104346

Le May C., Ney B., Lemarchand E., Schoeny A., Tivoli B. 2008. Effect of pea plant architecture on spatiotemporal epidemic development of Ascochyta blight (*Mycosphaerella pinodes*) in the field. Plant Pathology, 58 (2): 332–343 http://dx.doi.org/10.1111/j.1365-3059.2008.01947.x

Marcinkowska J. 2008. Fungi occurrence on seed of field pea. Acta Mycologica, 43 (1): 77–89

Mathur S. B., Kongsdal O. 2003. Common laboratory seed health testing methods for detecting fungi (3rd ed.)

Moussart A., Tivoli B., Lemarchand E., Deneufbourg F., Roi S., Sicard G. 1998. Role of seed infection by the *Ascochyta* blight pathogen of dried pea (*Mycosphaerella pinodes*) in seeding emergence, early disease development and transmission of the disease to aerial plant parts. European Journal of Plant Pathology, 104: 93–102 http://dx.doi.org/10.1023/A:1008673914537

Onfroy C., Tivoli B., Corbiere R., Bouznad Z. 1999. Cultural, molecular and pathogenic variability of *Mycosphaerella pinodes* and *Phoma medicaginis* var. *pinodella* isolates from dried pea (*Pisum sativum*) in France. Plant Pathology, 48: 218–229 http://dx.doi.org/10.1046/j.1365-3059.1999.00323.x

Prioul-Gervais S., Deniot G., Receveur E. M., Frankewitz A., Fourmann M., Rameau C., Pilet-Nayel M. L., Baranger A. 2007. Candidate genes for quantitative resistance to *Mycosphaerella pinodes* in pea (*Pisum sativum* L.). Theoretical and Applied Genetics, 114 (6): 971–984 http://dx.doi.org/10.1007/s00122-006-0492-y

Punithalingam E., Holliday P. 1972 (a). *Ascochyta pisi*. CMI Description of Pathogenic Fungi No. 334
Punithalingam E., Holliday P. 1972 (b). *Mycosphaerella pinodes*. CMI Description of Pathogenic Fungi No. 340
Punithalingam E., Gibson I. A. S. 1976. *Phoma medicaginis* var. *pinodella*. CMI Description of Pathogenic Fungi No. 518
Roger C., Tivoli B. 1996 (a). Effects of culture medium, light and temperature on sexual and asexual reproduction of four strains of *Mycosphaerella pinodes*. Mycological Research, 100 (3): 304–306 http://dx.doi.org/10.1016/S0953-7562(96)80159-6
Roger C., Tivoli B. 1996 (b). Spatio-temporal development of pycnidia and perithecia and dissemination of spores of *Mycosphaerella pinodes* on pea (*Pisum sativum*). Plant Pathology, 45: 518–528 http://dx.doi.org/10.1046/j.1365-3059.1996.d01-139.x
Roger C., Tivoli B., Huber L. 1999. Effects of interrupted wet periods and different temperatures on the development of *Ascochyta* blight caused by *Mycosphaerella pinodes* on pea (*Pisum sativum*) seedlings. Plant Pathology, 48: 10–18 http://dx.doi.org/10.1046/j.1365-3059.1999.00311.x
Schoeny A., Menat J., Darsonval A., Rouault F., Jumel S., Tivoli B. 2008. Effect of pea canopy architecture on splash dispersal of *Mycosphaerella pinodes* conidia. Plant Pathology, 57: 1073–1085 http://dx.doi.org/10.1111/j.1365-3059.2008.01888.x
Setti B., Bencheikh M., Henni J. E., Neema C. 2008. Effect of pea cultivar, pathogen isolate, inoculum concentration and leaf wetness duration on Ascochyta blight caused by *Mycosphaerella pinodes*. Phytopathologia Mediterrana, 47: 214–222
Sharma P. D. 2004. Epidemiology, assessments and forecasting of plant diseases. Sharma P. D. (ed.). Plant Pathology, p. 91–102
Tarakanovas P., Raudonius S. 2003. Agronominių tyrimų duomenų statistinė analizė taikant kompiuterines programas *ANOVA*, *STAT, SPLIT-PLOT iš paketo SELEKCIJA* ir *IRRISTAT*. Lithuanian University of Agriculture, 58 p. (in Lithuanian)
Timmerman-Vaughan G. M., Frew T. J., Russell A. C., Khan T., Butler R., Gilpin M., Murray S., Falloon K. 2002. QTL mapping of partial resistance to field epidemics of Ascochyta blight of pea. Crop Science, 42: 2100–2111 http://dx.doi.org/10.2135/cropsci2002.2100
Van der Plank J. E. 1963. Plant diseases: epidemics and control
Wallen V. R. 1974. Influence of three Ascochyta diseases of peas on the development and yield. Canadian Plant Disease Survey, Disease Highlights, 54: 86–90
Wang H., Hwang S. F., Chang K. F., Turnbull G. D., Howard R. J. 2000. Characterization of *Ascochyta* isolates and susceptibility of pea cultivars to the *Ascochyta* disease complex in Alberta. Plant Pathology, 49: 540–545 http://dx.doi.org/10.1046/j.1365-3059.2000.00489.x
Weber E., Bleiholder H. 2001. Phenological growth stages and BBCH-identification keys of pea (*Pisum sativum*). Meier U. (ed.). Growth sages of mono- and dicotyledonous plants. BBCH Monograph (2nd ed.), p. 138–140. < http://www.jki.bund.de/fileadmin/dam_uploads/_veroeff/bbch/BBCH-Skala_englisch.pdf> [accessed 10 04 2013]
Xue A. G. 2000. Effect of seed-borne *Mycosphaerella pinodes* and seed treatments on emergence foot rot severity, and yield of field pea. Canadian Journal of Plant Pathology, 22 (3): 248–253 http://dx.doi.org/10.1080/07060660009500471
Xue A. G. 2003. Efficacy of *Clonostachys rosea* strain ACM941 and fungicide seed treatments for controlling the root rot complex of field pea. Canadian Journal of Plant Science, 83: 519–524 http://dx.doi.org/10.4141/P02-078

ISSN 1392-3196 / e-ISSN 2335-8947
Zemdirbyste-Agriculture, vol. 100, No. 3 (2013), p. 283–288
DOI 10.13080/z-a.2013.100.036

Sėjamojo žirnio (*Pisum sativum* L.) jautrumas askochitozei Lietuvos sąlygomis

I. Gaurilčikienė[1], R. Česnulevičienė[2]

[1]Lietuvos agrarinių ir miškų mokslų centro Žemdirbystės institutas
[2]Lietuvos agrarinių ir miškų mokslų centro Perlojos bandymų stotis

Santrauka

2008–2010 m. skirtingomis dirvos ir klimato sąlygomis: 1) išplautžemyje (ID) Pietryčių Lietuvoje Perlojoje ir 2) rudžemyje (RD) Vidurio Lietuvoje Dotnuvoje tirta askochitozės intensyvumas sėjamojo žirnio (*Pisum sativum* L.) pusiau belapių veislių 'Profi', 'Eiffel', 'Simona', 'Tinker', 'Mascara' ir 'Pinochio' pasėliuose. Tyrimų metu siekta nustatyti sėjamojo žirnio veislių jautrumą askochitozei skirtingomis agroekologinėmis sąlygomis, įvertinti meterologinių veiksnių įtaką ligos intensyvumui ir nustatyti *Ascochyta* komplekso patogenų struktūrą ant žirnių augalų.

Visais tyrimų metais askochitozės AUDPC (angl. *area under disease progress curve* „plotas po ligos vystymosi per vegetaciją kreive") reikšmės buvo didesnės Perlojoje nei Dotnuvoje. Nepriklausomai nuo askochitozės infekcijos smarkumo, ligai jautriausi buvo veislės 'Tinker', mažiau jautrūs – veislių 'Simona' ir 'Pinochio' žirniai. Perlojoje nustatytas visų žirnių veislių esminis vidutinis arba stiprus koreliacinis ryšys tarp žirnių askochitozės AUDPC reikšmių ir kritulių kiekio bei efektyvių temperatūrų sumos ($\sum T \geq 5°$). Dėl nedidelio askochitozės intensyvumo Dotnuvoje tų pačių veiksnių sąveika buvo gerokai silpnesnė. Askochitozės išplitimą ant ankščių ir Dotnuvoje, ir Perlojoje iš esmės lėmė kritulių kiekis antroje vegetacijos pusėje, o Perlojoje – ir efektyvios temperatūros. *Ascochyta* komplekso patogenai ant visų veislių žirnių buvo gausiai aptinkami daigų tarpsniu, vėliau iki žydėjimo tarpsnio patogenų aptikimo dažnis mažėjo, o žydėjimo–grūdo formavimosi tarpsniu vėl padidėjo. Daigų tarpsniu ir vegetacijos metu Dotnuvoje *Ascochyta* komplekse vyravo *Mycosphaerella pinodes* ir *Phoma pinodella* patogenai, o vegetacijos pabaigoje ant ankščių – *Ascochyta pisi*. Perlojoje *A. pisi* santykinis tankis *Ascochyta* komplekso populiacijoje buvo mažas visos vegetacijos metu. Nuoseklios patogenų aptikimo dažnio nuo žirnių veislės priklausomybės nenustatyta.

Reikšminiai žodžiai: *Ascochyta* kompleksas, meterologinės sąlygos, *Pisum sativum*, žirnių askochitozės.