ACTA SCIENTIARUM POLONORUM *Acta Sci. Pol., Hortorum Cultus 12(2) 2013, 107-121*

OCCURRENCE OF FUNGI ON ANGELICA PLANTS *Archangelica officinalis* Hoffm.

Ewa Zalewska, Zofia Machowicz-Stefaniak, Ewa Król
University of Life Sciences in Lublin

Abstract. Microscopic fungi are important in reducing of the quality of the herb material. This study concerns the fungi that may colonize the above-ground and underground organs of angelica (*Archangelica officinalis*). The study was conducted in the years 2008–2011 in the natural conditions of plant growth. Disease and etiological symptoms occurring on plants at the stage of 8-week-old seedlings, at anthesis and during the harvest were observed. T those dates the mycological analysis of the studied plants was conducted by artificial culture methods, taking into account schizocarps for sowing as well as the roots, stem bases and stalks, leaves, umbels and formed schizocarps. A total of 32 species of fungi, including those pathogenic to angelica and other herbs, were cultured and identified. These include species of the genera *Colletotrichum, Phoma, Fusarium, Sclerotinia, Rhizoctonia, Ramularia* and *Phomopsis.*

Key words: microscopic fungi, herbs, healthiness

INTRODUCTION

Angelica is a biennial or a perennial plant of the family Apiaceae. It has universal application in medicine and as a spice plant, but the quality of the herb material significantly reduced by pathogenic microorganisms. Currently a rich literature on infectious diseases of herbs, including species of the family Apiaceae is available [Farr et al. 1995, Gabler and Ehring 2000, Machowicz-Stefaniak and Zalewska 2008, Machowicz-Stefaniak 2010, Machowicz-Stefaniak et al. 2011, 2012]. However, information about the diseases of angelica plants cultivated in Poland is very scarce. According to Grzybowska et al. [1975], the causal agent of premature leaf dieback can be spots caused by *Cercospora* spp. On the petioles and veins of *Angelica officinalis* and on the leaves of *Angelica sylvestris* the presence of rust, *Puccinia anglicae* (Schum.) Fuck. was detected [Studziński and Mikołajewicz 1989]. The brown spot of leaves and stems is caused by fungus *Ramularia archangelicae* Hachn., while the spot of leaves and petioles of angelica is caused by fungus *Fusicladium depressum*

Corresponding author: Ewa Zalewska, Department of Plant Pathology and Mycology, University of Life Sciences in Lublin, Leszczyńskiego 7, 20-069 Lublin, e-mail: ewa.zalewska@up.lublin.pl

(Berk. et Br.) Sacc. [Rumińska et al. 1991]. The occurrence of different species of fungi, including *Alternaria* spp., on the leaves, stems and flowers of angelica was detected by Mazur and Szczeponek [2005].

The aim of the present study was to recognize (elaborate) the symptomatology and etiology of angelica diseases caused by fungi.

MATERIAL AND METHODS

Schizocarps coming from the distributor Herbador Kinga Pastuszewska from Bydgoszcz and angelica plants growing on a patch of the area. 25 m^2, in Motycz near Lublin (51°14'21" N 22°22'46" E) were included in the studies. Schizocarps were sown in July 2008 and research was conducted in the years 2008, 2009, 2010 and 2011, i.e. in the first, second, third and fourth years of cultivation. On the field except a part from agricultural practices, the organic and mineral fertilization was used but plant protection treatments were not performed.

Two samples of 100 schizocarps without spots and 100 ones with spots on the surface were collected from angelica schizocarps intended for sowing. The schizocarps were sterilized for 1.5 minutes in a 10% sodium hypochlorite solution, rinsed three times per 3 minutes in sterile distilled water and then put in a solidified malt medium (Difco) in Petri dishes ∅ 10cm with 10 pieces in the dish [Machowicz-Stefaniak and Zimowska 2000].

The assessment of the plants` health growing in the field and the mycological analysis were performed each year at three dates: the stage of 8-week-old seedlings, which fell at the September, during anthesis, i.e. in the middle of June and during the harvest, i.e. at the end of August. For this purpose, each time 50 plants were chosen (5 × 10) on which the occurrence of disease and etiological symptoms was observed.

Table 1. Comparison of average value of monthly temperature of air and rainfalls with average many years in vegetation periods in 2008–2011

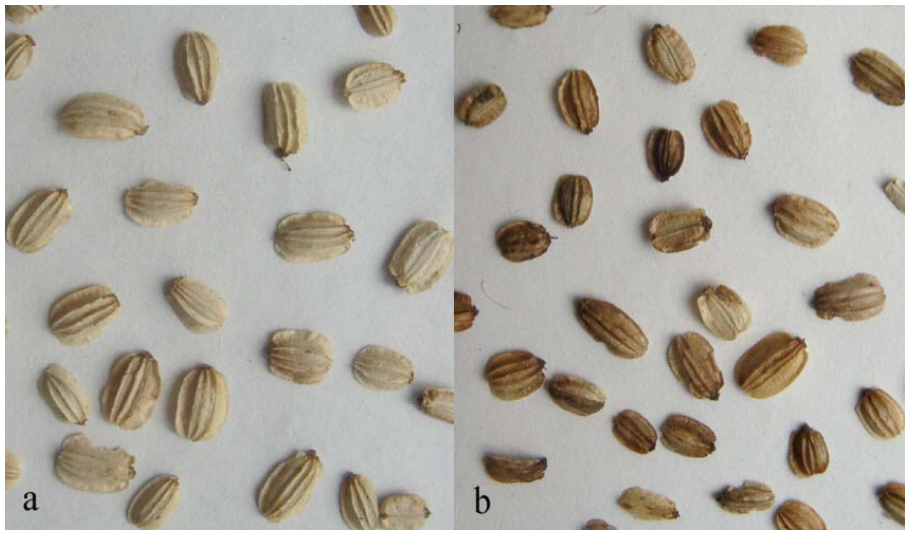
Month	Means of the years 1963–1992		Difference of mean air temperature in comparison with means of the years				Percentage of the average annual rainfalls			
	air temperature [°C]	rainfalls [mm]	2008	2009	2010	2011	2008	2009	2010	2011
May	13.3	60.9	-1.3	-0.2	0.7	0	75.5	1.8	108.9	-6.1
June	16.4	78.3	-0.6	-0.2	1.1	1.7	117.5	58.5	-23.2	0.9
July	17.8	77.9	0.7	1.8	1.8	0.75	154.0	-9.6	3.0	92.8
August	17.3	69.3	1.2	-0.3	-0.3	1.05	86.6	-14.3	33.0	-38.0
September	13.1	36.0	-0.3	-0.6	-0.6	1.75	188.9	-23.5	104.4	-30.7

Values with minus are low than the means of the years

Like for the schizocarps, the mycological analysis of plants was carried out using artificial cultures method [Machowicz-Stefaniak and Zimowska 2000, Machowicz-Stefaniak and Zalewska 2008]. The inocula were prepared separately from the roots, stem bases, stems and leaves, while during the harvest – from umbels and schizocarps. Each time, one hundred three millimeter fragments from individual organs were taken and placed on Petri dishes on solidified medium. The dishes with the plant material were placed in a thermostat at the temperature of 22°C in the dark for 6 days. The grown fungal colonies were moved on potato dextrose agar PDA slants (Difco) [Machowicz-Stefaniak and Zalewska 2008] and pure cultures were determined on PDA as well as on standard media. The fungi of *Fusarium* genus were determined on PDA and selected agar medium SNA by Leslie and Summerell [2006] and of the genus *Phoma* on the malt medium MA, oat agar OA, and cherry agar CA [Marcinkowska 1995, Boerema et al. 2004]. Other fungi were determined by the appropriate keys and monographs. The results were related to weather conditions on the basis of meteorological data for the Lublin area, obtained from the meteorological station in Radawiec using the data published on-line [http://www.weatheronline.pl] (tab. 1).

RESULTS

Research began with the assessment of schizocarps designed for sowing, because they had different appearance. Schizocarps without spots were the size of approximately 0.4 × 0.6 mm and they were cream-colored, ribbed, oval or spindle-shaped, flattened on the inner side and slightly pointed at the ends (phot. 1a). Schizocarps with spots had asimilar size and shape. On the surface there were clear and dark brown spots or they were all brown (phot. 1b). Such schizocarps accounted for 3% of the sowing material.



Phot. 1. Schizocarps of angelica: a – without spots, b – with spots (photo E. Zalewska)

As a result of the mycological analysis of schizocarps both without spots and with spots, 124 fungal isolates belonging to 6 species were obtained. Sixty-six isolates were obtained from schizocarps with spots and 58 from those without spots. Among 66 isolates obtained from schizocarps with spots the cultures of *Phoma exigua* and *Acremonium strictum* constituted respectively 43.9% and 39.4% (tab. 2). Moreover, *Alternaria alternata, Epicoccum purpurascens* and *Alternaria radicina*, whose isolates constituted respectively 9%, 6.06% and 1.5% of all the obtained cultures were identified (tab. 2). Mostly *P. exigua, A. strictum* and *A. radicina* were cultured from the schizocarps without spots (tab. 2).

Table 2. Fungi isolated from intended for sowing schizocarps of angelica (*Archangelica officianalis* Hoffm.) (X. 2008)

Fungi	Number (%) of isolates		Total
	schizocarps with spots	schizocarps without spots	
Acremonium strictum W. Gams	26 (39.4)	13 (22.4)	39 (31.5)
Alternaria alternata (Fr.) Keissl.	6 (9.0)	1 (1.7)	7 (5.7)
Alternaria radicina Meier Drechsler et E.D. Eddy	1 (1.5)	6 (10.3)	7 (5.6)
Epicoccum purpurascens Ehrenb.	4 (6.06)	–	4 (3.2)
Phoma exigua var. *exigua* Desm.	29 (43.9)	35 (60.3)	64 (51.6)
Sordaria fimicola (Roberge ex Desm.) Ces. et De Not	–	3 (5.2)	3 (2.4)
Total	66 (100)	58 (100)	124 (100)

During the first observation of the plants` health, the majority of the 8-week-old seedlings were 30 cm high and had 8–9 well-formed leaves with dark green coloration. On the leaves of about 3% of the plants there were dark, irregular spots with a diameter ranging from 1.5 mm to 3 mm. On the above-ground parts of seedlings no etiological symptoms were observed.

From the eight-week-old angelica seedlings 157 isolates were obtained, including 39 from the roots, 60 from collar-roots and 58 from the leaves. Those isolates belonged to eight species of fungi. *Fusarium oxysporum, Phoma exigua* and *Fusarium equiseti* were isolated most frequently from all the studied organs and their cultures constituted, respectively, 38.9%, 25.3% and 17.2% of all isolates (tab. 3). *Fusarium oxysporum* were isolated most frequently from the collar-root and the roots of plants, because the fungal isolates made up 81% and 35%. *F. equiseti* and *Rhizoctonia solani* cultures were obtained from the roots and collar-root while *Phoma exigua* only from the roots. Their isolates were, respectively, 23% and 15%, 15% and 5% and 23% of all cultures. Furthermore single isolates of *Alternaria* species were obtained from those plant parts (tab. 3). Fungi isolated from the eight-week-old seedlings leaves of angelica belonged to four species, and the most frequently isolated were *P. exigua* and *A. strictum*, which constituted, respectively, 33% and 26% of the isolates. Moreover, *F. equiseti* and *Phoma herbarum* were isolated from the leaves (tab. 3, phot. 2).

Table 3. Fungi isolated from various organs of eight-week-old seedlings of angelica (*Archangelica officinalis* Hoffm.) (IX. 2008)

Fungi	Number (%) of isolates			Total
	roots	hypokotyl	leaves	
Acremonium strictum W. Gams	–	–	15 (26)	15 (9.5)
Alternaria alternata (Fr.) Keissl.	–	1 (1.6)	–	1 (0.6)
Alternaria radicina Meier Drechsler et E.D. Eddy	1 (2.5)	–	–	1 (0.6)
Fusarium equiseti (Corda) Sacc.	9 (23)	9 (15)	9 (15.5)	27 (17.2)
Fusarium oxysporum Schlecht.	14 (35)	47 (81)	–	61 (38.9)
Phoma exigua var. *exigua* Desm.	9 (23)	–	31 (33)	40 (25.3)
Phoma herbarum Westend.	–	–	3 (5)	3 (1.2)
Rhizoctonia solani Kühn	6 (15.3)	3 (5)	–	9 (5.7)
Total	39 (100)	60 (100)	58 (100)	157 (100)

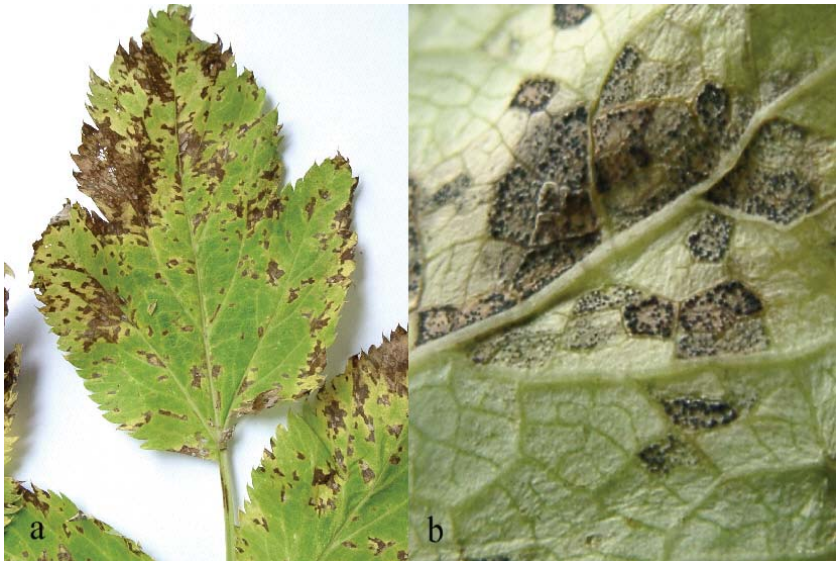
Phot. 2. 14-day-old colony and pycnidia of *Phoma herbarum* on cherry agar medium CA (photo E. Zalewska)

Table 4. Fungi isolated from various organs of plants of angelica (*Archangelica officinalis* Hoffm.) after overwintering in the years 2009–2011

Fungi	Number of isolates									Total noumber (%)
	roots			the base of stem			leaves			
	2009	2010	2011	2009	2010	2011	2009	2010	2011	
Acremonium strictum W. Gams		4						2		6 (2.0)
Alternaria alternata (Fr.) Keissl.	9				3		3	6	5	26 (8.8)
Botrytis cinerea Pers.	2						3			5 (1.7)
Colletotrichum dematium (Pers.) Grove						2			3	5 (1.7)
Colletotrichum gloeosporioides (Penz.) Penz. et Sacc.			2			8		2	2	14 (4.8)
Cylindrocarpon didymum (Harting) Wollenw.	9	4	3				1			17 (5.8)
Cylindrocarpon obtusisporum (Cooke et Harkn.) Wollenw.		11	2			4				17 (5.8)
Epicoccum purpurascens Ehrenb.						7			4	11 (3.7)
Fusarium avenaceum (Fr.) Sacc.		2		12	15	5	9	7		50 (17.0)
*Fusarium culmorum*Wm.G. Sm.				5						5 (1.7)
Fusarium equiseti (Corda) Sacc.					4					4 (1.4)
Fusarium graminearum Schwabe						6				6 (2.0)
Fusarium oxysporum Schlecht.		2	13	43	7					65 (22.0)
Fusarium solani (Mart.) Sacc.						8				8 (2.7)
Gliocladium catenulatum J.C. Gilman et E.V. Abbott		10								10 (3.4)
Humicola fuscoatra Traaen					2					2 (0.7)
Phoma complanata (Tode) Desm.									3	3 (1.0)
Phoma exigua var. *exigua* Desm.					2	4				6 (2.0)
Phoma herbarum Westend.		2								2 (0.7)
Ramularia archangelicae Lindr.					5	17			10	32 (10.8)
Stemphylium botryosum Wallr.	1									1 (0.3)
Total	21	35	20	60	38	61	16	17	27	295 (100)

Table 5. Fungi isolated from various organs of angelica (*Archangelica officinalis* Hoffm.) plants in the time of maturing of schizocarps in the years 2009–2011

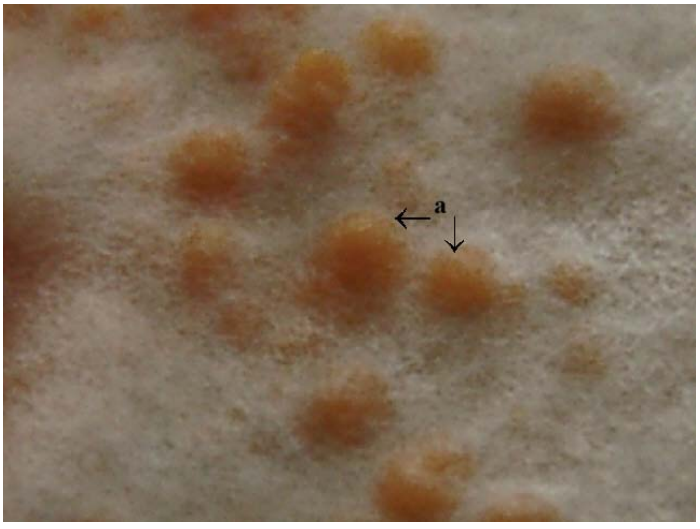
Fungi	Noumber of isolates																		Total noumber (%)
	roots			the base of stem			stem			leaves			umbels			schizocarps			
	2009	2010	2011	2009	2010	2011	2009	2010	2011	2009	2010	2011	2009	2010	2011	2009	2010	2011	
Alternaria alternata (Fr.) Keissl.	2	2	4	11	3		66	22	4	69	15	8	98	53	72	91	57	68	645 (48.0)
Alternaria radicina Meier Drechsler et E.D. Eddy															16			8	24 (1.9)
Botrytis cinerea Pers.				2			25	8	8	3				4					50 (3.7)
Chaetomium globosum Kunze											4								4 (0.3)
Cladosporium cladosporioides (Fresen) G.A. de Vries									4	3	2	4			4				17 (1.3)
Colletotrichum dematium (Pers.) Grove			4			4	3					40							51 (3.8)
Colletotrichum gloeosporioides (Penz.) Penz. et Sacc.			4		8	38	4	6			51			14	4		38		167 (12.4)
Cylindrocarpon didymum (Harting) Wollenw.	40	22	10																72 (5.4)
Cylindrocarpon obtusisporum (Cooke et Harkn.) Wollenw.			30																30 (2.2)
Epicoccum purpurascens Ehrenb.										9	2			4	4	7	2	20	48 (3.6)
Fusarium eqiuseti (Corda) Sacc.				7		4													11 (0.8)
Fusarium oxysporum Schlecht.		4		42		4	2			2									54 (4.0)
Fusarium sacchari (E.J. Butler et Hafiz Khan) W. Gams		4			2														6 (0.4)
Humicola grisea Traaen			12																12 (0.9)
Phoma complanata (Tode) Desm.	2	14				4			16			16	2						54 (4.0)
Phomopsis diachenii Sacc.														22					22 (1.6)
Pythium spp.						6													6 (0.4)
Rhizoctonia solani Kühn				2															2 (0.1)
Sclerotinia sclerotiorum (Lib.) de Bary									68										68 (5.2)
Total	44	46	64	64	13	60	100	36	100	86	74	68	100	97	100	98	97	96	1343 (100)



Phot. 3. Necrosis on the top part of leaves – a, concentration of conidiophores with conidia of *Ramularia archangelicae* on the down part of angelica leaf – b (photo E. Zalewska)

Phot. 4. Necrotic spots on leaves of angelica caused by complex of fungi: *Colletotrichum* spp., *Phoma* spp. i *Alternaria* spp. (photo E. Zalewska)

Phot. 5. The root of angelica with symptoms of infection with *Fusarium* spp. and *Cylindrocarpon* spp. (photo E. Zalewska)



Phot. 6. 14-day-old colony of *Colletotrichum gloeosporioides* with acervuli of fungus – a on PDA (photo E. Zalewska)

During the observations of plant health conducted after overwintering in the second, third and fourth years, the disease symptoms were observed on the lower and middle leaves of rosettes. They were bright, necrotic spots with a diameter of 5 mm. The leaves with the spots on their surface have a slightly undulating margin. Those plants, depending on the year constituted from 12% to 20%. On the surface of the infected leaves there were fungi hyphae.

As a result of the mycological analysis of overwintering plants, totally 295 isolates of fungi were obtained. The fungi were isolated most frequently from the stem base, then from the roots and leaves. In total, 21 species belonging to 12 genera were identified. 11 species of fungi were isolated from the roots, 14 species from the stem base and 10 from the leaves (tab. 4). Isolation of *Cylindrocarpon didymum, C. obtusisporum* and *Fusarium oxysporum* from angelica roots was repeated in all years of study. *F. avenaceum, F. oxysporum, P. exigua* var. *exigua* and *Ramularia archangelicae* were obtained from the stem bases. Isolation of *Alternaria alternata, Colletotrichum gloeosporioides* and *F. avenaceum* from the leaves was repeated, while in 2011 *Ramularia archangelicae* was also obtained (phots. 3a, b). Other species of fungi were isolated from different parts of angelica with low frequency (tab. 4).

The third observation of the plant health takes place every year during ripening showed that the disease symptoms in the form of necrosis occurred on all plant organs: umbels, leaves, stems and roots. The leaves have distinct, dark brown, irregular spots, with diameters ranging from 5 to 8 mm, which gradually increased in size and caused their yellowing (phot. 4). The spots were on the whole surface of the leaves. Necrotic spots on the stem were elongated, with a distinct dark red edge. On the roots and collar-root small changes in the form of small, dark, round spots, both at the base of the shoot and on the main root and lateral roots were observed (phot. 5). Plants with the described symptoms of disease accounted for 40%. During the hot and wet July 2010 an increased incidence of anthracnose on angelica leaves was found. Within a few days, necrosis, curling and drying of the leaves were observed in 80%.

As a result of the mycological analysis conducted during maturation, totally 1343 isolates of fungi belonging to 19 species were obtained. Fungi were isolated most frequently from the umbels and schizocarps, then stalks and leaves while much less frequently from the stem base and roots (tab. 5). The frequency of fungi isolation from the aboveground plant organs was similar in individual periods of vegetation but in 2010 less fungi were isolated from the stalk and stem base compared to the years 2009 and 2011. *Alternaria alternata* was obtained every year from all parts of angelica but most frequently from the stems, leaves, umbels and schizocarps. As a result of isolations during the summer, the majority of *C. gloeosporioides* isolates were obtained in 2010 and 2011 (phot. 6) as well as cultures of *C. dematium* which had not been reported on angelica before (tab. 5). Cultures of *C. gloeosporioides* during the study period were 12.4% (tab. 5). Fungi of genus *Fusarium* were obtained mainly from the roots and the stem base, totally, number of 71 isolates constituted 5.2% of all isolates. Isolates of *Cylindrocarpon* spp., *Sclerotinia sclerotiorum, Phoma complanata, Botrytis cinerea* and *Phomopsis diachenii*, which constituted respectively 7.5%, 5.2%, 4.0%, 3.7% and 1.6% (tab. 5).

DISCUSSION

Results of this study suggest that the well-developed schizocarps of angelica free from disease symptoms as well as those with spots on their surface are inhabited by different species of fungi, including pathogens. *Phoma exigua* var. *exigua* belongs to particularly dangerous species isolated from schizocarps. This species is one of the most famous polyphagous fungi occurring in the soil and on dead plant parts [Łacicowa et al. 1990, Marcinkowska 2003, Boerema et al. 2004, Machowicz-Stefaniak et al. 2008]. Many authors showed that the fungus can colonize both external and internal tissues of the seeds of different species of herbs and ornamental plants [Łacicowa et al. 1990, 1991, Machowicz-Stefaniak and Zimowska 2000, Boerema et al. 2004]. In the previous studies the fungus was recognized as a cause of leaf and stem necrosis of dill cultivated in the vicinity of Lublin [Machowicz-Stefaniak and Zalewska 2007]. Moreover, this species was frequently isolated from different parts of caraway [Machowicz-Stefaniak and Zalewska 2008]. Infection tests showed that *P. exigua* var. *exigua* may be an occasional parasite because it prevents germination of lemon balm and thyme seeds or inhibits the growth of seedlings [Machowicz-Stefaniak et al. 2008]. In India, this species was considered as the cause of leaf spot of ginger [Rai 1993].

A major achievement of the present study is isolation of *Phoma complanata*, which is considered as a pathogenic species to the stems of angelica [Farr et al. 1995] and damaging to the petioles, leaves and roots of parsnips, parsley and carrots [Boerema et al. 2004].

Isolates of *Phoma herbarum*, obtained in the present study should be considered as dangerous, because the fungus showed high pathogenicity against dandelion (*Taraxacum officinale*) in England and Canada. The harmfulness of this pathogen as well as *P. exigua* to dandelion was confirmed in infection tests using spore suspension [Neumann and Boland 2002, Stewart-Wade and Boland 2004]. The high pathogenicity of this species results from a high content of a phytotoxic compound, which is lactona herbarumin III [Nada 2005]. Due to the high pathogenicity of *P. herbarum* and *P. exigua* to dandelion, a spore suspension of these fungi were considered in England as an alternative to herbicides to control this weed. For this reason, *P. herbarum* and *P. exigua* were determined to be potential bioherbicides [Stewart-Wade and Boland 2004]. However, the occurrence of these pathogens on medical dandelion should be considered highly harmful to the herbal industry as it can lead to a significant reduction in the quality and quantity of the herbal material.

The obtained results on standard media concerning the growth of colonies of the tested isolates of *Phoma* spp., the morphology of pycnidia and conidia, compared to the descriptions given in the monograph section *Phoma*, *Phyllostictioides* and *Sclerophomella* [Boerema et al. 2004], helped to identify the studied species as *Phoma herbarum* and *P. exigua* and *P. complanata*. Morphological characteristics of the tested isolates, both microscopic and macroscopic ones, i.e. the growth rate, the color and structure of the mycelium, the formation of pycnidia, the size and shape of pycnidia and conidia were similar to descriptions in the monograth of Boerema et al. [2004]. The present study confirmed the importance of macro-and microscopic characteristics of *in vitro* cultures to identify the species within the genus *Phoma*. The results showed specific

reactions of the studied isolates of *Phoma* spp. with 1N NaOH. A new phenomenon in the Polish conditions is isolation of *Phomopsis diachenii* from angelica umbels. Fungi from this genus can cause necrosis and dieback of caraway umbels [Gabler and Ehring 2000]. The presence of this species was found in recent years on the above-ground parts of caraway in Poland. It seems that *P. diachenii* can become a dangerous pathogen of herbs from the family Apiaceae, especially in warm seasons [Machowicz-Stefaniak et al. 2012].

The fungus *Ramularia archangelicae* isolated in the present study is one of numerous species of this genus. They may occur on plants in moderate climates, causing leaf spot [Marcinkowska 2003]. Frequent isolation of fungi from the genera *Fusarium* and *Cylindrocarpon* from the collar-root and the roots of angelica suggests that they moved to the plants from the surrounding environment, particularly from the soil. *Fusarium oxysporum, F. equiseti, F. avenaceum* dominated among *Fusarium* spp., similarly to other species of herbs [Pappas and Elena 1997, Filoda et al. 1998, Machowicz-Stefaniak et al. 2002 a, b, Machowicz-Stefaniak and Zalewska 2008, Mazur and Szczeponek 2005]. In the case of *F. oxysporum*, the special forms of the fungus are the most dangerous to herbal plant. The species *F. avenaceum* and *F. equiseti*, often isolated from angelica in Poland, were also obtained from other herbs such as St. John`s wort and hyssop [Filoda et al. 1998], from thyme and lemon balm [Machowicz-Stefaniak et al. 2002 a, b] as well as dill and caraway [Machowicz-Stefaniak and Zalewska, 2007, 2008]. Previously, it was also shown that *F. avenacum* inhabited different organs of angelica [Mazur and Szczeponek 2005]. Pathogenicity of these fungi was confirmed by infection tests conducted for the thyme and lemon balm [Machowicz-Stefaniak and Zalewska 2004, Zalewska and Machowicz-Stefaniak 2004].

The obtained results indicated the occurrence of *Cylindrocarpon* spp. in the cultivated environment of angelica. Fungi of the genus *Cylindrocarpon* as *Fusarium* species live in the soil environment and in contact with a sensitive plant can cause disease symptoms. *Cylindrocarpon destructans* was considered the cause of root rot of ginseng in Poland [Pięta and Berbeć 1997].

The study indicated widespread colonization of various parts of angelica by fungi of the genus *Alternaria*. The occurrence of these fungi on the leaves should be considered particularly harmful because the spots caused by them on the green organs of plants leads to a reduction in the quantity and quality of the herbal material [Machowicz-Stefaniak and Zalewska 2008]. The widespread occurrence of this species on various organs of cultivated plants was described in the work by Łacicowa et al. [1991]. This fungus inhabits the seed cover of many plant species, it may cause a decrease in germination, as well as the pre-and post emergence blight [Machowicz-Stefaniak and Zimowska 2000, Machowicz-Stefaniak and Zalewska 2008]. Mazur and Szczeponek [2005] isolated a number of species of the genus *Alternaria* from the leaves, stems and flowers of angelica. These fungi are commonly widespred as saprotrophs on plant residues. Some species produce secondary metabolites called mycotoxins causing onychomycoza, such as nail fungal infection in humans and animal hooves [Marcinkowska 2003].

The lack of obligatory parasites in the present study which are described by other authors [Mazur and Szczeponek 2005] is probably associated with the weather

conditions during the vegetation period. They particularly did not favor the occurrence of powdery mildews, which are dangerous pathogens to different herb species in very warm and dry growing seasons [Machowicz-Stefaniak and Zalewska 2008].

A dangerous phenomenon observed in recent years is increasing colonization of herbs by fungi of the genus *Colletotrichum* causing anthracnose [Machowicz-Stefaniak 2010, Machowicz-Stefaniak et al. 2011]. The present study showed that *C. gloeosporioides* was one of the frequently isolated species from all aerial parts of mature plants and even the roots. Its presence in plants is probably connected with the high temperature reaching 28°C and frequent rainfalls during the summer [Machowicz-Stefaniak et al. 2011]. Several isolates of this species were obtained from the leaves of angelica by Mazur and Szczeponek [2005]. On the other hand, *C. dematium* obtained in the present study was not previously listed on the angelica plants in Poland. It was found in 2005–2007 on different organs of 1-year and 2-year caraway plants grown near Lublin [Machowicz-Stefaniak 2010].

CONCLUSIONS

1. The aboveground and underground organs of angelica are colonized by many species of microscopic fungi.

2. *Phoma* spp., *Colletotrichum* spp., *Fusarium* spp., *Phomopis* sp. and *Sclerotinia* sp. belong to the fungi which have a negative effect on the plants of angelica.

3. Three discovered species of the genus *Phoma*, namely *P. complanata*, *P. herbarum*, *P. exigua* var. *exigua* in addition to *Phomopsis diachenii*, have not been listed on the angelica plants in Poland.

4. The growing seasons with high temperatures and frequent rains contributed to the severity of anthracnose on angelica caused by *Colletotrichum gloeosporioides.*

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WYSTĘPOWANIE GRZYBÓW NA ROŚLINACH ARCYDZIĘGLA LITWORA *Archangelica officinalis* Hoffm.

Streszczenie. Grzyby mikroskopowe znacznie pogarszają jakość surowca zielarskiego. Niniejsze opracowanie dotyczy grzybów mogących zasiedlać nadziemne i podziemne organy arcydzięgla litwora (*Archangelica officinalis*). Badania prowadzono w latach 2008–2011 w naturalnych warunkach wzrostu roślin. Obserwowano objawy chorobowe i etiologiczne występujące na roślinach w stadium 8-tygodniowych siewek, w okresie kwitnienia roślin oraz w okresie zbioru. W tych terminach przeprowadzano analizę mykologiczną roślin metodą sztucznych kultur, uwzględniając rozłupki przeznaczone do wysiewu oraz korzenie, podstawę łodygi i łodygi, liście, baldachy i wytworzone rozłupki. Wyhodowano i zidentyfikowano łącznie 32 gatunki grzybów, w tym patogeniczne dla arcydzięgla i innych roślin zielarskich. Należą do nich gatunki z rodzajów *Colletotrichum, Phoma, Fusarium, Sclerotinia, Rhizoctonia, Ramularia* i *Phomopsis.*

Słowa kluczowe: grzyby mikroskopowe, zioła, zdrowotność

ACKNOWLEDGEMENTS

The studies were supported by Ministry of Science and Higher Education, grant No NN310449938.

Accepted for print: 20.08.2012