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THE EFFECT OF IRRIGATION AND FOLIAR FERTILIZATION ON THE COLONIZATION OF AMERICAN GINSENG (*Panax quinquefolium* L.) DISEASED PARTS BY DIFFERENT MICRO-ORGANISMS

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Abstract

Field studies on the health of American ginseng cultivated in the Lublin district on poor sandy soil were conducted in the years 2004-2006. The studies involved treatment combinations with irrigation and without irrigation as well as foliar fertilization with Alkalin PK and Resistim of American ginseng plants. Mycological analysis was made of diseased ginseng parts with the aim of determining the quantitative and qualitative composition of fungi-like organisms and fungi threatening the cultivation of this plant.

Fungi from the genera of *Cylindrocarpon, Fusarium* and the following species *Alternaria alternata, , Rhizoctonia solani, Sclerotinia sclerotiorum,* as well as fungi-like organisms: *Pythium irregulare* and *Phytophthora* sp., were isolated from the infected parts of ginseng. The smallest number of fungi was isolated from the plants growing on the plots without irrigation and those where foliar application with Alkalin PK was applied.

Key words: ginseng, fungi, fungi-like organisms, irrigation, foliar fertilization

INTRODUCTION

Poland is an important producer of herbs, both for the Polish market and for export (every year, the total production of raw material is over 26,000 tons) (Lutomski, 1999). Production of medicinal plants is likely to increase in the nearest future. Herbaceous plants are used in medicine, both in fresh form and as dried material. Increased consumption of these plants results from the biologically active substances produced by them, namely flavonoids, anthocyanins, antra-compounds, alkaloids, polyphenols or tannins. These substances have been used in treating a number of ailments, for example: respiratory and circulatory systems, the alimentary tract, urinary tracts and cancers (Berbeć, 1999; Dureja et al. 2003). Nowadays, American ginseng (*Panax quinquefolium* L.) is commonly used in alternative medicine and in the cosmetic industry. Ginseng is a perennial plant whose roots (*Panax Radix*) are collected as raw material after 4-6 years of cultivation (Kozłowski, 1993). In the pharmaceutical industry, this plant is used in fresh or dried form (Stelmach, 1998). Due to the long cultivation period required to obtain herbal raw material from this plant suitable for production purposes and the plant's specific requirements (permeable soil rich in humus, pH 5.5-6.0, the necessity of mulching and shading) (Berbeć and Dziedzic, 1996; Dziedzic, 1998), there is a big danger of ginseng plants being infected by pathogenic factors. According to Pięta and Berbeć (1995); Pięta (1997); Pastucha and Kołodziej (2005; 2007a,b), in the area of south-eastern Poland, American ginseng is most frequently infected by *Alternaria alternata, Rhizoctonia solani, Fusarium* spp. and *Cylindrocarpon* spp. and *Pythium* spp., *Phytophthora* sp.

The purpose of the present study was to determine the quantitative and qualitative composition of fungi threatening ginseng plants after the application of irrigation and foliar fertilization.

MATERIALS AND METHODS

A field experiment was conducted in the years 2004-2006 at Trzciniec near Chodel (Lublin district) on soil with the mechanical composition of poor loamy

soil. The soil was characterized by acidic reaction, i.e. pH 5.08 and a low content of phosphorus (25.3 mg×kg^{-1} of soil), potassium (41.53 mg×kg^{-1} of soil) and a very low amount of magnesium (0.9 mg×kg^{-1} of soil). Stratified seeds of ginseng were sown in autumn 2003 on raised beds at a row spacing of 15 cm x 5 cm, on 2m^2 plots in three replicates. Before seed sowing, phosphorus-potassium fertilization was applied in an amount of 120 kg P×ha^{-1} and 240 kg K×ha^{-1}. During the plants' growth, 40 kg N×ha^{-1} and 20 kg Mg×ha^{-1} were used in early spring each year. Besides, the plots were mulched with oat straw, shaded with a polypropylene net letting in 25% of sunshine and, when necessary, they were manually weeded. Every year, foliar fertilization was used in the form of high-alkaline Alkalin PK 5:25 (Intermag, Poland; at a dose of 2 l×ha^{-1} in 600 l of water) or Resistim^R (Mandops Lim. UK; in dose 3 l×ha^{-1} in 300 l of water), comparing the effects with the control plants which were sprayed with clean water. Every successive year of vegetation, the plants were sprayed in the form of low volume spray with 100 ml Alkalin or 50 ml Resistim per plot. The plants were sprayed with a manual sprayer three times (2, 16 and 30 June). Additionally, the experiment determined the effects of drip irrigation with t-Tapes dug at a depth of 40 cm before setting up the plantation. Irrigation was begun in the first year of vegetation and was repeated for 3 successive years in the period between May and September with 7-day intervals (a single dose of water – 15 ml×m^{-2}).

Six following combinations were considered, namely:

1 – control plants, irrigated without any fertilization
2 – irrigated plants and fertilization with Resistim
3 – irrigated plants and fertilization with Alkalin PK
4 – control plants without any irrigation or fertilization
5 – plants without any irrigation but fertilized with Resistim
6 – plants without any irrigation but fertilized with Alkalin PK

During the experiment, i.e. in the second 10-day period of July, field observations were performed on particular plots. Plant density and the proportion of plants with disease symptoms were calculated each time. Ginseng plants with necrotic spots on the roots and leaves were considered diseased. Every year, 5 plants with disease symptoms were taken from particular experimental combinations. Those plants were subjected to laboratory mycological analysis which was carried out according to the method described by P i ę t a and B e r b e ć (1995).

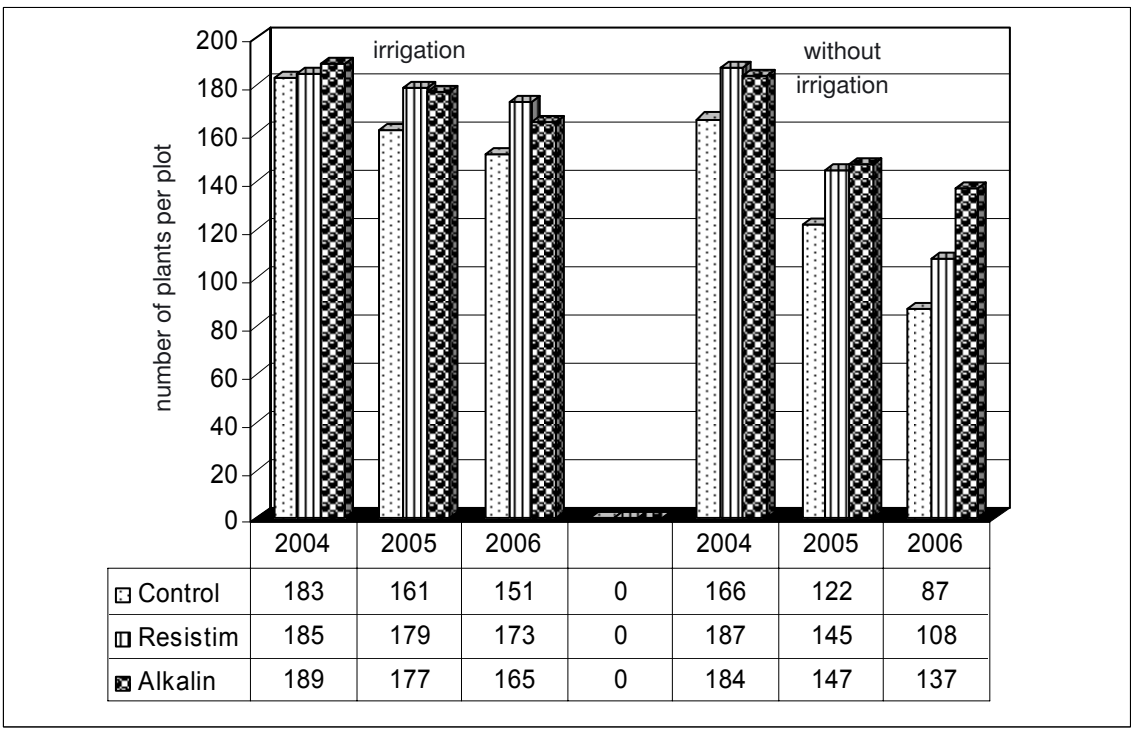
RESULTS

The field observations pointed to a differentiated effect of irrigation and foliar fertilization with Alkalin PK or Resistim on the number and health of ginseng plants in particular experimental combinations (Fig. 1). It was shown that the lowest plant density with the greatest proportion of infected plants characterized the control plots (Fig.1). The most plants, with the smallest proportion of those with disease symptoms, were found on the plots after the application of Alkalin PK, both in the combinations with irrigation of ginseng plants and without it (Fig. 1).

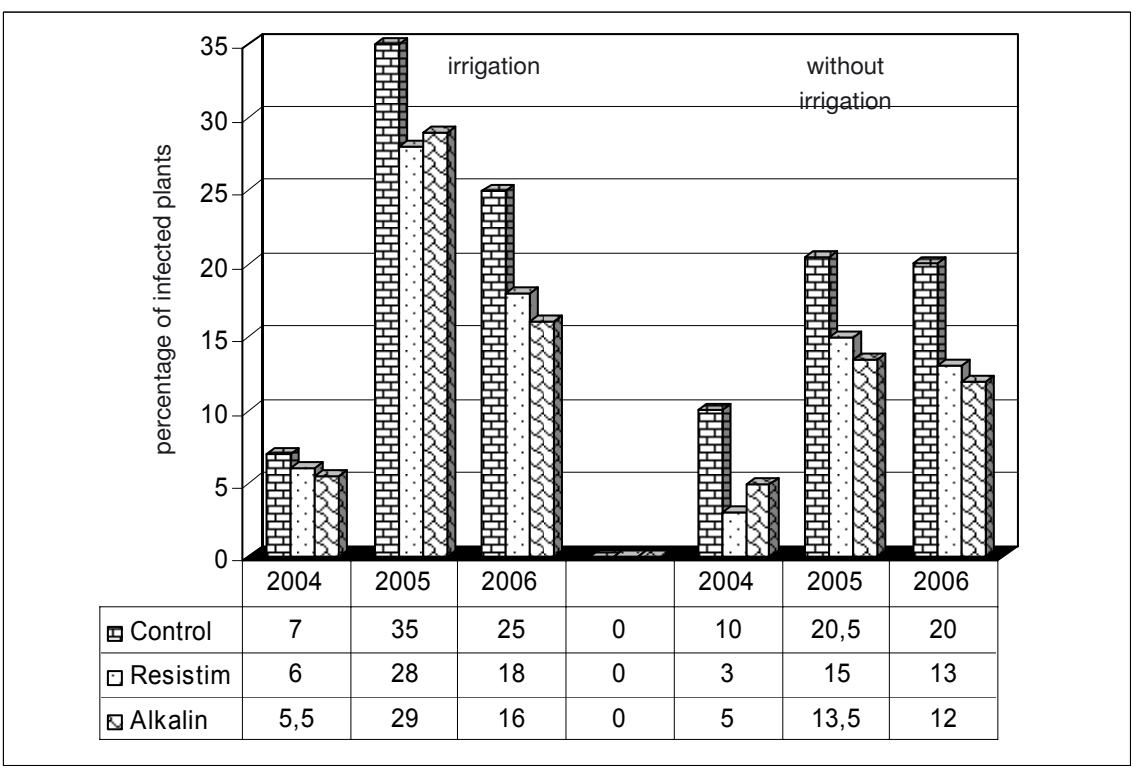
During mycological analysis of the infected ginseng plants in 2004, 415 colonies of different fungi and fungi-like species were isolated (Table 1). Of all isolated species, the most fungi isolates were obtained from the plants growing on irrigated plots, especially from the control combination (Table 1). Species of the genus *Fusarium* were found among the fungi potentially pathogenic to the infected parts of ginseng. They were represented by *F. culmorum, F. oxysporum, F. poae* and *F. solani.* The colonies of these fungi were much more frequently isolated from plants growing on irrigated plots, mainly from the control plots and after using Resistim, as compared to the other experimental combinations (Table 1). Besides, *Alternaria alternata, Cylindrocarpon destructans, Rhizoctonia solani* and *Sclerotinia sclerotiorum* as well as cultures of *Pythium irregulare* were isolated. Isolates of those species were most frequently obtained from the infected ginseng plants taken from irrigated plots, mainly from the control plants (Table 1). Saprotrophic species, represented by *Cladosporium cladosporioides, Mucor hiemalis, Penicillium purpurogenum, Trichoderma harzianum* and *Trichoderma koningii*, were also isolated from necrotic parts of the studied parts.

In the second year of the study, 584 colonies of fungi and fungi-like organisms belonging to different species were obtained from the analyzed parts of ginseng (Table 2). The highest number among all isolates was obtained from the plants taken from control plots, both those irrigated and not irrigated ones (Table 2). Potentially pathogenic species from the genera of *Cylindrocarpon* and *Fusarium* as well as *Alternaria alternata, Rhizoctonia solani* and cultures of *Phytophthora* sp. were often obtained from the infected parts of ginseng. The genus *Fusarium* proved to be dominant, and it was represented by *F. culmorum, F. oxysporum* and *F. solani* (Table 2). The greatest number of fungi species of this genus was isolated from the studied parts of control plants, both from the combination with irrigation and without it. As regards the plants from the plots without any irrigation but

after the application of Alkalin, *F. oxysporum , F. solani*, *Phytophthora* sp. and *Rhizoctonia solani* were not isolated, while the other species of the obtained microorganisms were isolated in a higher number from the studied plants taken from the irrigated plots, mainly the control ones (Table 2). The following saprotrophic fungi were obtained: *Penicillium* spp., *Trichoderma* spp., *Acremonium strictum, Cladosporium cladosporioides, Humicola grisea, Mucor hiemalis, Rhizopus nigricans* and *Talaromyces flavus* (Table 2).

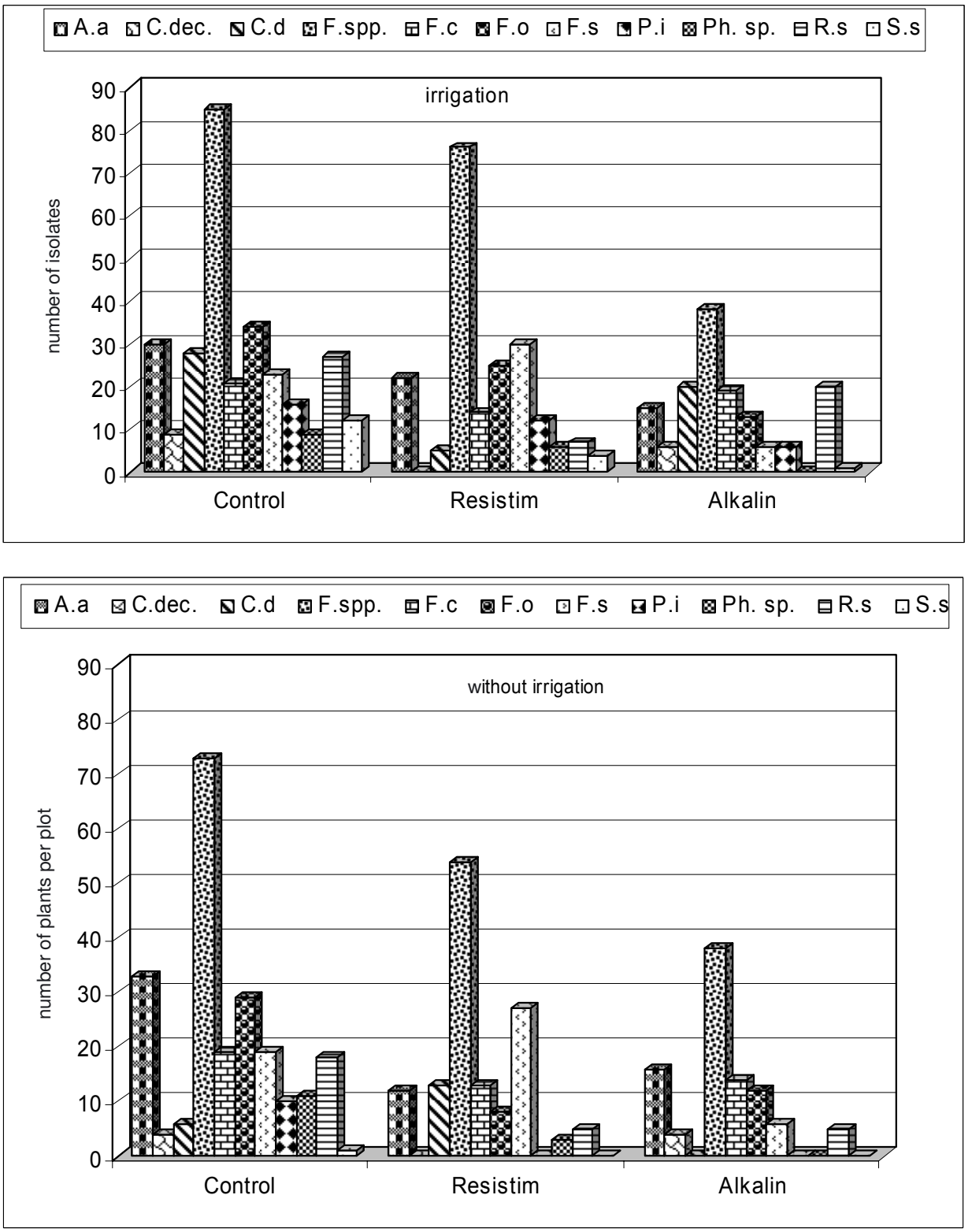


	2004	2005	2006		2004	2005	2006
Control	183	161	151	0	166	122	87
Resistim	185	179	173	0	187	145	108
Alkalin	189	177	165	0	184	147	137



	2004	2005	2006		2004	2005	2006
Control	7	35	25	0	10	20,5	20
Resistim	6	28	18	0	3	15	13
Alkalin	5,5	29	16	0	5	13,5	12

Fig. 1. Health of ginseng plants in individual experimental combinations



A.a – *Alternaria alternata*, C.dec – *Cylindrocarpon decumbens*, C.d – *Cylindrocarpon destructans*, F.spp. – *Fusarium* spp., F.c – *Fusarium culmorum*, F.o – *Fusarium oxysporum*, F.s – *Fusarium solani*, P.i – *Pythium irregulare*, Ph.sp. – *Phytophthora* sp. R.s – *Rhizoctonia solani*, S.s – *Sclerotinia sclerotiorum*

Fig. 2. Potential pathogenic fungi and fungi-like organisms isolated from infected ginseng plants in the years 2004-2006

Table 1

Fungi and fungi-like organisms isolated from infected ginseng plants in 2004

Species of fungi and fungi-like organisms	Experimental combination / Number of isolates														**Total**
	Irrigation						Without irrigation						Total stem roots bases		
	Control		Resistim		Alkalin		Control		Resistim		Alkalin				
	roots	stem bases	roots	stem bases	roots	stem bases	roots	stem bases	roots	stem bases	roots	stem bases			
Alternaria alternata (Fr.) Keissler	1	5	5	4	1	9	5	11	3	1	-	2	15	32	**47**
Cladosporium cladosporioides (Fres.) de Vries	-	4	1	5	2	4	-	5	-	2	5	-	8	20	**28**
Cylindrocarpon destructans (Zins.) Scholt.	6	5	2	-	3	2	3	-	2	-	-	-	16	7	**23**
Fusarium culmorum (W. G. Sm.) Sacc.	3	4	-	-	4	1	-	3	-	-	2	1	9	9	**18**
Fusarium oxysporum Schl.	8	2	5	3	1	6	4	5	-	4	3	2	21	22	**43**
Fusarium poae (Peck.) Wollenw.	3	4	6	1	-	-	5	1	6	-	4	2	24	8	**32**
Fusarium solani (Mart.) Sacc.	1	2	5	4	2	1	3	-	2	4	3	1	16	12	**28**
Mucor hiemalis Wehmer	3	-	2	3	1	3	7	3	-	4	-	3	13	16	**29**
Penicillium purpurogenum Stoll	-	3	-	-	1	4	-	2	5	-	2	-	8	9	**17**
Pythium irregulare Buisman	8	2	3	5	2	4	6	2	-	-	-	-	19	13	**32**
Rhizoctonia solani Kűhn	6	5	4	3	5	2	2	-	2	3	3	2	22	15	**37**
Sclerotinia sclerotiorum (Lib.) de Bary	5	7	-	4	1	-	-	1	-	-	-	-	6	12	**18**
Trichoderma harzianum Rifai	1	1	4	1	2	1	-	-	1	3	-	5	8	11	**19**
Trichoderma koningii Oud.	2	-	-	2	-	-	1	-	3	10	10	16	16	28	**44**
Total	**47**	**44**	**37**	**35**	**25**	**37**	**36**	**33**	**24**	**31**	**32**	**34**	**201**	**214**	**415**
Total	91		72		62		69		55		66				

Table 2

Fungi and fungi-like organisms isolated from infected ginseng plants in 2005

Species of fungi and fungi-like organisms	Experimental combination / Number of isolates												Total stem roots bases		Total
	Irrigation						Without irrigation								
	Control		Resistim		Alkalin		Control		Resistim		Alkalin				
	roots	stem bases	roots	stem bases	roots	stem bases	roots	stem bases	roots	stem bases	roots	stem bases			
Acremonium strictum W. Gams	2	1	1	4	2	3	4	2	4	1	2	2	15	13	**28**
Alternaria alternata (Fr.) Keissler	8	2	2	3	-	1	4	1	2	3	3	4	19	14	**33**
Cladosporium cladosporioides (Fres.) de Vries	1	2	3	1	3	5	2	3	-	5	2	3	11	19	**30**
Cylindrocarpon decumbens Corda	6	3	-	-	6	-	3	1	-	-	1	3	16	7	**23**
Cylindrocarpon destructans (Zins.) Scholt.	5	4	-	-	2	8	-	-	4	3	-	-	11	15	**26**
Fusarium culmorum (W. G. Sm.) Sacc.	4	2	6	4	1	5	4	3	3	4	5	1	23	19	**42**
Fusarium oxysporum Schl.	7	5	5	3	-	-	6	5	-	-	-	-	18	13	**31**
Fusarium solani (Mart.) Sacc.	8	4	9	5	-	-	4	7	6	8	-	-	27	24	**51**
Humicola grisea Domsch	3	-	-	-	10	13	2	5	-	6	-	-	15	24	**39**
Mucor hiemalis Wehmer	-	2	-	4	-	-	-	-	-	-	-	-	-	6	**6**
Penicillium expansum Link ex S. F. Gray	1	-	-	-	6	5	-	3	7	3	2	4	16	15	**31**
Penicillium frequentans Westling	8	3	4	5	-	3	1	7	-	-	-	-	13	18	**31**
Penicillium purpurogenum Stoll	3	-	4	3	2	1	-	-	8	9	6	3	23	16	**39**
Penicillium verrucosum Dierckx var. *cyclopium* (West.) Samson et al.	-	-	-	-	1	3	6	4	5	3	-	-	12	10	**22**
Penicillium verrucosum Dierckx var. *verrucosum* Samson et al.	-	3	2	2	-	-	3	2	1	4	2	3	8	14	**22**
Phytophthora sp.	4	2	3	1	-	-	-	-	-	3	-	-	7	6	**13**
Rhizoctonia solani Kűhn	5	4	-	-	4	5	5	6	-	-	-	-	14	15	**29**
Rhizopus nigricans Ehrenberg	-	3	4	1	3	5	-	1	2	1	1	7	10	18	**28**
Talaromyces flavus (Ben.) Stolk et Samson	1	-	2	5	-	-	-	-	-	-	-	-	3	5	**8**
Trichoderma hamatum (Bon.) Bain.	-	-	2	-	2	-	-	3	-	1	2	5	6	9	**15**
Trichoderma harzianum Rifai	-	3	-	-	-	-	-	-	-	-	-	-	-	3	**3**
Trichoderma koningii Oud.	-	-	2	1	-	1	2	1	-	-	4	-	8	3	**11**
Trichoderma pseudokoningii Rifai	2	-	-	-	-	-	4	-	4	3	-	-	10	3	**13**
Trichoderma viride Pers ex S. F. Gray	-	1	3	-	3	-	-	2	-	-	-	1	6	4	**10**
Total	**68**	**44**	**52**	**42**	**45**	**58**	**50**	**56**	**46**	**57**	**30**	**36**	**291**	**293**	**584**
Total	112		94		103		106		103		66				

Table 3

Fungi and fungi-like organisms isolated from infected ginseng plants in 2006

Species of fungi and fungi-like organisms	Experimental combination / Number of isolates														**Total**
	Irrigation						Without irrigation						Total stem roots bases		
	Kontrola Control		Resistim		Alkalin		Kontrola Control		Resistim		Alkalin				
	roots	stem bases	roots	stem bases	roots	stem bases	roots	stem bases	roots	stem bases	roots	stem bases			
Alternaria alternata (Fr.) Keissler	8	6	3	5	2	2	5	7	2	1	4	3	24	24	**48**
Cladosporium cladosporioides (Fres.) de Vries	3	2	1	1	4	2	3	-	3	1	4	5	18	11	**29**
Cylindrocarpon destructans (Zins.) Scholt.	6	3	2	1	3	2	2	1	1	3	-	-	14	10	**24**
Fusarium culmorum (W. G. Sm.) Sacc.	5	3	2	2	4	4	4	5	2	4	2	3	19	21	**40**
Fusarium oxysporum Schl.	8	4	5	4	2	4	3	6	2	2	3	4	23	24	**47**
Fusarium solani (Mart.) Sacc.	3	5	4	3	3	-	2	3	4	3	2	-	18	14	**32**
Mucor hiemalis Wehmer	-	-	1	1	-	-	-	-	3	2	2	2	6	5	**11**
Mucor mucedo Fresenius	2	2	1	3	4	2	3	3	3	3	-	-	13	13	**26**
Penicillium expansum Link ex S. F. Gray	-	-	2	2	-	-	4	3	-	-	2	1	8	5	**13**
Penicillium nigricans (Bain.) Thom	4	2	-	-	5	3	-	2	2	2	-	-	11	7	**18**
Phytophthora sp.	2	1	1	1	-	-	6	5	-	-	-	-	9	7	**16**
Pythium irregulare Buisman	4	2	2	2	-	-	1	1	-	-	-	-	7	5	**12**
Rhizoctonia solani Kűhn	3	4	-	-	3	1	2	3	-	-	-	-	8	8	**16**
Rhizopus nigricans Ehrenberg	-	-	1	1	2	1	3	2	3	2	-	-	9	6	**15**
Trichoderma aureoviride Rifai	2	1	-	2	-	-	-	1	2	1	-	1	4	6	**10**
Trichoderma koningii Oud.	-	-	1	-	4	2	-	-	-	1	1	1	6	4	**10**
Trichoderma viride Pers ex S. F. Gray	-	1	-	2	-	3	-	1	3	-	-	2	3	9	**12**
Total	**50**	**36**	**26**	**30**	**36**	**26**	**38**	**40**	**30**	**25**	**20**	**22**	**200**	**179**	**379**
Total	86		56		62		78		55		42				

The mycological analysis conducted in 2006 gave 379 colonies of different fungi and fungi-like species (Table 3). The greatest number of such isolates was obtained from the plants collected on irrigated plots. Species of the genus *Fusarium* were isolated from the infected ginseng plants, except of *F. solani*. Cultures of this fungus were not isolated from infected stem bases in two experimental combinations after the application of Alkalin PK. Isolates of *Fusarium* spp. were most frequently obtained from the plants from irrigated plots, mainly from the control (Table 3). Besides, such species as *Alternaria alternata, Cylindrocarpon destructans, Rhizoctonia solani* and fungi-like microorganisms, i.e. *Pythium irregulare* and *Phytophthora* sp. (Table 3), were also obtained from the plants, but not in each combination. Saprotrophic fungi such as *Mucor* spp., *Penicillium* spp., *Trichoderma* spp. *Cladosporium cladosporioides* and *Rhizopus nigricans* were also obtained from the sampled plants (Table 3).

The three-year mycological study of infected ginseng plants showed that species of the genus *Fusarium* were most frequently isolated from all combinations (Fig. 2). *F. oxysporum* turned out to be dominant, especially with respect to the plants taken from control plots. *Fusarium solani* and *Fusarium culmorum* were also frequently obtained from the studied plant material (Fig. 2). The smallest number of fungi and fungi-like organisms that were potentially pathogenic was isolated, in the course of three years of the study, from infected ginseng plants sampled from non-irrigated plots, after foliar application of Alkalin PK (Fig. 2; Tables 1, 2, 3).

DISCUSSION

The studies conducted by the present authors provided information on microorganisms colonizing diseased ginseng plants after the application of irrigation and foliar fertilization. Numerous disease symptoms observed on plants in the form of necrosis of the root and stem base, frequently together with the softening of the plant tissues, were probably caused by fungi from the genera of *Fusarium, Cylindrocarpon, Rhizoctonia solani, Sclerotinia sclerotiorum* and fungi-like organisms from the soil-borne genera of *Pythium* and *Phytophthora*. The abovementioned microorganisms are frequently described in literature as pathogens of underground plant parts, capable of causing the symptoms described above (Parke and Shotwell, 1989; Mitchell and Kannwischer–Mitchell, 1992; Li and Utkhede, 1993; Nicol et al. 2003; Mahfuzur and Punja, 2005). Introducing irrigation to the ginseng cultivation technology probably had a positive effect on the growth and development of certain pathogens, especially the fungi-like organisms from the genera of *Pythium* and *Phytophthora* as well as the species of *Rhizoctonia solani*. This is confirmed by the studies by Parke and Shotwell (1989) and Davis and Shoemaker (1999); Yeoung et al. (2004) who showed that with high humidity of the subsoil, and especially with irrigation and poor air circulation, numerous zoospores of *Pythium* spp. and *Phytophthora* sp. are formed in a very short time. Those spores infect the plant parts which have contact with the soil. The roots infected by fungi-like organisms are subject to soft rot (Pięta and Berbeć, 1995). High humidity is also conducive to the growth of *R. solani* biomass, which was reflected in the present study since that fungus colonized mainly the diseased parts of ginseng in the combinations with irrigation. Fungi-like organisms, i.e. *Pythium* spp. and *Phytophthora* sp. as well as the species of *R. solani* pose a big threat not only to ginseng cultivated in eastern Poland but also in the United States of North America (Mitchell and Kannwischer-Mitchell, 1992; Davis and Shoemaker, 1999) and Bulgaria (Bayen et al. 2003).

Isolation of the species of *Cylindrocarpon* in each year of the study confirmed earlier observations made by Pięta and Berbeć (1995); Pięta (1997) as well as Pastucha and Kołodziej (2007a, b) on the occurrence of this fungi on the roots of ginseng cultivated in the region of Lublin. According to (Domsch and Gams, 1970; Punja, 1997; Mahfuzur and Punja, 2005), fungi of this genus occur quite commonly in cultivated soil, causing root necrosis of a lot of host plants. In the soil, they live as saprophytes in the form of chlamydospores. Bruehl (1975) includes *Cylindrocarpon* spp. in the pioneers infecting the roots of the plant under discussion. Literature provides abundant information on the occurrence of fungi of this genus in ginseng cultivation of other countries (Reeleder and Brammall, 1994; Axelrood et al. 1998; Hausbeck, 2004; Mahfuzur and Punja, 2005). The above information and the common isolation of *Cylindrocarpon* spp. in the present study are evidence of high harmfulness of these fungi to ginseng plants in the Lublin area.

Frequent isolations of fungi from the genus *Fusarium* can point to their considerable harmfulness to the analyzed parts. It is known from literature that particular species of *Fusarium* spp. (*F. culmorum, F. oxysporum, F. solani*) cause fusariosis wilt, seedling rot, and rot of the roots, fruits and seeds (Booth, 1971; Kwaśna et al. 1991; Filoda et al. 1998; Machowicz–Stefaniak et al. 2002; Machowicz–Stefaniak and Zalewska, 2004; Mazur and Szczeponek, 2005). Those fungi were already isolated from the infected parts of ginseng in earlier studies conducted by Pięta and

Berbeć (1995); Berbeć and Dziedzic (1996); Pięta (1997), Pastucha and Kołodziej (2005, 2007a). Besides, the occurrence of *Fusarium* spp. on ginseng is especially harmful due to the fact that these fungi produce numerous toxic metabolites (Goswami et al. 2008; Punja et al. 2008). In the studied conditions, irrigation and the long period of cultivation on the same field, which caused accumulation of infectious factors in the soil, are likely to favour the development of fusariosis on ginseng (Punja, 1997). It should then be supposed that, with many years of ginseng cultivation and irrigation, favourable conditions for the development of various pathogenic factors occurred. These include especially *Rhizoctonia solani* and fungi-like organisms, i.e. *Pythium* spp. and *Phytophthora* sp., which were isolated from ginseng plants showing disease symptoms. The reduced occurrence of pathogenic microorganisms after the application of Alkalin PK justifies considering it to be more suitable on ginseng plantations than Resistim. Studies conducted by Kołodziej (2008) also proved that foliar fertilization in the form of Alkalin PK in ginseng cultivation improved plant growth, resulted in an increase in the weight of roots, stems and leaves and increased the production of fruit and seeds. Besides, high pH of Alkalin effectively limited the development of fungi which prefer an acidic environment (Jabłoński, 2007). On the other hand, the weaker effect of Resistim was probably caused by the fact that, with high accumulation of pathogenic factors in the studied cultivation environment of the plants, the biostimulating fertilizer Resistim was not able to induce the natural plant resistance mechanisms fast enough (http : / www.ho.haslo.pl/article.php.2086).

CONCLUSIONS

1. The conditions of plant growth in particular experimental combinations affected the differentiation in the qualitative and quantitative composition of fungi and fungi-like organisms colonizing the diseased parts of ginseng.
2. The fact that the largest populations of microorganisms were obtained from the experimental combination in which plant irrigation was applied is evidence of its positive effect on the development of potential plant pathogens.
3. Frequent isolation of fungi from the genera of *Fusarium, Cylindrocarpon, Rhizoctonia solani* and fungi-like organisms from the genera of *Pythium* and *Phytophthora* from the diseased ginseng plants testifies to their big harmfulness towards this plant.
4. The observed positive effect of spraying with Alkalin PK on the health of ginseng justifies recommending the application of this fertilizer in the cultivation of this plant.

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Wpływ nawadniania i nawożenia dolistnego na zasiedlanie chorych organów żeńszenia (*Panax quinquefolium* L.) przez różne mikroorganizmy

Streszczenie

W latach 2004-2006 przeprowadzono badania polowe nad zdrowotnością żeń-szenia pięciolistnego uprawianego w województwie lubelskim, na słabej glebie piaszczystej. W badaniach uwzględniono kombinacje z nawadnianiem i bez nawadniania roślin oraz z nawożeniem dolistnym preparatami Alkalin PK lub Resistim. Z każdej kombinacji doświadczenia pobierano do laboratoryjnej analizy mikologicznej chore rośliny żeń-szenia, celem ustalenia składu ilościowego i jakościowego organizmów grzybopodobnych i grzybów, zagrażających uprawie tej rośliny.

Z porażonych organów żeń-szenia często wyosabniano grzyby z rodzajów *Cylindrocarpon, Fusarium,* gatunki *Alternaria alternata*, *Rhizoctonia solani* i *Sclerotinia sclerotiorum* oraz organizmy grzybopodobne *Pythium irregulare* i *Phytophthora* sp. Najmniej kolonii tych mikroorganizmów wyizolowano z roślin wzrastających na poletkach bez nawadniania i po zastosowaniu nawożenia dolistnego Alkalinem.