J. Elem. s. 379–388 DOI: 10.5601/jelem.2012.17.3.02

SEVERITY OF LATE BLIGHT (*PHYTOPHTHORA INFESTANS* /MONT./ DE BARY) AND EARLY BLIGHT OF POTATO (*ALTERNARIA SOLANI* SORAUER, *A. ALTERNATA* /FR./ KEISSLER) IN THREE POTATO CULTIVARS UNDER DIFFERENTIATED SOIL AND FOLIAR FERTILIZATION

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Abstract

Late blight (*Phytophthora infestans* /Mont./ de Bary) and early blight of potato (*Alternaria solani* Sorauer, *A. alternata* /Fr./ Keissler) belong to very severe potato diseases, which are able to decimate potato plantations in Poland and worldwide. In a strict plot experiment, run from 2008 to 2010, the severity of late blight (*Phytophthora infestans*) and early blight (*Alternaria* spp.) was determined, during the growing season, on three potato cultivars: medium-early cv. Adam, medium-late cv. Pasja Pomorska and late cv. Ślęza, which received NPK soil fertilization (two fertilization levels) and foliar nutrition consisting of complex fertilizers with micronutrients (Basfoliar 12-4-6, ADOB Mn, Solubor DF). The extent to which the pathogens infected potato plants was evaluated twice during each growing season, on a 9-degree scale (Pietkiewicz 1985), and the results (means from two observations) expressed as a percentage represented an infestation index. During the first two seasons, the late blight symptoms were significantly less severe on the late and medium-late rather than on the medium-early cultivar. In the last year, the cultivars Adam and Ślęza proved to be the least infected by *P. infestans*. Differences in the intensity of early blight of potato on the examined potato cultivars appeared in the third year, when cv. Adam proved to be the healthiest variety. Some non-significant differences were demon-

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strated in the severity of the diseases depending on the applied foliar fertilization and the levels of NPK fertilization.

Key words: potato, late blight, early blight, foliar fertilization.

NASILENIE ZARAZY ZIEMNIAKA (*PHYTOPHTHORA INFESTANS*) I ALTERNARIOZY (*ALTERNARIA* SPP.) NA TRZECH ODMIANACH ZIEMNIAKA PRZY ZRÓŻNICOWANYM NAWOŻENIU DOGLEBOWYM I DOLISTNYM

Abstract

Zaraza ziemniaka (*Phytophthora infestans* /Mont./ de Bary) i alternarioza (*Alternaria solani* Sorauer, *A. alternata* /Fr./ Keissler) należą do groźnych chorób ziemniaka, dewastujących uprawy tego gatunku w kraju i na świecie. W ścisłym doświadczeniu poletkowym (2008-2010) w okresie wegetacji określano nasilenie zarazy ziemniaka (*Phytophthora infestans*) i alternariozy (*Alternaria* spp.) na trzech odmianach ziemniaka: średnio wczesnej Adam, średnio późnej Pasja Pomorska i późnej Ślęza nawożonych doglebowo NPK (dwa poziomy nawożenia) i dokarmianych wieloskładnikowych nawozami dolistnymi z mikroelementami (Basfoliar 12-4-6, ADOB Mn, Solubor DF). Porażenie przez patogeny oceniano dwukrotnie w okresie wegetacji wg 9-stopniowej skali (Pietkiewicz 1985), a wyniki (średnie z dwóch obserwacji) podano w procentach jako indeks porażenia. Zanotowano istotnie mniejsze nasilenie zarazy na roślinach późnych odmian niż na średnio wczesnej w pierwszych dwóch analizowanych sezonach wegetacyjnych oraz mniejsze nasilenie tej choroby na roślinach średnio wczesnej i późnej odmiany niż średnio późnej w ostatnim roku badań. Zróżnicowanie w nasileniu alternariozy na badanych odmianach ziemniaka stwierdzono w ostatnim roku badań, a najzdrowsza okazała się odmiana Adam. Stwierdzono nieistotne zróżnicowanie w nasileniu chorób w zależności od stosowanego nawożenia dolistnego i poziomów nawożenia mineralnego NPK.

Słowa kluczowe: ziemniak, zaraza ziemniaka, alternarioza, nawożenie dolistne.

INTRODUCTION

The severity of late blight (*Phytophthora infestans*) and early blight (*Alternaria solani*, *A. alternata*) of potato is affected by a variety of factors, including the weather conditions, the potato cultivar (Sadowski 2006) or the applied plant protection chemicals (Kurzawińska, Gajda 2004, Shailbala, Pundhir 2008). Foliar application of multi-component fertilizers is part of a modern potato cultivation technology, which gains in importance whenever organic and mineral fertilization treatments are not adequately utilized by plants. The yield-stimulating effect (including an increased percentage of large tubers) has been demonstrated to result from foliar application of N, K, P, Mg and micronutrients (Brar, Navdeep-Kaur 2006) as well as the application of elemental sulphur or potassium sulphate (Klikocka et al. 2005). Foliar fertilization affects the quality of tubers as well (Kozera et al. 2006). The micronutrients such as Zn, Fe, B, Mn, Cu and Mn, found in fertilizers,

shape the potato's resistance to pathogens (HABERLAND 2000, MAHMOUD 2007, MALAHOUTI 2008). The literature contains some reports on the limiting effect of foliar fertilization on the development of late blight (KAPSA 2002, BASU et al. 2003) and early blight of potato (OSOWSKI 2005). However, the influence of complex foliar fertilizers on the health of potato tubers remains debatable. BOLIGŁOWA (2003) observed that infection caused by *Streptomyces scabies* was more severe under a combined fertilization treatment with Insol 7 and urea. COOKE and LITTLE (2002) found weaker symptoms of infection caused by *P. infestans* following foliar application of phosphorus.

In the present study, the authors analyzed the severity of late and early blight on three potato cultivars grown under various systems of soil NPK mineral fertilization and foliar application of multi-component fertilizers including micronutrients.

MATERIAL AND METHODS

Our tests on the health of potatoes of three cultivars: medium-early cv. Adam, medium-late cv. Pasja Pomorska and late cv. Ślęza, were carried out in a strict plot experiment (2008-2010) set up by the staff of the Chair of Agrotechnology and Crop Production Management of the University of Warmia and Mazury in Olsztyn (with randomly chosen sub-blocks and four replications), which was located in Bałcyny, near Olsztyn (53°78'N, 20°48'E), on grey-brown podzolic soil originating from light silty clay, which belonged to complex 4 class III in the Polish soils classification system. The preceding crop consisted of cereal plants. Certified tubers were planted in rows at a 40-cm distance, with spaces between rows equal 62.5 cm. The first factor of the experiment comprised two levels of mineral fertilization: I – 80 kg N ha^{-1}, 80 kg P ha^{-1}, 120 K ha^{-1}, II – 120 kg ha^{-1} P 144 kg ha^{-1} K 156 kg ha^{-1}). The second factor included variants with foliar fertilization: A. Basfoliar 12-4-6 (8 dm^3 ha^{-1}), B. ADOB Mn (4 dm^3 ha^{-1}), C. Solubor DF (2 dm^3 ha^{-1}), D. ADOB Mn (2 dm^3 ha^{-1}) + Solubor DF (1 dm^3 ha^{-1}), E. ADOB Mn (2 dm^3 ha^{-1}) + Basfoliar 12-4-6 (4 dm^3 ha^{-1}), F. Basfoliar 12-4-6 (4 dm^3 ha^{-1}) + + Solubor DF (1 dm^3 ha^{-1}), G. Basfoliar 12-4-6 (2.7 dm^3 ha^{-1}) + ADOB Mn (1.3 dm^3 ha^{-1}) + Solubor DF (0.7 dm^3 ha^{-1}), H. control without foliar fertilization. The fertilizers were applied once, at the beginning of flowering (BBCH 61). Identical agrotechnical (as recommended by the Institute of Soil Science and Plant Cultivation – National Research Institute, Puławy) and plant protection treatments (as recommended by the Institute of Plant Protection – National Research Institute, Poznań) were performed on all the plots. The content of particular components in % weight was as follows: Basfoliar 12-4-6 (N – 12, K – 6, P – 4, Mg – 0.2, B – 0,02, Mn – 0.01, Cu – 0.01, Fe – 0.01, Zn – 0.005, Mo – 0.005), ADOB Mn (N – 6.5, Mg – 2, Mn – 10), Solubor DF (B – 17.5).

Table 1

The weather conditions (the Meteorological Station in Bałcyny)

Temperature (°C)													
Month	2008				2009				2010				mean for 1960--1990
	monthly mean	mean for 10 days			monthly mean	mean for 10 days			monthly mean	mean for 10 days			
May	12.3	11.6	12.0	13.3	12.2	11.5	11.0	13.9	12.0	10.7	12.1	13.2	12.4
June	16.6	18.0	14.9	17.0	14.7	12.1	13.9	18.2	15.7	17.4	14.8	15.1	15.7
July	18.3	17.4	18.4	19.2	18.9	18.6	19.1	19.1	20.8	19.4	23.6	19.5	15.3
August	17.8	18.3	19.0	16.2	18.5	19.7	17.8	17.8	19.3	20.2	21.4	16.6	17.9
Mean for growing season	16.3	16.3	16.1	16.4	16.1	15.5	15.5	17.3	17.0	16.9	18.0	16.1	15.3
Rainfall (mm)													
Month	monthly sum	sum for of 10 days			monthly sum	sum or 10 days			monthly sum	sum for 10 days			sum for 1960--1990
May	48.4	41.8	2.2	4.4	89.6	11.5	1.8	76.3	105,5	19.2	38.6	47.7	56.7
June	27.8	0.0	11.2	16.6	133.1	56.7	30.4	46.0	73.7	12.0	39.8	21.9	68.3
July	47.0	10.8	23.8	12.4	82.2	60.0	10.3	11.9	87.8	16.8	21.5	49.5	81.3
August	103.1	43.0	26.0	34.1	25.7	13.4	11.2		99.3	17.4	13.8	68.1	78.1
Sum for growing season	226.3	95.6	63.2	67.5	330.6	141.6	53.7	135.3	366.3	65.4	113.7	187.2	284.4

During the plants' growth, 3 and 5 weeks after a foliar fertilization treatment carried out on 30 plants, the severity of late blight and early blight infection was assessed on a 9-degree scale (PIETKIEWICZ 1985), where 0 stands for no infection symptoms and 9 means the most severe infection case. The results (means from two observations) were given in percentage as an infection index Ii and then processed statistically using analysis of variance for random blocks (Statistica® 9.0 v. 2009). For comparison of the means, Duncan's test was applied at the level of significance equal 0.05.

The distribution of temperatures from May to August during the analyzed growing seasons was similar, with the average temperatures in July and August higher than the multi-year means for the same months (Table 1). In contrast, the rainfalls were varied, e.g. they were nearly 50% higher in the first than in the second and third season.

RESULTS AND DISCUSSION

The cultivars determined the intensity of late blight and early blight symptoms on potato plants in the present experiment. The resistance to potato late blight is a trait that seems to be most frequently tested in potato breeding programmes, which include new cultivars with improved resistance of leaves and tubers to late blight (SADOWSKI 2006). During the first two seasons, stronger symptoms of an infection by *P. infestans* appeared on potato plants belonging to cv. Adam (the infection indices from 50.5% – the variant with Solubor DF during the 2009 growing season to 68% – the combination with ADOB Mn and Solubor DF applied together, in 2008) than on the other two cultivars, at the higher and lower NPK mineral fertilization rate respectively (Table 2). When analyzing the severity of late blight on the later cultivars evaluated at the same time, the infection indices ranged from 29.1% for cv. Ślęza in the combination consisting of Basfoliar 12-4-6 in 2009 to 44.1% for cv. Pasja Pomorska in the fertilization variant with ADOB Mn in 2008 (variant II of mineral fertilization).

BASU et al. (2003) prove that foliar fertilization of potatoes with $ZnSO_4$ and $CuSO_4$ alleviated the severity of symptoms of potato late blight on leaves and tubers. Foliar application of phosphates inhibited the development of *P. infestans* on leaves (LOBATO et al. 2008). JABŁOŃSKI and BERNAT (2001), while concluding that the efficacy of the applied Mikrosol Zm in combination with half the recommended dose of fungicides was comparable to the whole recommended dose of the latter, perceive it as a possible way to reduce the chemical control of potato late blight. Similar results were obtained by ANN (2001): combined application of fungicides and foliar fertilizers Nutri-Phite P Foliar and Guard PK successfully limited the extent of infection caused by *P. infestans*. In his latest report, SZEWCZUK (2009) also implies that potato

Table 2

Symptoms of infection of potato plants by P. *infestans* during the study (% infection index), Bałcyny 2008-2010

Level of NPK	Foliar fertiliz.	2008			x	2009			x	2010			x
		Adam	Pasja P.*	Ślęza		Adam	Pasja P.	Ślęza		Adam	Pasja P.	Ślęza	
I**	A***	61.5^{ab****}	$42.2^{c\text{-}f}$	$37.7^{c\text{-}g}$	47.1^{a}	63.2^{a}	48.5^{cde}	$35.2^{k\text{-}o}$	49.0^{a}	43.7^{bc}	64.3^{a}	46.5^{bc}	51.5^{a}
	B	60.5^{ab}	$39.4^{c\text{-}g}$	$35.5^{c\text{-}g}$	45.1^{a}	59.7^{ab}	$43.2^{d\text{-}j}$	$35.1^{k\text{-}o}$	$46.0^{a\text{-}e}$	43.2^{bc}	62.6^{a}	48.0^{b}	51.3^{a}
	C	65.2^{ab}	$40.3^{c\text{-}g}$	$35.5^{c\text{-}g}$	47.0^{a}	62.3^{a}	$43.9^{d\text{-}i}$	$35.2^{k\text{-}o}$	$47.1^{a\text{-}d}$	44.3^{bc}	62.7^{a}	47.8^{b}	51.6^{a}
	D	68.0^{a}	$40.6^{c\text{-}g}$	$35.2^{c\text{-}g}$	47.9^{a}	59.9^{ab}	$40.4^{f\text{-}l}$	$37.4^{g\text{-}n}$	$45.9^{a\text{-}e}$	39.9^{c}	64.3^{a}	46.8^{bc}	50.3^{a}
	E	59.2^{ab}	$38.7^{c\text{-}g}$	$36.0^{c\text{-}g}$	44.6^{a}	59.8^{ab}	45.8^{def}	$35.8^{j\text{-}o}$	$47.1^{a\text{-}d}$	42.5^{bc}	63.9^{a}	46.2^{bc}	50.9^{a}
	F	63.2^{ab}	$40.2^{c\text{-}g}$	33.5^{efg}	45.6^{a}	60.4^{ab}	$41.3^{e\text{-}l}$	32.4^{mno}	$44.7^{a\text{-}e}$	42.1^{bc}	63.9^{a}	45.2^{bc}	50.4^{a}
	G	62.3^{ab}	$39.6^{c\text{-}g}$	$35.2^{c\text{-}g}$	45.7^{a}	59.5^{ab}	46.0^{def}	$39.6^{f\text{-}m}$	48.4^{ab}	44.2^{bc}	62.6^{a}	47.1^{bc}	51.3^{a}
	H	63.4^{ab}	$41.1^{c\text{-}f}$	$34.6^{d\text{-}g}$	46.4^{a}	53.2^{bc}	$40.4^{f\text{-}l}$	31.3^{no}	41.6^{e}	45.9^{bc}	60.8^{a}	47.2^{bc}	51.3^{a}
x		62.9^{a}	40.3^{b}	35.4^{c}	46.2^{a}	59.8^{a}	43.7^{b}	35.3^{c}	46.2^{a}	43.2^{c}	63.1^{a}	46.9^{a}	$51.1a$
II	A	59.5^{ab}	42.6^{cde}	$35.6^{c\text{-}g}$	45.9^{a}	61.2^{a}	$40.6^{f\text{-}l}$	29.1^{o}	43.6^{cde}	43.0^{bc}	61.4^{a}	45.8^{bc}	50.1^{a}
	B	58.9^{ab}	44.1^{cd}	32.0^{fg}	45.0^{a}	58.4^{ab}	$38.2^{f\text{-}n}$	$36.3^{i\text{-}o}$	$44.3^{b\text{-}e}$	43.0^{bc}	62.4^{a}	45.9^{bc}	50.4^{a}
	C	61.6^{ab}	$41.8^{c\text{-}f}$	$35.2^{c\text{-}g}$	46.2^{a}	50.5^{cd}	$42.4^{e\text{-}k}$	$36.3^{i\text{-}o}$	43.1^{de}	42.0^{bc}	63.3^{a}	46.3^{bc}	50.5^{a}
	D	61.1^{ab}	$42.0^{c\text{-}f}$	$34.0^{d\text{-}g}$	45.7^{a}	57.9^{ab}	$39.5^{f\text{-}n}$	$34.3^{l\text{-}o}$	43.9^{cde}	43.5^{bc}	62.7^{a}	45.6^{bc}	50.6^{a}
	E	62.2^{ab}	$42.4^{c\text{-}f}$	30.3^{g}	45.0^{a}	60.4^{ab}	$38.4^{f\text{-}n}$	$33.4^{l\text{-}o}$	$44.1^{b\text{-}e}$	$42.9bc$	60.8^{a}	46.5^{bc}	50.1^{a}
	F	57.6^{b}	$40.4^{c\text{-}g}$	$34.8^{d\text{-}g}$	44.3^{a}	60.7^{ab}	45.6^{def}	$36.9^{h\text{-}n}$	47.7^{abc}	42.2^{bc}	60.5^{a}	46.9^{bc}	50.0^{a}
	G	61.2^{ab}	$40.3^{c\text{-}g}$	$33.7^{d\text{-}g}$	45.0^{a}	61.0^{a}	$45.2^{d\text{-}g}$	$37.6^{g\text{-}n}$	47.9^{abc}	42.9^{bc}	64.0^{a}	45.5^{bc}	50.8^{a}
	H	65.2^{ab}	45.2^{c}	$34.4^{d\text{-}g}$	48.3^{a}	61.7^{a}	$44.3^{d\text{-}h}$	30.8^{no}	$45.6^{a\text{-}e}$	44.7^{bc}	61.2^{a}	47.1^{bc}	51.0^{a}
x		60.9^{a}	42.4^{b}	33.8^{c}	45.7^{a}	59.0^{a}	41.8^{b}	34.3^{c}	45.0^{a}	43.0^{c}	62.0^{a}	46.2^{a}	50.4^{a}
x for the cultivar		61.9^{a}	41.3^{b}	34.6^{c}	-	59.4^{a}	42.7^{b}	34.8^{c}	-	43.1^{c}	62.6^{a}	46.5^{b}	-

Key: *Pasja P. – Pasja Pomorska, ** I, II level of NPK (I – 80 kg N ha^{-1}, 80 kg P ha^{-1}, 120 kg K ha^{-1}, II – 120 kg N ha^{-1}, 120 kg P ha^{-1}, 180 kg ha^{-1}) ***A, B, C, D, E, F, G, H – foliar fertilization (A-Basfoliar 12-4-6, B-ADOB Mn, C-Solubor DF, D-ADOB Mn + Solubor DF, E-ADOB Mn + Basfoliar 12-4-6, F-Basfoliar 12-4-6 + Solubor DF, G-Basfoliar 12-4-6 + ADOB Mn + Solubor DF, H-control ,**** values marked with these letters do not differ significantly within the years

plants can be effectively protected against this dangerous pathogen by a combined application of the foliar fertilizers Rolvit B and Plonvit and the fungicides Tattoo C 750 and Bravo 500 SC.

During the 2010 growing season, with its highest total rainfall in the summer months, more severe symptoms of late blight were observed on plants belonging to cv. Pasja Pomorska than on the other two cultivars. The infection index observed on plants of this medium-late cultivar treated with the fertilizer Basfoliar 12-4-6 and ADOB Mn + Solubor DF (in variant I of NPK fertilization) and with the three fertilizers applied conjunctively (in variant B) exceeded 64%. The infection indices assigned to potato plants of cv. Adam and Ślęza did not exceed 50%, and the differences between their values in particular fertilization treatments at both levels of mineral fertilization were non-significant.

During the whole period covered by this study, significant differences were found between the average infection indices for all the cultivars in both mineral fertilization variants. In the first two years, the medium-early cultivar Adam was the most badly infected one, but in the last year, it was the medium-late variety Pasja Pomorska that suffered the worst damage. No significant differences in the severity of infection were observed on the plots where foliar application of fertilizers was carried out and on the control plot. The mineral fertilization applied in two rates for particular macronutrients, during the three years of the experiment, did not differentiate the infection severity, although the symptoms appeared to be somewhat more severe on plants fertilized with the lower NPK dose. According to Matkowski et al. (2004), different nitrogen fertilization rates did not influence the severity of late blight of potato.

The signs of potato early blight on potato plants were weaker than those of late blight. During the first two years of the experiment, the index for infection caused by *Alternaria* spp. ranged from 18% on cv. Ślęza plants treated with the fertilizer ADOB Mn+Solubor DF (variant I of the mineral fertilization) and ADOB Mn during the first growing season (variant II of the mineral fertilization) to around 35% for cv. Adam potato plants without foliar nutrition and with the application of the fertilizer ADOB Mn+Solubor DF (variant II of the mineral fertilization), likewise in the first growing season (Table 3). The differences in the infection index values for the above cultivars grown on particular plots, at both mineral fertilization levels, were significant in 2008 and 2009, except the combination including the application of Solubor DF and the higher NPK rate (2009). In the last year of the experiment, significantly less severe infection was observed on the medium-early cultivar plants treated with foliar fertilizers, at both levels of mineral fertilization, than on plants of the medium-late and late cultivars. Osowski (2005) demonstrated the limiting effect of the fertilizer Basfoliar 12-4-6 applied in conjunction with the fungicide Antracol 70 WG and Unikat 75 WG on potato being infected by *A. alternata* during the vegetative season. Analo-

Table 3

Symptoms of infection of potato plants by *Alternaria alternata,* A. solani during the study (% infection index), Bałcyny 2008-2010

Level of NPK	Foliar fertiliz.	2008			x	2009			x	2010			x
		Adam	Pasja P.*	Ślęza		Adam	Pasja P.	Ślęza		Adam	Pasja P.	Ślęza	
I**	A***	$30.3^{a\text{-}h****}$	$21.8^{i\text{-}n}$	18.5^{mn}	23.5^{a}	$30.4^{a\text{-}h}$	$26.3^{b\text{-}m}$	$22.3l^{mn}$	26.2^{ab}	18.2^{c}	32.2^{ab}	33.4^{ab}	27.9^{a}
	B	$27.9^{a\text{-}k}$	$24.8^{e\text{-}n}$	18.7^{mn}	23.8^{a}	$29.9^{a\text{-}j}$	$23.0^{h\text{-}n}$	18.4^{n}	23.8^{b}	19.3^{c}	32.9^{ab}	36.0^{ab}	29.4^{a}
	C	$28.4^{a\text{-}j}$	$22.2^{i\text{-}n}$	18.3^{n}	23.0^{a}	33.0^{ab}	$24.5^{d\text{-}n}$	$22.6^{j\text{-}n}$	26.7^{ab}	18.2^{c}	31.0^{ab}	34.7^{ab}	28.0^{a}
	D	$32.4^{a\text{-}e}$	$24.7^{f\text{-}n}$	18.0^{n}	25.0^{a}	33.2^{ab}	$27.8a\text{-}l$	$23.3g\text{-}n$	28.1^{a}	20.2^{c}	32.2^{ab}	36.8^{a}	$29.7a$
	E	$28.6^{a\text{-}i}$	$25.6^{d\text{-}n}$	$19.3l^{mn}$	24.5^{a}	32.9^{ab}	$25.0^{c\text{-}n}$	$22.2l^{mn}$	26.7^{ab}	18.2^{c}	30.2^{ab}	34.2^{ab}	27.6^{a}
	F	$28.9^{a\text{-}i}$	$21.3^{i\text{-}n}$	$19.0l^{mn}$	23.1^{a}	$30.2^{a\text{-}i}$	$23.0^{h\text{-}n}$	19.3^{mn}	24.2^{ab}	18.3^{c}	31.0^{ab}	33.9^{ab}	27.7^{a}
	G	$30.7^{a\text{-}g}$	$19.6l^{mn}$	$20.7^{j\text{-}n}$	23.7^{a}	$31.5^{a\text{-}e}$	$21.5l^{mn}$	18.9^{mn}	24.0^{ab}	19.8^{c}	31.5^{ab}	33.6^{ab}	28.3^{a}
	H	33.7^{abc}	$20.4^{k\text{-}n}$	18.7^{mn}	24.3^{a}	33.7^{a}	$25.2^{c\text{-}m}$	$25.2c\text{-}m$	28.0^{a}	19.2^{c}	31.3^{ab}	35.4^{ab}	28.6^{a}
x		30.1^{b}	22.5^{c}	18.9^{d}	23.9^{b}	31.9^{a}	24.5^{b}	21.5^{c}	26.0^{a}	18.9^{c}	31.5^{b}	34.8^{a}	28.4^{a}
II	A	$31.6^{a\text{-}f}$	$23.2^{g\text{-}n}$	$20.5^{k\text{-}n}$	25.1^{a}	33.0^{ab}	$23.0^{h\text{-}n}$	18.2^{n}	24.7^{ab}	19.9^{c}	32.5^{ab}	32.3^{ab}	28.2^{a}
	B	$32.8^{a\text{-}d}$	$26.3^{c\text{-}m}$	18.0^{n}	25.7^{a}	$31.5^{a\text{-}e}$	$21.5l^{mn}$	$24.1^{f\text{-}n}$	25.7^{ab}	17.2^{c}	29.2^{b}	35.6^{ab}	27.3_{a}
	C	34.1^{ab}	$22.9^{k\text{-}n}$	$20.3^{k\text{-}n}$	25.8^{a}	$29.7^{a\text{-}k}$	$23.7^{f\text{-}n}$	$23.4^{g\text{-}n}$	25.6^{ab}	18.3^{c}	33.1^{ab}	35.5^{ab}	29.0^{a}
	D	34.8^{a}	$20.7^{j\text{-}n}$	18.5^{mn}	24.7^{a}	$31.0^{a\text{-}f}$	$22.3^{k\text{-}n}$	$22.8^{i\text{-}n}$	25.4^{ab}	18.0^{c}	32.5^{ab}	34.7^{ab}	28.4^{a}
	E	$32.2^{a\text{-}f}$	$23.1^{g\text{-}n}$	18.7^{mn}	24.7^{a}	33.2^{ab}	$23.2^{g\text{-}n}$	$25.0^{c\text{-}n}$	27.1^{ab}	18.4^{c}	30.1^{ab}	34.6^{ab}	27.7^{a}
	F	$32.6^{a\text{-}d}$	$22.1^{i\text{-}n}$	$18.9l^{jm}$	24.5^{a}	31.9^{abc}	$23.0^{h\text{-}n}$	$24.3^{e\text{-}n}$	26.4^{ab}	19.8^{c}	31.8^{ab}	34.1^{ab}	28.6^{a}
	G	34.0^{a}	$23.9^{g\text{-}n}$	$18.9l^{mn}$	25.6^{a}	$31.7^{a\text{-}d}$	$24.6^{c\text{-}n}$	$23.2^{g\text{-}n}$	26.5^{ab}	19.8^{c}	30.6^{ab}	33.4^{ab}	27.9^{a}
	H	34.5^{a}	$26.7^{b\text{-}l}$	$20.0l^{mn}$	27.1^{a}	$30.5^{a\text{-}g}$	$24.6^{c\text{-}n}$	$21.1l^{mn}$	25.4^{ab}	19.9^{c}	33.2^{ab}	36.2^{ab}	29.8^{a}
x		33.3^{a}	23.6^{c}	19.2^{d}	25.4^{a}	31.6^{a}	23.2^{bc}	22.8^{bc}	25.9^{a}	18.9^{c}	31.6^{b}	34.6^{a}	28.4^{a}
x for the cultivar		31.8^{a}	23.1^{b}	19.1^{c}	-	31.7^{a}	23.9^{b}	22.1^{c}	-	18.9^{c}	31.6^{b}	34.7^{a}	-

Key as under Table 2

gously, in our earlier study (CWALINA-AMBROZIAK et al. 2007), less numerous isolates of *A. alternata* were obtained from aerial parts of potato plants nourished with Basfoliar 12-4-6 together with the fertilizers ADOB Mn and Solubor DF.

The statistical calculations performed on the results of our present experiment have shown that the intensity of early blight in the three examined potato cultivars was not significantly differentiated under the influence of the applied foliar fertilization in any of the analyzed growing seasons. Some non-significant differences were observed in infection indices between the two mineral fertilization levels (lower I and higher II variants), but it was only in the first growing season that more severe symptoms of early blight were found on plants receiving the higher rate of mineral fertilizers. MAC DONALD et al. (2007) claimed that high N rates reduced symptoms of late blight on potato plants. In the present study, the factor that most strongly determined the severity of symptoms of infection caused by *Alternaria* spp. was the cultivar, i.e. significant differences appeared between the mean infection indices within each examined cultivar. The most severely infected cultivar during the first two seasons was cv. Adam; cultivar Ślęza was the least infected one. In the final year of the experiment, cv. Adam proved to be the healthiest.

CONCLUSIONS

1. The cultivars determined the intensity of late blight and early blight symptoms on potato plants in the present experiment. During the first two seasons, plants of the medium-early potato cultivar Adam were the most severely infected by *P. infestans*; in the last year, they were the plants of the medium-late cultivar Pasja Pomorska. Significant differences in the intensity of early blight of potato on the examined potato cultivars appeared in the third year, when cv. Adam proved to be the healthiest variety.

2. No significant differences in the intensity of either of the diseases were found between the plots with the foliar fertilization and between the two tested NPK fertilization variants in any of the analyzed growing seasons. Only in the first year of study more severe symptoms of early blight appeared on potato plants receiving the higher rate of NPK than lower rate.

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