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FUNGI COLONISING OF AMERICAN GINSENG PLANTS AFTER THE APPLICATION OF MINERAL MULCH AND DIFFERENT METHODS OF PLANT PROTECTION

Alina Pastucha, Barbara Kołodziej
Agricultural University of Lublin

Abstract. In the years 2004–2006 on American ginseng plantation covered with the mineral mulch Agran, located in Krasnystaw (the Lublin region) there were compared the effects of five methods of plant protection. Each year 5 plants showing disease symptoms were sampled from particular experimental combination in order to perform the mycological analysis. The results of the analysis showed that in particular years of the experiment the quantitative and qualitative composition of pathogenic fungi isolated from the examined ginseng parts was differentiated. There was proved that fungi from the genera of *Altenaria, Fusarium, Cylindrocarpon, Phytophthora* and *Pythium irregulare, Rhizoctonia solani Botrytis cinerea* create a considerable danger for the ginseng plants.

Key words: fungi colonising of ginseng, methods of plant protection

INTRODUCTION

A simplified soil cultivation system, creating favorable conditions for the seed germination, and after that during the growth and yielding of plants is very common in the worldłs agriculture, lately [Radecki and Opic 1991, Kęsik et al. 2006]. Among the many systems of cultivation, the so-called conserving system, which, besides the proecological effect, has influence upon the phytosanitary state of the soil, is the most significant [Kuc and Zimny 2004, Kęsik et al. 2006]. This kind of cultivation makes use of the inter-crop cover plants, which can be introduced into the soil or remain on its surface [Hőppner et al. 1995].

Corresponding author – Adres do korespondencji: Alina Pastucha, Department of Phytopathology, Agricultural University of Lublin, 7 Leszczyńskiego Str., 20-069 Lublin, e-mail: alina.pastucha@ar.lublin.pl., Barbara Kołodziej, Department of Industrial and Medicinal Plants, University of Agriculture, 15 Akademicka Str., 20-950 lublin e-mail: barbara.kolodziej@ar.lublin.pl

The use of mulch in the cultivation of the soil and plants has an effect on the physical, chemical and biological properties of the soil [Miczyński and Siwicki 1962, Duer 1996, Błażewicz-Woźniak 2003, Kuc and Zimny 2004, Pięta and Kęsik 2007].

According to Pięta and Kęsik [2007], the kind of mulch has a great effect on the microbiological activity of the soils, and especially on the composition of antagonistic microorganisms towards plant pathogens the populations.

The objective of the present studies was to establish the species composition of fungi colonizing the organs of American ginseng after the application of mineral mulch and in dependence on different methods of plant protection.

MATERIAL AND METHODS

The studies were conducted in the years 2004–2006 on a plantation of American ginseng located on light loamy sand in Krasnystaw (Lublin region). Before the experiment was set up, rye was sown in autumn of 2002 and next it was ploughed over at the beginning of May. Then mustard and buckwheat were successively sown and these were ploughed over in vegetation season of 2003 too. The stratified seeds of ginseng were sown at the end of October on the raised beds (with the height of 30 cm and the width of 120 cm) at the spacing of 15×3 cm and after that soil was mulched with mineral mulch (Agran). Before the seeds sowing, mineral fertilization was applied, and during the vegetation the plants were shaded [Pastucha and Kołodziej 2007].

The experiment was set within the method of complete randomization in three replications on plots with the area of 2.4 m^2. The experiment comprised five methods of protecting the plants from diseases, i.e.:

A – control object (without any protective treatments); B – the application of Alkalin 10:20 – foliar fertilizer with pH – 11.5 containing 10% P_2O_5 and 20% K_2O; annually in the form of a double spraying with the concentration of 0.33%; C – the application of biopreparations recommended in ecological agriculture (alternately every 7 days – Biochikol 020 PC (2.5%), Biosept 33 SL (0.2%), Bioczos BR, Miedzian Champion 50 WP (0.25%); D – joint application of Alkalin 10:20 (like in the object B) and biopreparations recommended in ecological agriculture (like in the object C); E – the application of fungicides recommended on commercial plantations according to Anon [1999], i.e. alternate spraying every 10 days with preparations such as: Bravo 500 SC (0.2%), Tribenox 330 FS (0.08%), Alliette (0.1%), Dithane M-45 (0.1%), Ridomil MZ 72 WP (0.1%), Antracol 70 WP (0.1%), Rowral Flo 225 SC (0.1%) – totally 13 sprayings in the vegetation season; F – the application of Alkalin 10:20 (like in the object B) and fungicides (alternately every 15 days, totally 9 sprayings in the vegetation season).

Every year in the mid-July 5 plants with disease symptoms were sampled from particular experimental combinations. Those plants were submitted to a laboratory mycological analysis with the aim of determining the species composition of fungi infecting ginseng plants. The analysis was conducted using the method described by Pięta and Berbeć [1995].

Meteorological data from the studied region were obtained from the Department of Agrometeorology of the Agricultural University in Lublin.

RESULTS

The weather conditions during the studies were differentiated.

In 2004 it was observed a cold period between April and July as the average air temperature was lower than -0.7°C (in June) and up to -1.1°C (in May), and only higher than +0.2 (in July) up to +0.4°C (in April) in comparison with long-term period (tab. 1). In 2005 and 2006 the warmest month was July since the temperature was higher, correspondingly, by +1.9 to +0.4°C as compared to the means of long-term period. June of 2005 was the warmest month in the vegetation period, and the temperature was lower by 0.5°C as compared to the means of long-term period.

Table. 1. Wheather conditions in the region of experiment in the years 2004–2006 on the backgroun of long-term period

Tabela. 1. Warunki pogodowe w rejonie prowadzonych badań w latach 2004–2006 na tle średnich wieloletnich

Month Miesiąc	Mean from the years 1951–2000 Średnia wieloletnia za okres 1951–2000		Difference of mean temperature in comparison with long-term period Różnica temperatury powietrza w porównaniu ze średnią wieloletnią			Percentage of the average annual rainfalls Procent normy opadów		
	air temperatures °C temperatura powietrza °C	rainfalls mm opady deszczu w mm	2004	2005	2006	2004	2005	2006
Aprill – Kwiecień	7.5	40.6	+ 0.4	+1.6	+1.2	93.8	45.8	74.6
May – Maj	13.0	58.3	-1.1	+0.2	+0.6	65.2	168.0	102.0
June – Czerwiec	16.5	65.8	-0.7	-0.5	+0.4	75.8	84.9	57.6
July – Lipiec	17.9	78.0	+0.2	+1.9	+4.0	116.0	140.7	8.7

The vegetation period in 2004 was not abundant in rainfalls. The rainfalls in July only constituted 116% of the norm calculated on the basis of the data taken from 49 years (1951–2000) period (tab. 1). The driest month of 2004 was May. In 2005 the highest rainfalls were recorded in May and July and they were 168% and 140.7% of the norm for long-term period observations. The year 2006 was characterized by the smallest rainfalls. It was only in May that they were slightly higher as compared to the means of long-term period accepted as the norm (tab. 1).

The field observations on the plantation of American ginseng found plants with checked growth and development. Brown necrotic spots were visible on the roots of those plants (phot. 1), while a narrowing was observed on the border of the root passing into the stem, the result of which was stems breaking (photo 2).

187 colonies of fungi species were obtained from the mycological analysis of those plants conducted in 2004 (tab. 2). Almost twice as many fungi isolates were obtained from the infected roots of ginseng as compared to the stem base. Particular fungi species were most frequently isolated from the plants growing in the control combination, whereas the least frequently from the mixed combination, i.e. of Alkalin and biopreparations. In 2004 such pathogenic fungi as *Altenaria alternata, Cylindrocarpon destructans, Pythium irregulare, Rhizoctonia solani, Sclerotinia sclerotiorum* as well as fungi

Table 2. Fungi isolated from the ginseng plants in 2004
Tabela 2. Grzyby wyosobnione z roślin żeń-szenia pięciolistnego w 2004 r.

Fungus species Gatunek grzyba	The combination of the experiment / number of isolates Kombinacja doświadczenia / liczba izolatów												Σ		Total Razem %
	a		b		c		d		e		f				
	k	pł	k	pł	k	pł	k	pł	k	pł	k	pł	k	pł	
Alternaria alternata (Fr.) Keissler	-	4	-	1	5	1	-	-	1	-	2	1	8	7	15 (8.0)
Cladosporium cladosporioides (Fres.) de Vries	-	-	8	5	-	-	-	-	-	1	-	-	8	6	14 (7.4)
Cylindrocarpon destructans (Zins.) Scholt.	4	6	3	-	-	-	8	2	7	5	3	1	25	14	39 (20.9)
Fusarium oxysporum Schl.	6	2	1	-	1	1	4	1	-	-	3	2	15	6	21 (11.2)
Fusarium poae (Peck.) Wollenw.	-	-	-	-	-	-	5	1	-	-	-	-	5	1	6 (3.2)
Mucor hiemalis Wehmer	-	-	-	2	2	1	4	3	-	4	2	2	8	12	20 (10.7)
Pythim irregulare Buisman	18	2	-	-	-	-	2	-	4	-	1	-	25	2	27 (14.4)
Rhizoctonia solani Kűhn	-	-	-	-	2	4	-	-	-	-	2	-	4	4	8 (4.3)
Sclerotinia sclerotiorum (Lib.) de Bary	2	4	-	-	-	-	4	-	8	-	-	-	14	4	18 (9.6)
Trichoderma koningii Oud.	4	-	3	2	1	2	-	3	-	3	1	-	9	10	19 (10.2)
Razem – Total	34	18	15	10	11	9	27	10	20	13	14	6	121	66	187 (100.0)
Ogółem – Total	52		25		20		37		33		20		187		

k – root – korzeń; pł – stem base – podstawa łodygi
a – control – kontrola; b – Alkalin; c – Alkalin + biopreparations – Alkalin + biopreparaty; d – biopreparations – biopreparaty; e – Alkalin + fungicides – Alkalin + fungicydy; f – fungicides – fungicydy

Table 3. Fungi isolated from the ginseng plants in 2005
Tabela 3. Grzyby wyosobnione z roślin żeń-szenia pięciolistnego w 2005 r.

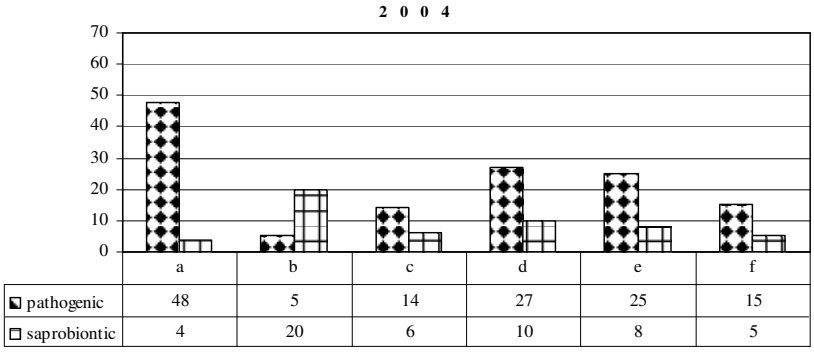
Fungus species Gatunek grzyba	The combination of the experiment / number of isolates Kombinacja doświadczenia / liczba izolatów												∑		Total Razem %
	a		b		c		d		e		f				
	k	pł	k	pł	k	pł	k	pł	k	pł	k	pł	k	pł	
Alternaria alternata (Fr.) Keissler	-	-	3	2	2	1	-	4	2	3	3	1	10	11	21 (4.8)
Acremonium strictum W. Gams	3	2	-	-	3	5	2	1	1	1	5	2	14	11	25 (5.7)
Botrytis cinerea Pers.	1	4	-	-	-	-	-	-	-	-	-	-	1	4	5 (1.1)
Cladosporium cladosporioides (Fres.) de Vries	-	-	-	-	-	-	3	5	1	2	2	3	6	10	16 (3.6)
Cylindrocarpon decumbens Corda	2	1	7	9	-	-	6	5	-	-	5	4	20	19	39 (8.9)
Cylindrocarpon destructans (Zins.) Scholt.	5	1	5	2	-	-	-	-	1	2	1	3	12	8	20 (4.6)
Fusarium culmorum (W. G. Sm.) Sacc.	-	-	-	-	4	2	-	-	-	-	-	-	4	2	6 (1.4)
Fusarium oxysporum Schl.	3	4	4	6	-	-	1	-	3	2	6	4	17	16	33 (7.5)
Humicola grisea Domsch	-	-	6	3	-	1	4	3	1	1	-	-	11	8	19 (4.3)
Mucor hiemalis Wehmer	1	6	-	5	2	3	-	-	-	-	-	-	3	14	17 (3.9)
Penicillium expansum Link ex S. F. Gray	-	5	3	-	-	-	-	-	2	1	-	-	5	6	11 (2.5)
Penicillium frequentans Westling	-	-	1	4	3	5	2	1	-	-	4	1	10	11	21 (4.8)
Penicillium purpurogenum Stoll	4	2	2	-	3	2	-	-	-	-	-	-	9	4	13 (3.0)
Penicillium verrucosum Dierckx var. *cyclopium* (West.) Samson et al.	2	1	-	5	1	4	-	5	2	1	7	6	12	22	34 (7.7)
Penicillium verrucosum Dierckx var. *verrucosum* Samson et al.	-	-	-	-	8	5	2	3	-	-	2	1	12	9	21 (4.8)
Rhizoctonia solani Kűhn	5	6	6	9	4	6	7	5	2	3	-	-	24	29	53 (12.1)
Rhizopus nigricans Ehrenberg	-	-	-	-	2	3	-	7	4	-	-	-	6	10	16 (3.6)
Talaromyces flavus (Ben.) Stolk et Samson	16	7	-	-	-	-	-	-	-	2	-	-	16	9	25 (5.7)
Trichoderma hamatum (Bon.) Bain.	-	-	2	1	4	3	-	-	1	1	-	-	7	5	12 (2.7)
Trichoderma harzianum Rifai	-	1	-	1	-	-	3	4	-	-	-	-	3	6	9 (2.1)
Trichoderma koningii Oud.	-	-	-	-	3	2	-	-	1	2	-	3	4	7	11 (2.5)
Trichoderma pseudokoningii Rifai	-	-	1	1	-	-	-	2	-	-	-	-	1	3	4 (0.9)
Trichoderma viride Pers ex S. F. Gray	2	-	-	-	-	-	4	1	-	-	1	-	7	1	8 (1.8)
Total – Razem	44	40	40	48	39	42	34	46	21	21	36	28	214	225	439 (100.0)
Total – Ogółem	84		88		81		80		42		64		439		

k – root – korzeń; pł – stem base – podstawa łodygi
a – control – kontrola; b – Alkalin; c – Alkalin + biopreparations – Alkalin + biopreparaty; d – biopreparations – biopreparaty; e – Alkalin + fungicides – Alkalin + fungicydy; f – fungicides – fungicydy

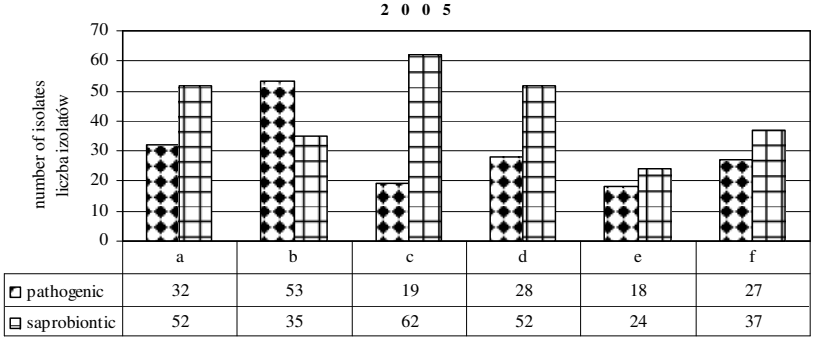
Table 4. Fungi isolated from the ginseng plants in 2006
Tabela 4. Grzyby wyosobnione z żeń-szenia pięciolistnego w 2006 r.

Fungus species Gatunek grzyba	The combination of the experiment / number of isolates Kombinacja doświadczenia / liczba izolatów												Σ		Total Razem %
	a		b		c		d		e		f				
	k	pł	k	pł	k	pł	k	pł	k	pł	k	pł	k	pł	
Alternaria alternata (Fr.) Keissler	-	-	2	3	8	7	8	8	1	1	3	-	22	19	41 (17.9)
Cladosporium cladosporioides (Fres.) de Vries	4	3	-	-	1	1	-	-	-	1	2	1	7	6	13 (5.7)
Cylindrocarpon destructans (Zins.) Scholt.	-	-	1	-	-	-	-	1	2	-	6	2	9	3	12 (5.2)
Fusarium culmorum (W. G. Sm.) Sacc.	1	2	-	-	2	1	1	1	-	-	2	1	6	5	11 (4.8)
Fusarium oxysporum Schl.	3	4	2	2	3	3	3	1	3	1	2	1	16	12	28 (12.2)
Fusarium solani (Mart.) Sacc.	1	-	-	-	-	-	-	-	2	1	-	1	3	2	5 (2.2)
Mucor hiemalis Wehmer	-	-	3	3	-	-	1	1	-	-	-	-	4	4	8 (3.5)
Mucor mucedo Fresenius	2	2	-	-	1	2	-	-	1	2	-	-	4	6	10 (4.4)
Penicillium expansum Link ex S. F. Gray	2	1	1	1	-	-	2	1	-	-	1	1	6	4	10 (4.4)
Penicillium nigricans (Bain.) Thom	-	-	-	-	2	2	1	-	1	1	2	1	6	4	10 (4.4)
Phytophthora sp.	2	-	1	3	-	-	-	-	4	1	-	-	7	4	11 (4.8)
Pythium irregulare Buisman	4	4	10	3	-	-	-	-	1	-	-	-	15	6	21 (9.2)
Rhizoctonia solani Kűhn	-	-	-	-	-	-	2	3	-	-	2	1	4	4	8 (3.5)
Rhizopus nigricans Ehrenberg	-	-	-	-	3	2	1	4	2	-	2	1	8	7	15 (6.6)
Trichoderma aureoviride Rifai	1	1	-	-	1	1	2	-	1	-	1	1	6	3	9 (3.9)
Trichoderma koningii Oud.	-	-	-	-	-	-	3	1	-	-	-	-	3	1	4 (1.7)
Trichoderma viride Pers ex S. F. Gray	-	-	2	1	1	1	4	2	-	2	-	-	7	6	13 (5.7)
Total – Razem	20	17	22	15	22	20	28	23	18	10	23	11	133	96	229 (100.0)
Total – Ogółem	37		37		42		51		28		34		229		

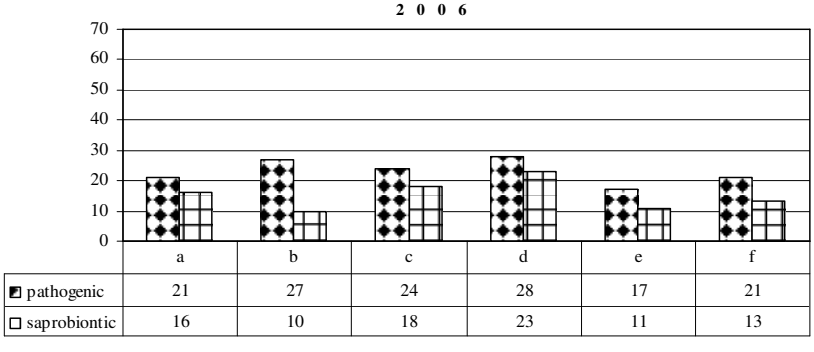
k – root – korzeń; pł – stem base – podstawa łodygi
a – control – kontrola; b – Alkalin; c – Alkalin + biopreparations – Alkalin + biopreparaty; d – biopreparations – biopreparaty; e – Alkalin + fungicides – Alkalin + fungicydy; f – fungicides – fungicydy



	a	b	c	d	e	f
pathogenic	48	5	14	27	25	15
saprobiontic	4	20	6	10	8	5



	a	b	c	d	e	f
pathogenic	32	53	19	28	18	27
saprobiontic	52	35	62	52	24	37



	a	b	c	d	e	f
pathogenic	21	27	24	28	17	21
saprobiontic	16	10	18	23	11	13

Fig. 1. The occurence of possible pathogenic and saprobiontic fungi in the particular experimental combinations: a – control; b – Alkalin; c – Alkalin + biopreparations; d – biopreparations; e – Alkalin + fungicides; f – fungicides

Rys. 1. Występowanie grzybów potencjalnie patogenicznych i saprobiontów w poszczególnych kombinacjach doświadczenia: a – kontrola; b – Alkalin; c – Alkalin + biopreparaty; d – biopreparaty; e – Alkalin + fungicydy; f – fungicydy

from genus *Fusarium* were obtained from the examined parts of ginseng (tab. 2). The highest number of pathogenic fungi colonies were isolated from the infected plants of ginseng growing in the control combination, while the lowest one – in the combination after Alkalin application (tab. 2, fig. 1). Saprobionts, which were the most numerously obtained from ginseng from the combination with Alkalin, also occurred among the isolated fungi (tab. 2, fig. 1).

439 fungi colonies belonging to 23 species were isolated in 2005 from the infected ginseng parts (tab. 3). Both the roots and the stem base of ginseng were colonized by *Altenaria alternata.* The isolates of this species were most frequently obtained from the plants sampled from the combination after Alkalin and fungicides application (tab. 3). What is more *Botrytis cinerea* was isolated from the plants taken from the control combination in the analyzed year (tab. 3). Fungi from genera *Cylindrocarpon, Fusarium* and *Rhizoctonia solani* were isolated among the pathogenic fungi, but not from each experimental combination (tab. 3). The most isolates of pathogenic fungi were obtained from ginseng growing in the combination after the application of Alkalin only. On the other hand, the smallest number of phytopathogens were isolated from the plants from the combination where Alkalin together with fungicides were applied (tab. 3, fig. 1). The mycological analysis conducted in 2005 gave numerous species of saprobionts, i.e. *Acremonium strictum, Mucor hiemalis, Cladosporium cladosporioides, Humicola grisea, Rhizopus nigricans, Penicillium* spp. and *Trichoderma* spp. The most saprobionts were obtained from ginseng plants from the combination with Alkalin together with biopreparations, whereas the fewest colonies of these fungi were obtained from the plants sampled from the combination with Alkalin and fungicides application (tab. 3, fig. 1).

The mycological analysis of the infected roots and the stem base of ginseng conducted in 2006 isolated 229 fungi colonies belonging to 17 different species (tab. 4). The dominating species was *Altenaria alternata*, whose proportion constituted 17.9% of all isolations (tab.4). The most colonies of this pathogen were obtained from the analyzed plant parts taken from the combinations with biopreprations spraying. Besides, *Cylindrocarpon destructans*, whose proportion was 5% of all isolates, was isolated from the roots and the stem base. The greatest number of the colonies of this pathogen were isolated from the plants sampled from the combinations after the application of fungicides (tab. 4). Species from genus *Fusarium* were also isolated among the obtained pathogens. This genus was mainly represented by *F. oxysporum*, and in smaller numbers, by *F. culmorum* and *F. solani* (tab. 4). The mycological analysis of the infected plant parts isolated *Pythium irregulare*, whose isolates constituted 9.1% of all fungi. This pathogen was not isolated from the studied ginseng parts after the application of Alkalin together with biopreparations as well as biopreparations and fungicides (tab. 4). Fungus *Phytophthora* sp. isolated in 2006 constituted 4.8% of all isolations. The most colonies of this pathogen were obtained from the infected parts of ginseng after the application of Alkalin together with fungicides. Besides, *R. solani* was isolated from the plants from the combination with separately biopreparations and fungicides use as a plant protection methods (tab. 4). Fungi from genera *Trichoderma, Penicillium, Mucor, Rhizopus nigricans* and *Cladosporium cladosporioides* were obtained, but only sporadically and not from each experimental combination (tab. 4). The most colonies of saprobionts were isolated from ginseng plants growing in the combination with the use of biopreparations (fig. 1).

Photo 1. Necrosis of the ginseng roots
Fot. 1. Nekroza korzeni żeń-szenia pięciolistnego

Photo 2. Necrosis of the roots tissues and narrowing of the ginseng stems
Fot. 2. Nekroza tkanek korzeni i przewężenie łodyg żeń-szenia pięciolistnego

Table 5. Fungi isolated from ginseng leaves in the years 2004–2006
Tabela 5. Grzyby wyosobnione z liści żeń-szenia pięciolistnego w latach 2004–2006 r.

Fungus species Gatunek grzyba	Number of isolates Liczba izolatów	%
Acremonium strictum W. Gams	5	5.1
Alternaria alternata (Fr.) Keissler	36	36.8
Cladosporium cladosporioides (Fres.) de Vries	23	23.5
Fusarium poae *(Peck.) Wollenw.*	9	9.2
Mucor hiemalis Wehmer	8	8.2
Penicillium expansum Link ex S. F. Gray	2	2.0
Penicillium verrucosum Dierckx var. *verrucosum* Samson et al.	2	2.0
Rhizopus nigricans Ehrenberg	7	7.2
Trichoderma aureoviride Rifai	1	1.0
Trichoderma harzianum Rifai	2	2.0
Trichoderma koningii Oud.	2	2.0
Trichoderma viride Pers ex S. F. Gray	1	1.0
Total – Razem	98	100.0

The mycological analysis conducted on the infected ginseng leaves showed that the dominating species in the period of three years of studies was *Altenaria alternata*, and its isolates constituted 36.8% of all isolations (tab. 5). Besides, *F. poae, Cladosporium cladosporioides* (23.5%), *Rhizopus nigricans, M. hiemalis, Acremonium strictum* as well as fungi from genera *Penicillium* and *Trichoderma* (tab. 5) were isolated from the necrotic spots of ginseng leaves.

DISCUSSION

The results obtained from the mycological analysis of the infected organs of American ginseng indicated on the occurrence of numerous infectious diseases during in its cultivation. Both the roots and the stem base of ginseng were colonized by various pathogens. Among them, fungi from genera *Altenaria, Cylindrocarpon, Fusarium, Phytophthora* and *Pythium* as well as *Botrytis cinerea, Rhizoctonia solani* and *Sclerotinia sclerotiorum* were of importance for the plants of ginseng [Reeleder and Brammall 1994, Pięta and Berbeć 1995, 1997, Punja 1997, Nicol et al. 2002, Pastucha and Kołodziej 2005]. The studies also pointed to their common occurrence on the analyzed parts of ginseng.

Ginseng plants included within the studies were frequently infected by the species of genus *Fusarium*, especially *Fusarium oxysporum.* The latter species is of big significance as one of the most dangerous pathogens causing the necrosis of the seedlings on ginseng as well as the rusty necrosis of the roots [Berbeć and Dziedzic 1996]. The occurrence of fungi of this genus was also found on other species of herbaceous plants [Filoda et al. 1998, Zimowska and Machowicz 2004, Mazur and Szczeponek 2005].

Simultaneous infection by different species from genus *Fusarium* turned out to be especially harmful to ginseng roots. The roots infected by *F. culmorum, F. poae, F. oxysporum* and *F. solani* showed complete necrosis. Such disease symptoms confirm earlier observations made by Pięta and Berbeć [1995, 1997].

The roots and the stem base of ginseng were infected by *Cylindrocarpon* spp., *Pythium irregulare, Phytophthora* sp., *Rhizoctonia solani* and *Sclerotinia sclerotiorum.* Their presence on the infected organs can result from the polyphagous character of parasitism [Reeleder and Brammall 1994, Pięta and Berbeć 1997, Zimowska and Machowicz 2004, Mazur and Szczeponek 2005].

Every year in the period of the experiment *Altenaria alternata* was isolated from all analyzed ginseng parts (especially in big quantities from the leaves). It is a fungus very difficult to control and its presence may lead to a decreased quality of the herb raw material through the appearance of different kinds of spots on the green parts of plants, and then to dying out. The common occurrence of this fungus on ginseng and its negative consequences are testified to in the studies conducted earlier by Pięta and Berbeć [1995,1997], Yu [1987], Pastucha and Kołodziej [2005].

The weather conditions play a significant role in the growth and development of plant pathogens in the soil and in the process of plant infection. The air temperature and the rainfalls during the vegetation in the years 2004–2006 were differentiated, which also affected the number of fungi isolates isolated from the infected ginseng organs. It should be supposed that the weather conditions in 2005 were especially favourable to the growth and development of plant pathogens since the greatest number of fungi colonies was obtained in that year.

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GRZYBY ZASIEDLAJĄCE ROŚLINY ŻEN-SZENIA PIĘCIOLISTNEGO PO ZASTOSOWANIU MULCZU MINERALNEGO ORAZ RÓŻNYCH SPOSOBÓW OCHRONY ROŚLIN

Streszczenie. W latach 2004–2006 przeprowadzono badania na istniejącej plantacji żeńszenia pięciolistnego zlokalizowanej w Krasnymstawie (woj. lubelskie). W badaniach uwzględniono mulcz mineralny Agran oraz pięć sposobów ochrony roślin. Każdego roku z poszczególnych kombinacji doświadczenia pobierano po 5 roślin wykazujących objawy chorobowe celem wykonania analizy mikologicznej. Wyniki analizy wykazały, że w poszczególnych latach badań skład ilościowy i jakościowy grzybów chorobotwórczych wyosobnionych z badanych organów żeń-szenia był zróżnicowany. W prowadzonych badaniach wykazano, że dla roślin żeń-szenia duże zagrożenie stanowią grzyby rodzajów *Alternaria, Fusarium, Cylindrocarpon, Phytophthora* oraz *Pythium irregulare, Rhizoctonia solani* i *Botrytis cinerea*.

Słowa kluczowe: grzyby zasiedlające żeń-szeń, metody ochrony roślin

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