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THE POSSIBILITIES OF USING CHEMICAL AGENTS FOR PROTECTION OF LAWSON CYPRESS (*Chamaecyparis lawsoniana*) AGAINST *Phytophthora cinnamomi*

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Abstract. The purpose of this research was to assess the usefulness of 7 fungicides for protection of Lawson cypress (*Chamaecyparis lawsoniana*) against *Phytophthora cinnamomi*. Under the laboratory conditions, activity of the tested agents was assessed on the basis of growth of *P. cinnamomi* on a medium containing fungicides and the size of necrosis of the inoculated cypress shoots. In field research, the degree of infestation of plants in the infested medium. Laboratory research conducted indicated the highest effectiveness in limitation of growth of *P. cinnamomi* of Acrobat MZ 69 WG and Infinito 687.5 S.C. In field research, complete limitation of infestation of cypress with *P. cinnamomi* was achieved by applying two-component protection agents, containing propamocarb hydrochloride (Infinito 687.5 SC and Previcur Energy 840 SL), fosetyl-aluminium (Mildex 711,9 WG and Previcur Energy 840 SL) or mancozeb in combination with metalaxyl (Ridomil Gold 68 WG). Differences in terms of effectiveness of the agents examined depending on the application method were examined. Higher effectiveness was achieved through watering in comparison with foliar spraying using the same agents.

Key words: chemical protection of plants, coniferous ornamentals, plants pathogens

INTRODUCTION

In the recent years, the problem of diseases caused by fungous microorganisms, including such as *Phytophthora,* has become increasingly important. The cause of this fact is the growing trade in plant material [Brasier 2008], which increases the probability of

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bringing into the country new pathogens. The increasing economic losses are of significance in this regard. The problem applies to horticultural crops, as well as forest plants, since various species of *Phytophthora* are known to invade plants that are grown under cover, in fields and in natural ecosystems. Research conducted for more than ten years on the presence of *Phytophthora* spp. in Poland indicates not only the emergence of new species, but also broadening of the scope of host plants [Ptaszek et al. 2009, Orlikowski et al. 2015]. One of the most dangerous species of this kind, invading many host plants, is *Phytophthora cinnamomi* Rands [Erwin and Ribeiro 1996, Hardham 2005]. The species was described for the first time after it invaded a cinnamon tree in Sumatra in 1922 [Erwin and Ribeiro 1996]. By year 1980, this pathogen had been identified on almost 1000 host plants. In Poland, it is known as the main cause of death of ericaceous, coniferous and some deciduous plants [Orlikowski et al. 2015]. Duda et al. [2004] and Orlikowski [2002] have proven that *P. cinnamomi* is particularly dangerous to Lawson cypress crops (*Chamaecyparis lawsoniana*). In the 1970s, in the Netherlands, losses in Lawson cypress plantings caused by *P. cinnamomi* reached 100%. At present, despite substantial development in the field of plant protection, this species has remained a cause of substantial losses in nurseries, which cultivate coniferous shrubs [Orlikowski et al. 2012].

The symptoms caused by *P. cinnamomi* include decay at the base of the shoots and the roots, which leads to plant death. A key role in increased occurrence of the disease is played by environmental conditions [McConnell and Balci 2014]. The growth of this species is determined by temperature, humidity and pH of the environment. The factors, which influence epiphytosis are floods and droughts, which occur seasonally in a given area. In Central Europe, as it has been noted by Jung [2009], increase in temperature in the winter period and intensification of heavy rains, which occur almost throughout the year, contributes to plant infestation with *Phytophthora* spp. The source of this group of pathogens in gardening, particularly in container nurseries and in cultivation of plants under cover may include seedlings and cuttings, non-disinfected medium, as well as watercourses and water reservoirs [Ptaszek and Orlikowski 2015].

The above data, in particular, the economic aspect, force the producers to seek numerous corrective measures, including quarantine, destruction of the infested nursery material and constant monitoring of health of the plants cultivated. A significant component of these activities have been the principles of integrated plant protection. Nevertheless, in the case of phytoftorosis, it is necessary not only to remove the infested plants, but also to apply chemical agents.

Research is still conducted on the possibilities of chemical protection of plants against

Phytophthora spp. Already in the 1980s, fungicidal agents were tested in protection of rhododendrons [Benson 1980] and cypresses [Smith 1980] against *Phytophthora* spp. However, the effectiveness of the substances tested varied greatly. At present, emphasis is put on the risk and the cases of resistance of *Phytophthora* spp. to plant protection agents, including the widely used mefenoxam and metalaxyl [Hwang and Benson 2005]. In order to achieve high efficiency and avoid increasing resistance, rotational application of plant protection agents is recommended [Benson and Parker 2011].

Caring for plant health is one of the main tasks of modern, intensive plant production. In most cases, the entire plant is subject to trade; therefore, its price and profitability of production is related directly to their quality. Achievement of satisfactory effects is possible only under the condition of proper protection against plant pathogens, taking advantage of components of integrated activity, known as Integrated Plant Protection [Daughtrey and Benson 2005]. Taking into account the constant intensification of production of decorative plants in Poland, the losses caused by such species as *Phytophthora,* the limited possibilities of chemical protection and insufficient information in domestic literature on minimization of the threat by *P. cinnamomi* is the topic of this work.

The purpose of research was to develop effective chemical methods for protection of Lawson cypress against *Phytophthora cinnamomi*, taking into account the application mode.

MATERIAL AND METHODS

During research, effectiveness of 7 chemical plant protection agents, listed in Table 1, was assessed. Experiments were conducted using isolates of *Phytophthora cinnamomi* from the collection of the Laboratory of Decorative Plant Diseases of the Institute of Gardening in Skierniewice. Research was conducted using Lawson cypress 'Ellwoodii'.

Table 1. A list of the plant protection agents examined

Trade name of the agent	Active substances and their concentration (g/kg or l)	Registration for protection of decorative plants/application mode
Acrobat MZ 69 WG	dimethomorph (90 g/kg), mancozeb (600 g/kg)	no
Infinito 687.5 SC	propamocarb hydrochloride (625 g/l), fluopicolide (62.5 g/l)	no
Luna Sensation 500 SC	fluopyram (250 g/l), trifloxystrobin (250 g/l)	no
Pyton Consento 450 SC	propamocarb hydrochloride (375 g/l), phenamidon (75 g/l)	no
Ridomil Gold MZ Pepite 67.8 WG	metalaxyl-M (38.8 g/kg), mancozeb (640 g/kg)	yes/watering
Mildex 711.9 WG	fosetyl-aluminium (667 g/kg), phenamidon (44 g/kg)	yes/spraying
Previcur Energy 840 SL	propamocarb hydrochloride (530 g/l), fosetyl-aluminium (310 g/l)	yes/watering

The assessment of effectiveness of the selected agents in protection of Lawson cypress against *P. cinnamomi* was conducted on the basis of laboratory and field tests.

Laboratory assessment of activity of the agents examined. *In vitro* experiments were conducted to examine the impact of the agents, listed above, on linear growth of *P. cinnamomi*. Research was conducted using 7-day cultures of the species, grown on the medium of glucose and starch (Potato Dextrose Agar) at the temperature of 25°C, in the dark. The chemical agents examined were added to flasks containing sterilized PDA, cooled to 50°C, to make sure that the concentration of the active substance amounts to 1, 10, 100 ppm, respectively. The control medium contained no fungicide. The medium with the agent was mixed, and then poured into petri dishes – 25 ml in each – of diameter of 90 mm. The dishes were placed in a laminar flow cabinet for 24 hours, until complete setting of the medium. After this time, in the central part of the dish, agar disks were placed of diameter of 5 mm, overgrown with filaments of *P. cinnamomi*. On the bottom of the dishes, two perpendicular lines were drawn, intersecting one another at a right angle in the center of the inoculum. The dishes were placed in an incubator at the temperature 25°C. Observations of thallus growth was conducted after 4 and 8 days of incubation. The diameter of the colony was measured along the lines drawn. For each combination, the experiment was repeated 4 times, one dish in each. The experiments were repeated twice, at 2-week intervals.

During the second stage of laboratory research, assessment of the effectiveness of the agents tested in inhibition of colonization of Lawson cypress tissue inoculated with *P. cinnamomi,* in accordance with the methodology provided by Orlikowski and Szkuta [2002]. For inoculation of shoots, 7-day cultures of *P. cinnamomi* were used, grown on V8 medium under the temperature of 25°C [Erwin and Ribeiro 1996]. The tested plant protection agent solutions, at the concentration of 0.1, 0.15 and 0.2% were prepared in glass beakers. The apices of cypress shoots of the length of about 5 cm were soaked for 2 minutes in the solutions prepared, and then they were placed in trays (of dimensions of 32.5 × 25.5 × 5.5 cm), lined with moist, sterile, synthetic mats, covered with plastic net in order to prevent their direct contact with the moist medium. Fragments of the medium of diameter of 3 cm, overgrown with filaments of *P. cinnamomi*, collected from the edges of 7-day cultures, growing in the temperature of 25°C, were applied to the base of the shoots. The trays were covered with thin film and incubated on laboratory tables in the temperature of 22–24°C. Each time, the tests included a non-infested control dish, in which the plant organs were inoculated with clean medium disks, and the infested control dish, in which the plant fragments were soaked only in distilled water, and then – infested with filaments of *P. cinnamomi*. The measure of impact of the plant protection agents examined on the pathogen was the necrotized shoot length. Observations was conducted after 6 and 11 days of incubation.

The experiment was conducted entirely randomly, in 4 repetitions, 5 shoot fragments in each. The experiment was conducted twice, in 2-week time intervals.

Field assessment of activity of the plant protection agents examined. The cultures of *P. cinnamomi* for research purposes were prepared using the method described by Orlikowski [1999] on an oatmeal medium (OM). The medium, overgrown with the pathogen, was homogenized with the addition of distilled water (150 ml per 1 dish), and the homogeneous suspension, obtained in this manner, was mixed with the medium in accordance with the following proportions: the content of 1 dish per 1 liter of the peat substrate. The medium was placed in bags and incubated at the greenhouse for the period of 14 days. After this period, the root cuttings of Lawson cypress of the average initial height of 72 mm were planted in 1-liter pots, filled with infested peat substrate, and placed on black mats in the container room. Afterwards, the plants were treated with the plant protection agents being tested (tab. 1). 2 modes of application of the plant protection agents were used: in the first, the cuttings were watered with 25 ml of the working liquid, and in the second, they were sprayed thoroughly.

Each time, the research included a non-infested control (without the pathogen) and an infested control (infested medium without application of the plant protection agent). In the control trials, the plants were sprayed/watered with pure water only. During the experiment, the degree of plant infection was assessed after 10, 14, 18 and 20 weeks after planting, applying the scale of 0 to 5: 0 – no symptoms of disease; 1 – withering of individual shoots; 2 – visible withering of the apices or change in color; 3 – complete withering of the plant; 4 – complete withering and initial browning of the plant; 5 – browning and/or death of the plant.

In addition, after 8, 11, 14 and 20 weeks, the average increase in plant height was assessed (in mm), and after 20 weeks of cultivation – increase in the perimeter (in mm) and the degree of infestation of the roots according to a scale of 1 to 4:1 – weak infestation (1–10%); 2 – weak infestation (11–30%); 3 – strong infestation (31–60%); 4 – strong infestation (61–100%).

The experiments were conducted in blocks, picked randomly in 4 repetitions, 10 plants in each, and they were repeated 2 times in 2-week intervals.

After completion of laboratory and field tests, the causal factor was isolated from tissue plants with disease symptoms and from the medium used for plant growth, and it was once again identified to species.

Statistical analysis. The results obtained were subjected to statistical analysis using the variance analysis method. The significance of differences between the average values was assessed using Duncan's test at the significance level $\alpha = 0.05$.

RESULTS

Assessment of biological activity of plant protection agents in dish tests indicated that application of as little as 1 µg/ml of active substance in the medium inhibited growth of *P. cinnamomi* (fig. 1). Total inhibition of growth of *P. cinnamomi* at the concentration of 10 µg of active substance per 1 ml was observed in combination with Acrobat MZ 69 WG and Infinito 687.5 SC (fig. 1). The same level of effectiveness for Mildex 711.9 WG was achieved at the concentration of 100 µg of the active substance. The effect was observed for the following 4 days of incubation (fig. 2).

The agents examined, except for Luna Sensation 500 SC and Previcur Energy 840 SL, used for soaking of the Lawson cypress shoots, significantly ($p < 0.05$) limited their colonization by *P. cinnamomi* during the first 6 days of incubation (fig. 3). Use of higher concentrations did little to increase their effectiveness. After 11 days of incubation, necrosis of the shoots was inhibited only by about 50%, regardless of the concentration of the agents tested (fig. 4). A significantly lower level ($p < 0.05$) of effectiveness in comparison with other agents was recorded for Luna Sensation 500 SC and Previcur Energy 840 SL (fig. 4).

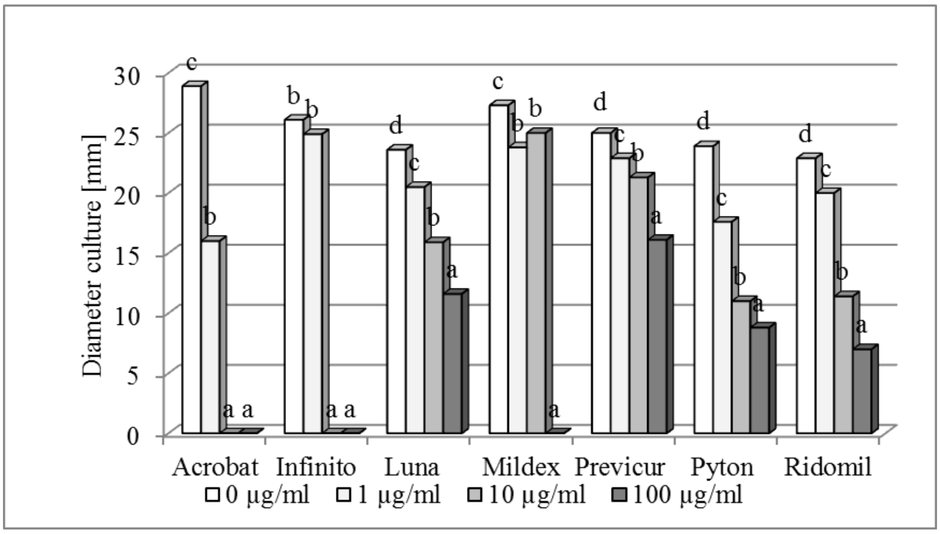

Fig. 1. Influence of the concentration of tested products on the growth of *P. cinnamomi* after 4 days of incubation

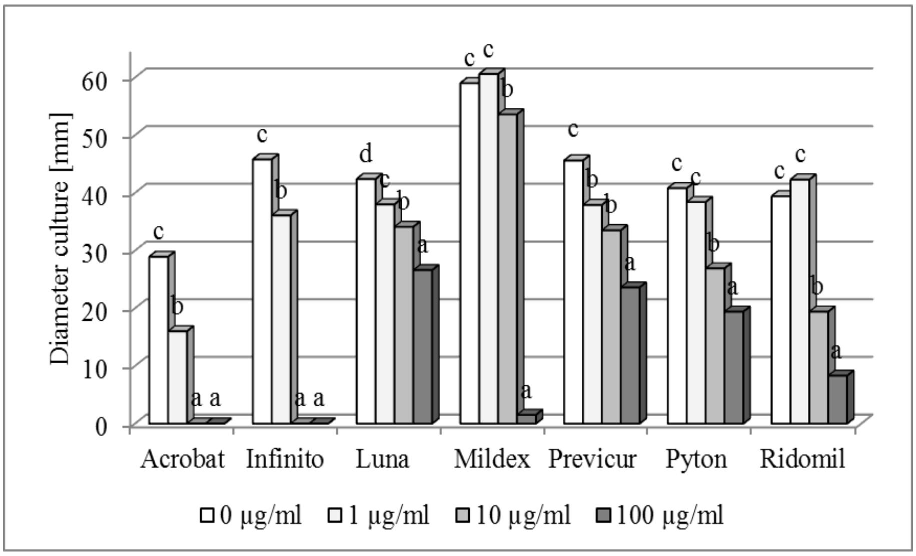

Fig. 2. Influence of the concentration of tested products on the growth of *P. cinnamomi* after 8 days of incubation

Table 2. Impact of tested products on the health condition of Lawson cypress cultivated in a substrate infected with *P. cinnamomi*

Plant protection agents	Concentration (%)	Application mode	Degree of infestation on a scale of 0 to 6 after × weeks of cultivation				Degree of root infestation on a scale of 0–4 after 20 weeks of cultivation
			10	14	18	20	
Non-infested control	–	–	0.03 ab	0.1 a–c	0.3 a	0.5 a	0.3 a
Infested control	–	–	0.1 a–c	0.4 a–d	1.7 c–f	2.0 c–e	1.5 c–f
Acrobat MZ 69 WG	0.2	spraying	0.2 a–c	1.5 g	2.9 g	3.0 g	2.3 g
	0.2	watering	0.1 a–c	0.5 a–d	1.7 c–f	2.0 c–e	0.9 bc
Infinito 687.5 SC	0.2	spraying	0.3 a–c	1.2 e–g	2.3 d–g	2.9 fg	2.0 fg
	0.2	watering	0 a	0 a	0 a	0.1 a	0.1 a
Luna Sensation 500 SC	0.2	spraying	0.1 a–c	0.6 b–d	1.5 cd	2.0 c–e	1.6 d–f
	0.2	watering	0.3 bc	1.0 d–f	1.9 c–f	2.1 c–f	1.2 cd
Mildex 711.9 WG	0.2	spraying	0.1 a–c	0.3 a–c	1.6 c–e	1.9 cd	1.2 c–e
	0.2	watering	0 a	0.1 ab	0.3 a	0.4 a	0.2 a
Previcur Energy 840 SL	0.2	spraying	0.08 a–c	1.0 d–f	2.3 e–g	2.6 d–g	1.9 fg
	0.2	watering	0 a	0 a	0.05 a	0.1 a	0.1 a
Pyton Consento 450 SC	0.2	spraying	0.2 a–c	0.7 c–e	1.8 c–f	2.1 c–e	1.4 c–f
	0.2	watering	0.03 ab	0.2 a–c	1.2 bc	1.4 bc	1.0 c
Ridomil Gold 68 WG	0.2	spraying	0.4 c	0.9 d–f	2.4 fg	2.8 e–g	1.7 d–f
	0.2	watering	0 a	0.1 a–c	0.6 ab	0.7 ab	0.5 ab

* – values in the columns, marked with the same letter, show no significant difference (5%) according to Duncan's test

Table 3. Impact of tested products on the growth of Lawson cypress cultivated in a substrate infected with *P. cinnamomi*

Plant protection agents	Concentration (%)	Application mode	Average growth in plant height (mm) after × weeks of cultivation				Average perimeter increase (mm) after 20 weeks of cultivation
			8	11	14	20	
Non-infested control	–	–	31.8 h*	73.8i	93.4 f	128.1f	198.3f
Infested control	–	–	18.3 ab	32.6ab	40.1 a	59.1ab	143.5a–c
Acrobat MZ 69 WG	0.2	spraying	28.6 g	43.2e–g	53.5 cd	65.6a–c	133.8ab
	0.2	watering	21.5b–d	34.3a–d	41.4 a	59.5ab	138.5ab
Infinito 687.5 SC	0.2	spraying	23.7de	38.8b–e	50.8 bc	68.3a–c	151.5b–d
	0.2	watering	17.8 a	32.6 ab	51.7 c	74.6b–d	168.5de
Luna Sensation 500 SC	0.2	spraying	21.6b–d	43.0e–g	54.9 cd	71.2a–d	140.3a–c
	0.2	watering	25.0ef	40.4de	44.6 ab	57.1a	146.1a–c
Mildex 711.9 WG	0.2	spraying	27.1fg	50.9h	60.6 d	77.1cd	154.3b–e
	0.2	watering	23.8de	40.9e	56.0 cd	84.6de	160.5c–e
Previcur Energy 840 SL	0.2	spraying	27.8fg	47.4f–h	57.6 cd	71.9a–d	139.3a–c
	0.2	watering	27.8fg	48.9gh	68.7 e	91.2e	173.0e
Pyton Consento 450 SC	0.2	spraying	21.9c–e	39.8c–e	54.0cd	62.6a–c	141.3a–c
	0.2	watering	18.7a–c	28.7a	40.7a	64.2a–c	127.4a
Ridomil Gold 68 WG	0.2	spraying	21.9c–e	41.9ef	52.9c	66.5a–c	153.0b–e
	0.2	watering	29.2gh	43.1e–g	52.7c	70.9a–d	146.3a–c

* – values in the columns, marked with the same letter, show no significant difference (5%) according to Duncan's test

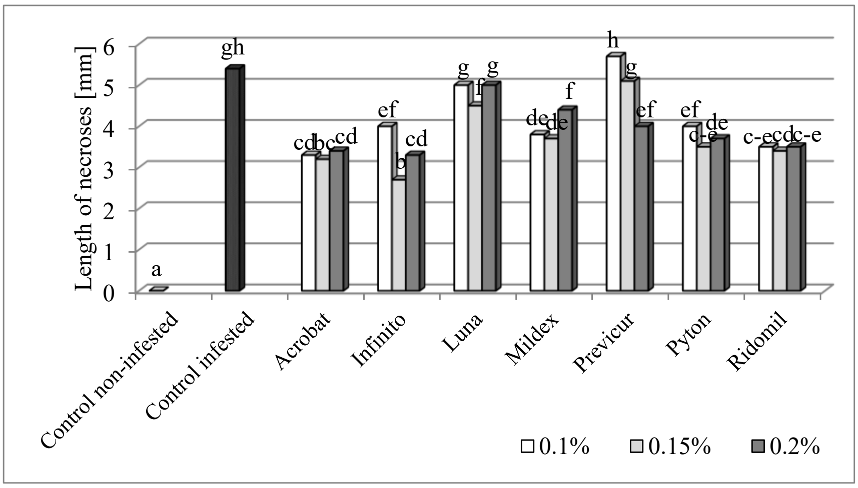

Fig. 3. Influence of the concentration of tested products on the colonization of Lawson cypress shoots by *P. cinnamomi* after 6 days of incubation

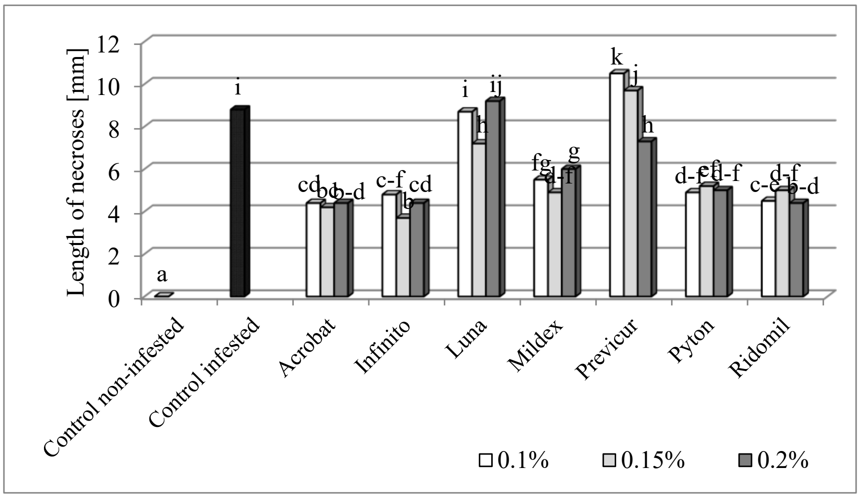

Fig. 4. Influence of the concentration of tested products on the colonization of Lawson cypress shoots by *P. cinnamomi* after 11 days of incubation

In field research, the analysis of the degree of infestation of cypress plants after 10 weeks of cultivation in the medium infested by *P. cinnamomi* showed no significant differences with regard to activity of the agents examined ($p > 0.05$) (tab. 2). After 14 weeks of cultivation, a significantly higher ($p < 0.05$) degree of plant infestation was found when sprayed with Acrobat MZ 69 WG and Infinito 687.5 SC (comparing all agents tested). Analysis of the degree of infestation of cypress roots after 20 weeks from planting showed sporadic symptoms in plants watered with Infinito 687.5 SC, Mildex 711,9 WG, Previcur Energy 840 SL and Ridomil Gold 68 WG (tab. 2).

Fig. 5. Lawson cypress growth in the experiment aimed at protection against *P. cinnamomi*; in the middle, plants treated with Infinito 687.5 SC

Analysis of impact of the tested agents on cypress growth showed that after 11 weeks of cultivation, all plants growing in the infested medium were significantly lower than those cultivated in non-infested medium ($p < 0.05$) (tab. 3). Greater shoot growth in comparison with the infested control plants was found in the case of application of Mildex 711,9 WG (regardless of the application method) and Previcur Energy 840 SL (introduced into the soil) ($p < 0.05$). Plant measurements showed that cypresses watered with Infinito 687.5 SC and Previcur Energy 840 SL had a greater perimeter (on the average, by 25 mm and 29.5 mm) in comparison with unprotected plants ($p < 0.05$). In the case of application of Infinito 687.5 SC for watering, significant impact on the color of plants tested was found ($p < 0.05$). The cypresses were intensely green, and their color differed significantly from the remaining plants (fig. 5).

DISCUSSION

In the research conducted, 7 two-component plant protection agents were tested, based on various active substances. In the *in vitro* tests, Acrobat MZ 69 WG, containing dimethomorph and mancozeb, turned out to be the most effective agent. On the other hand, in field research, full limitation of phytoftorosis in cypresses was achieved by using preparations containing propamocarb hydrochloride and fosetyl-aluminium, as well as mancozeb with metalaxyl, applied by watering. The research conducted indicates that the mode of application of the tested agents was of decisive significance for their effectiveness in protection of cypress plants against *P. cinnamomi*. In field tests, application of these agents into the soil increased their effectiveness in comparison with foliar spraying.

The results achieved confirm the earlier data of Muszyńska and Orlikowski [2010], indicating high effectiveness of Previcur Energy 840 SL in protection of Lawson cypress and geraniums when applied into the soil. On the other hand, in experiments conducted by Orlikowski [1982], fosetyl-aluminium and metalaxyl significantly limited phytoftorosis in gerberas. Slavov [2009] conducted dish tests indicating the effectiveness of fungicides based on propamocarb and metalaxyl in limiting of *P. cactorum*, *P. capsici*, *P. citricola*, *P. citrophtora* and *P. cryptogea*. Erwin and Ribeiro [1996] have pointed out that plant protection agents based on systemic substances, such as propamocarb hydrochloride or fosetyl-aluminium, usually lead to limitation of sporulation and inhibition of the disease, although they fail to eliminate *Phytophthora* spp. completely.

The impact of the agents on organs of *Phytophthora* spp. has been shown by Orlikowski [2004]. In the research conducted, a mix of fosetyl-aluminium with phenamidon (Mildex 711.9 WG) was the most effective in inhibition of emergence of chlamydospores of *P. ramorum* on leaf blades and petioles, collected from the protected rhododendrons. A mixture of these compounds was significantly more effective in comparison with fosetyl-aluminium (a single-component agent – Aliette 80 WP), or its mix with propamocarb (Previcur Energy 840 SL). All of the agents examined, added to the soil extract in the concentration of 8 µg s.a./cm^3 at least in 70% inhibited the emergence of zoosporangia of *P. ramorum*. Korzeniowski and Orlikowski [2008] examined the agents containing fosetyl-aluminium, propamocarb and phenamidon in protection of rhododendrons against *P. ramorum* and *P. citricola*. The compounds analyzed inhibited creation of zoosporangia and chlamydospores of *P. ramorum* on the rhododendron leaves and they limited development of necrosis stains on the leaves, and they fully protected the stems against infection by *P. citricola.*

Research conducted in the 1980s indicated high usefulness of preparations based on metalaxyl in protection of plants against *Phytophthora* spp. Allen et al. [1980] used metalaxyl to protect pineapples and avocado against *P. cinnamomi*, and they achieved a strong limitation of decay of the plant roots. On the other hand, Smith [1980] confirmed a high level of activity of this compound in protection of Lawson cypress against *P. cinnamomi*, regardless of its concentration.

Own research has confirmed high usefulness of Ridomil Gold MZ Pepite 68 WG for protection of Lawson cypress, in particular, in the case of application into the soil. In field tests, watering turned out to be a more effective application method. On the basis of the available literature, it should be noted, however, that it is necessary to take into account the risk of increasing resistance of *Phytophthora* species against metalaxyl. In order to avoid this phenomenon, the protection programme for this plant should provide for selection of substances with varying mechanism of action, such as Mildex 711.9 WG, Previcur Energy 840 SL and preparations, which have not been registered for protection of decorative plants, such as Acrobat MZ 69 WG or Infinito 687.5 SC, which will be used for rotation in the developed Integrated Decorative Plant Protection programmes.

The research results, presented in this work, bring new data on activity of plant protection agent in limiting of *P. cinnamomi*, which attacks Lawson cypress crops, as well as many other plant species. Numerous researchers, including Lipa et al. [2005], Daughtrey and Benson [2005] have emphasized that effective production of decorative plants, aimed at obtaining of plants free from *Phytophthora* spp., must be based on complex activity. It consists of integrated production and integrated protection, such as: application of healthy material for reproduction in nurseries and plantations, use of all available organizational, physical, biological and chemical methods to limit pathogens, including the *Phytophthora* species.

CONCLUSIONS

1. During *in vitro* tests, the highest effectiveness in limitation of *P. cinnamomi* was recorded for Acrobat MZ 69 WG and Infiinito 687.5 S.C.

2. In field research, full limitation of cypress infestation with *P. cinnamomi* was achieved by using two-component protection agents, containing propamocarb hydrochloride (Infinito 687.5 SC and Previcur Energy 840 SL), fosetyl-aluminium (Mildex 711.9 WG and Previcur Energy 840 SL) or mancozeb combined with metalaxyl (Ridomil Gold 68 WG).

3. Differences in effectiveness of the agents examined depending on the application method were found. Higher effectiveness was achieved by watering in comparison with foliar spraying using the same agents.

4. In the case of application of Infinito 687.5 SC by watering, for protection of Lawson cypress, a significant impact of the agent on the color of the plants tested was found. The plants treated were intensely green and their color differed from the remaining groups of plants. This can be used by manufacturers and purchasers of the plants to maintain the color, as a positive trait.

5. The broad scope of the agents applied and the application modes can be used for more effective limitation of losses caused by *P. cinnamomi* in Lawson cypress cultivation.

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MOŻLIWOŚĆ WYKORZYSTANIA ŚRODKÓW CHEMICZNYCH W OCHRONIE CYPRYSIKA LAWSONA (*Chamaecyparis lawsoniana*) PRZED *Phytophthora cinnamomi*

Streszczenie. Celem badań była ocena przydatności siedmiu fungicydów w ochronie cyprysika Lawsona przed *Phytophthora cinnamomi*. W warunkach laboratoryjnych aktywność testowanych środków oceniono na podstawie wzrostu *Phytophthora cinnamomi* na pożywce zawierającej fungicydy oraz wielkości nekrozy indukowanych pędów cyprysika. W badaniach polowych oceniono stopień porażenia roślin posadzonych w zakażonym podłożu. Z badań laboratoryjnych wynika, że najwyższą skutecznością w ograniczaniu rozwoju *Phytophthora cinnamomi* odznaczał się Acrobat MZ 69 WG i Infinito 687,5 S.C. W badaniach polowych całkowite ograniczenie porażenia cyprysika przez *P. cinnamomi* uzyskano po zastosowaniu dwuskładnikowych, zawierających chlorowodorek propamokarbu (Infinito 687,5 SC i Previcur Energy 840 SL), fos etyl glinowy (Mildex 711,9 WG i Previcur Energy 840 SL) lub mankozeb połączony z metalaksylem (Ridomil Gold 68 WG) środków ochrony. Wykazano różnice w skuteczności badanych środków w zależności od metody aplikacji. Większą skuteczność uzyskano przez podlewanie niż przez wykonanie opryskiwań nalistnych tymi samymi środkami.

Słowa kluczowe: chemiczna ochrona roślin, iglak rośliny ozdobne, patogeny roślin

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