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EVALUATION OF STABILITY OF FIELD PEA GENOTYPES IN RESPONSE TO *MYCOSPHAERELLA PINODES* INFECTION

ABSTRACT

Interaction of genotypes with environment for quantitative traits among them certain disease resistance makes difficult choice of proper genotypes for breeding proposes and may affects further cultivation effects. The aim of this study was assessment of stability of reaction to *Mycosphaerella pinodes* infection for the set of pea genotypes in four years field experiments with vary epidemic pressure. The Sheffé-Caliński mixed model and the Caliński-Kaczmarek joint regression model for genotype-environment interaction analysis was applied. Tested pea genotypes were grouped into two categories; responding stable to *M. pinodes* (reacting proportionally to changed environment) and unstable ones (showing significant interaction with environment). The unstable genotypes reacted irregularly to environments (not able to describe the reaction to *M. pinodes* by any linear regression function). Pea genotypes PI 142441, PI 142442, PI 404221, PI 413691, cv. Radley and Bohun were characterized by high negative main effects (most resistant) for disease severity and showed stable response to *M. pinodes* infection. Stability of mycosphaerella blight reactions was not associated with the level of resistance in the cultivars tested.

Key words: field pea, genotype-environment interaction, Mycosphaerella blight, stability

INTRODUCTION

Mycosphaerella blight is an important yield constrains of pea worldwide. According to Marcinkowska (1996 and 2002) *M. pinodes* was prevalent on pea in several regions of Poland. The disease is apparent as a severe foliar blight and foot rot, causing yield losses. The yield losses in commercial pea fields were estimated from 10% to 20%, but in some trials were also over 50% (Xue *et al.*, 1997; Xue and Warkentin, 2001; Boros and Wawer, 2007). Using host resis-

tance is the most economical means in managing the disease. No complete resistance to *M. pinodes* has been identified in peas; however sources of partial resistance have been identified and are being used in breeding programme (Tivoli *et al.* 2006). In field pea, Bretag *et al.* (2000) found that disease severity varied considerably between years, regions and fields in the same region and was attributed to differences in climatic conditions and in the availability of inoculum.

Since the inheritance of resistance to *M. pinodes* is quantitative traits controlled by multiple genes (Pirioul-Gervais *et al.* 2007; Zhang *et al.* 2007), and expression of resistance is substantially influenced by environment (Worth 1999; Zhang and Gossen 2007) we decided to assess stability of reaction to *M. pinodes* infection of some partial resistant accessions in comparison with some commercial pea cultivars under field conditions with vary epidemic pressure.

MATERIALS AND METHODS

Field studies were conducted in 2005-2008. Twenty one field pea genotypes, among them commercial cultivars, partially resistant accessions from USDA-ARS collection (PI 142441, PI 142442, PI 381132, PI 404221 and PI 413691) and cv. Radley were used for these tests. Peas were grown on two-row 20 cm spaced plots, 1.5 m long with 100 plants per plot and 50 cm between plot spacing with three replications. Prior to flowering plants were inoculated with *M. pinodes* ($2 \times 10^6 \times \text{ml}^{-1}$). Control plots were sprayed with fungicide Bravo. Disease severity was assessed with 0-9 scale (Xue *et al.* 1996) where increasing scores represent higher disease severity and disease development higher in the plant canopy. The Sheffé-Caliński mixed model and the Caliński-Kaczmarek joint regression model for genotype-environment interaction analysis was applied (Madry and Kang 2005). Statistical analysis were performed with statistical package SERGEN 3 (Caliński *et al.* 1998).

RESULTS AND DISCUSSION

Analysis of variance of pea accessions across environments for major agronomic traits revealed significant differences among cultivars, environments, and their interactions ($G \times E$). Table 1 contains a summary of the mean cultivar values across four environments for major agronomic traits among them infection with *M. pinodes* and corresponding to infection scores, seed yield reduction. In each environment, significant differences among cultivars were found for all parameters measured. The environmental diversity is shown in the disease score means (Table 1) among four environments which ranged from 3.09 in 2008 to 4.93 in 2007 growing season. Significant differences among environments indicate that the cultivars were exposed to and evaluated at significantly different

disease levels. A mean yield losses ranged from 8.7 to 14.5% in comparison to fungicide protected combination. An average seed yield reduction due to *M. pinodes* in this study was lower than that of previous experiments (Boros and Marcinkowska 2010).

Table 1
Environment mean values over cultivars and replications for disease severity and agronomic parameters from 2005-2008.

Years	Vegetation [days]	Plant height [cm]	Lodging [0-9 scale]	Disease severity [0-9 scale]	Seed yield/plot [g]	Seed yield reduction [%]
2005	98	75.8	6.57	4.22	0.37	12.08
2006	89	75.3	5.52	4.83	0.31	14.46
2007	90	67.5	4.55	4.93	0.23	11.16
2008	89	62.6	5.42	3.09	0.27	8.71
LSD _{0.05}	0.5	2.4	0.28	0.17	0.01	1.82

Fig. 1. Mean infection score of field pea genotypes inoculated with *M. pinodes* assessed in field trials

The genetic diversity among genotypes in their reaction to *M. pinodes* infection is shown in the Fig. 1. The *M. pinodes* infection score means among tested genotypes ranged from 3.6 for PI 142441, PI 142442 pea lines to 5.3 for cultivar Rubin. The four out of five accessions (PI 142441, PI 142442, PI 404221 and PI 413691) with partial resistance to *M. pinodes* identified by Kraft *et al.* (1998) from USDA –ARS collection of pea germplasm along with Radley, Bohun and Miko cultivars were the most resistant genotypes also in current study confirming previous reports (Boros and Wawer 2007). Similarly to other reports (Zhong *et al.* 2006; Xue and Warkentin 2001; Fondevilla *et al.* 2005; Boros and Wawer 2007; Boros and Marcinkowska 2010) differences in susceptibility among cultivars have been demonstrated but no strong resistance are known in *Pisum sativum*.

Table 2

Results of stability analysis of response to *M. pinodes* infection among field pea genotypes

Cultivar	Estimation of main effect	F-statistics			
		For main effect	For G × E interactions	For regression of interaction of G vs. E	For deviations from regression of interaction
Agra	0.692	133.08**	0.19	-	-
Bohun	-0.341	5.43	1.14	-	-
Brylant	0.259	1.93	1.86	-	-
Komandor	0.117	0.18	4.16**	0.00	6.23**
Krezus	0.676	5.65	4.31**	0.00	6.46**
Merlin	-0.174	0.24	6.86**	1.58	5.74**
Olimpik	0.226	3.19	0.85	-	-
Ramrod	-0.166	1.74	0.84	-	-
Set	-0.041	0.32	0.28	-	-
Stig	0.401	2.01	4.27**	0.32	5.52**
Tarchalska	0.076	0.32	0.97	-	-
Wenus	0.059	0.70	0.27	-	-
Rubin	1.067	17.52*	2.47	-	-
Miko	-0.224	0.69	3.88*	0.62	4.44*
Bohatyr	0.151	0.90	1.35	-	-
PI142441	-0.633	10.95*	2.14	-	-
PI142442	-0.683	20.11*	1.24	-	-
PI381132	-0.074	0.14	2.03	-	-
PI404221	-0.508	75.95**	0.18	-	-
PI413691	-0.391	12.26*	0.66	-	-
Radley	-0.491	37.45**	0.34	-	-

*, ** indicate significance at P=0.05 and P=0.01 respectively

Genotype-environment interaction (G × E) has been important issue for plant breeders in developing improved varieties. Several methods are available for analysis GxE interaction and to assess genotype stability (Becker and Leon 1988; Fuentes *et al.* 2005; Mađry and Kang 2005; Letta and Tilahun 2007).

The results of applied statistical model of analysis of stability in response to *M. pinodes* infection among field pea genotypes are presented in Table 2. Tested pea genotypes were grouped into two classes; responding stable to *M. pinodes* (reacting proportionally to changed environment) and unstable ones (showing significant interaction with environment). The unstable genotypes can be divided in two subgroups: predictable and non predictable - reacted irregularly to environments (not able to describe the reaction to *M. pinodes* by any linear regression function). Within the first class cv. Agra and Rubin had high mean values for disease severity (highest and significant main effect) and non-significant G x E indicating that they are stable susceptible cultivars while PI 142441, PI 142442, PI 381132, PI 404241, cv. Radley, Bohun and Ramrod had low mean values for disease severity (lowest negative, significant main effect), were the most resistant, stable in response to *M. pinodes* infection among tested genotypes (Table 3). Also in seedling test and detached leaf assessment they were the most resistant genotypes tested (data not included). Results from stability analysis revealed stability for *M. pinodes* response in moderately resistant, moderately susceptible and susceptible pea genotypes (Table 3). Our results are in agreement with that of Fuentes *et al.* (2005) as well as with that of Letta and Tilahun (2007) who concluded that stability for *Fusarium head blight* (FBH) reaction in spring wheat and stem rust resistance in durum wheat varieties respectively, was not associated with the level of resistance in the cultivars tested. Similarly in potato association between stability for *Phytophthora infestans* resistance with the level of cultivars resistance has not been observed (Tatarowska *et al.* 2003).

Table 3
Genotypes grouping according to their stability in reaction to *M. pinodes* under field conditions

Resistance group	Genotypes stable	Genotypes unstable	
		Predictable	Unpredictable
Susceptible	Agra, Rubin	-	Krezus Stig
Moderately susceptible	Brylant, Olimpik, Set, Tarchalska, Wenus, PI 381132, Bohatyr	-	Komandor,
Moderately resistant	PI 142441, PI 142442, PI404221, PI 413691, Radley, Bohun, Ramrod	-	Merlin, Miko

CONCLUSION

Ideally, resistant cultivars should possess significant negative major effect (low mean values) for parameters of disease severity and not showing significant interaction with environment. The conidial-spray inoculation method provided disease levels sufficient to differentiate resistant and susceptible cultivars.

When breeding for mycosphaerella blight resistance, it is crucial to evaluate lines with resistant and susceptible check cultivars known to be stable in their disease response. Stability of mycosphaerella blight reactions was not associated with the level of resistance in the cultivars tested. The stability and level of the resistance reported in this study indicated that some accessions may be a good sources of resistance needed to improve the level of resistance to *M. inodes* in pea crop.

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