Katarzyna GLEŃ-KAROLCZYK, Elżbieta BOLIGŁOWA
University of Agriculture in Krakow, Department of Agricultural Environment Protection
Al. Mickiewicza 21, 31-120 Kraków, Poland
e-mail: rrglen@cyf-kr.edu.pl

ESTIMATION OF PLANT EXTRACTS EFFICACY IN VEGETABLE PROTECTION AGAINST *CERCOSPORA BETICOLA* AND *ERYSIPHE UMBELLIFERARUM*

Summary

Presented work aimed at estimating potential applications of water extracts of stinging nettle leaves (Utrica dioica L.), birch (Betula verrucosa Ehrh.) bark and walnut (Juglans regia) leaves in protection of beetroot (Beta vulgaris var. conditiva) and root parsley (Patroselium crispoum) against fungal diseases. Field experiments revealed a considerable limiting of Cercospora leaf spot (Cercospora beticola) and powdery mildew (Erysiphe umbelliferarum) development in effect of the applied plant water extracts. However, the extract from the nettle leaves revealed the highest efficacy in the diseases limiting. Soil application of the tested plant water extracts much more inhibited the intensity of infection with C. beticola and E. umbelliferarum extracts than foliar application.
Key words: *protection, plant water extracts, Cercospora beticola, Erysiphe umbelliferarum*

OCENA SKUTECZNOŚCI WYCIĄGÓW ROŚLINNYCH W OCHRONIE WARZYW PRZED *CERCOSPORA BETICOLA* I *ERYSPIPHE UMBELLIFERARUM*

Streszczenie

Celem niniejszej pracy była ocena możliwości wykorzystania wodnych wyciągów roślinnych z ziela pokrzywy zwyczajnej (Utrica dioica L.), kory brzozy brodawkowatej (Betula verrucosa Ehrh.) i liści orzecha włoskiego (Juglans regia) w ochronie buraka ćwikłowego (Beta vulgaris var. conditiva) oraz pietruszki zwyczajnej korzeniowej (Patroselinum crispum) przed chorobami grzybowymi. W badaniach polowych stwierdzono istotne ograniczenie rozwoju grzybów Cercospora beticola (chwościk buraka) i Eryspiphe umbelliferarum (mączniaka prawdziwego pietruszki) pod wpływem zastosowanych wodnych wyciągów roślinnych. Jednak najwyższą skuteczność w ograniczeniu chorób wykazał wyciąg z ziela pokrzywy. Doglebowa aplikacja testowanych wodnych wyciągów roślinnych w porównaniu z nalistną istotnie silniej ograniczała nasilenie porażenia przez C. beticola i E. umbelliferarum.
***Słowa kluczowe**: wyciągi wodne, warzywa korzeniowe, choroby grzybowe*

1. Introduction

Organic agriculture, while taking care about the quality of food and environment protection, excludes the use of artificial fertilizers and chemical plant protection. In such system of agriculture, the basic plant protection against agrophages uses prophylactic measures based on proper agrotechnology, i.e. soil tillage, crop rotation, the use of natural and organic fertilizers and mixed sowing based on the Good Agricultural Practice Code [6]. Plant protection against pests and diseases allows for the use of biological and biotechnological means basing on natural substances [8, 9, 10, 14], including plant water extracts. Biological methods of reducing harmful organisms development are desirable due to the absence of toxic effect on the soil, its micro- and mezofauna, but also on beneficial organisms, which is compliant with the idea and principles of integrated plant protection [10]. Natural plant protection means do not persist in soil or pollute underground and surface waters. Moreover, they undergo a fast biodegradation and do not accumulate in plant organs. Plants cultivated using organic methods are safe both for consumers and animals [8].

Seeking alternative plant protection means resulted in research on potential applications of natural compounds present even in common plant species [9]. Numerous laboratory tests have demonstrated that water extracts and plant extracts may efficiently limit the development of pathogenic fungi and protect plants against phytopathogens [1, 4, 5, 12]. On the other hand few field studies have been conducted to test the efficacy of plant water extracts in plant protection. A scant literature [2, 8, 13] shows that natural means, including plant water extracts may be applied both for the protection of agronomic plants and vegetables.

Presented work aimed at the estimation of potential applications of plant water extracts of stinging nettle (*Utrica dioica* L.) leaves, birch *(Betula verrucosa Ehrh.)* bark and walnut (*Juglans regia*) leaves in beetroot*(Beta vulgaris* var. conditiva*)* protection against Cercospora leaf spot *(Cercospora beticola)* and root parsley *(Patroselinum crispum)* protection against powdery mildew *(Erysiphe umbelliferarum).*

2. Methods

The field experiments were conducted in 2010-2011 in Wieliczka (near Krakow) on good wheat complex soil. The two-factor experiment was set up in randomised sub-blocks design in three replications. The plant extract (nettle leaves, birch bark and walnut leaves, control – without plant extract application was the first experimental factor, the second factor included the method of application (simultaneously foliar application and to the soil – watering).

The field where the experiment was conducted had been set aside for five years. Sowing of root parsley and beetroot seeds was preceded by a careful mechanical soil tillage. In autumn a deep winter ploughing was carried out, while in

spring a cultivator and harrowing were applied. The seeds were sown in the first decade of April, in rows at 40 cm spacing: parsley, Alba c.v. in the amount of 7kg·ha^{-1}to the depth of 1.5 cm, beetroots, Czerwona Kula c.v. – 700 thousand pieces ·ha^{-1} to the depth of 3cm. The plants were thinned by the end of May leaving 6cm distances for parsley and 8cm for beetroots. The area of a single plot was 5 m^2.

The experiment was conducted in compliance with organic farming principles, where no fertilization was applied and the plants were protected against diseases by means of water extracts from stinging nettle leaves, birch bark and walnut leaves. The extracts were prepared in the 1:3 proportion (the mass of used herb to water), whereas 10% plant extracts were applied to the soil and foliarly (watering 1l·m^{-2}) for beetroot protection against cercospora leaf spot (*C. beticola*) and parsley against powdery mildew (*E. umbelliferarum*). The first foliar and soil application of plant water extracts was performed at the phase of three leaves forming by test plants. The next measure was conducted at the moment when the first disease symptoms appeared on the leaves (3rd decade of June). The subsequent protection measures (foliar and to the soil) were conducted systematically twice a week from the end of June for 6 weeks. The healthiness of beetroot and parsley above-ground parts was evaluated three days after completed application of the tested preparations. The intensity of individual diseases was assessed on 25 plants from each species. The degree of infection was determined on a 9-degree scale (9- healthy leaf blades; 1- spots covering over 50% of the leaf blade). Subsequently, mean infection index was computed according to Townsend and Heuberger [15].

Obtained results were subjected to the analysis of variance and the significance of differences was tested by T-Student test at the significance level α=0.05.

3. Results and discussion

Diversified weather conditions were observed during plant vegetation period. Total precipitation from April to August in the analysed years (2010 and 2011) was higher than the multi annual average (Tab. 1).

Table 1. Weather conditions during plant vegetation 2010-2011
Tab. 1. Warunki pogodowe w okresie wegetacji roślin 2010-2011

Years	Months					Sum
	April	May	June	July	August	
Monthly percipitation sums [mm]						
2010	39.50	294.60	155.50	92.70	127.50	709.80
2011	77.90	60.70	44.40	194.40	70.10	447.50
Mean	58.70	177.65	99.95	143.55	98.80	578.65
1977-2007	50.19	65.26	80.04	74.88	78.50	348.87
Mean monthly temperature [°C]						Mean
2010	9.07	12.60	17.10	20.50	17.90	15.43
2011	10.23	13.67	17.83	17.57	19.20	15.70
Mean	9.65	13.14	17.47	19.04	18.55	15.57
1977-2007	8.12	13.74	16.50	18.19	17.90	14.89

Source: own work / Źródło: opracowanie własne

In 2010 a thrice increase in precipitations in comparison with the multi annual period was noted. Generally, this were more wet and warmer vegetation seasons than in the multi annual period. In 2011 particularly high rainfall was registered in May and July. The excess of precipitations noted in 2010 and their uneven distribution in 2011 affected the plants healthiness (Tab. 2). Average level of beetroot infection with *C. beticola* and parsley by *E. umbelliferarum* in 2010 was significantly higher than in 2011. Similarly, Chmura et al. [5] think that an excess of precipitations increases the degree of plant infection by pathogenic fungi.

Table 2. The average degree of plant infection by pathogenic fungi in the years 2010-2011
Tab. 2. Średni stopień porażenia roślin przez grzyby chorobotwórcze w latach 2010-2011

Years	Diseases			
	Cercospora leaf spot (*C. beticola)*	$LSD_{0.05}$	Powdery mildew parsley *(E. umbelliferarum)*	$LSD_{0.05}$
2010	4.23	1.56	5.98	1.79
2011	7.19		8.46	
Mean	5.71	-	7.22	-

Source: own work / Źródło: opracowanie własne

The first disease symptoms on beetroot and root parsley leaves in 2010 appeared in the first decade of June and in 2011 in the third decade of June. Cercospora leaf spot (*C. beticola*) appeared on beetroot leaves and powdery mildew (*E. umbelliferarum*) on parsley.

Taking into account the quality of agricultural products and environmental protection on organic farms or garden plots, plants are protected against harmful organisms by means of water plant extracts [2, 38]. In the Author's own studies the intensity of beetroot Cercospora leaf spot and powdery mildew of parsley depended on the fungi species, the kind of applied plant water extract and the method of application (Tab. 3, Fig. 1, 2 and 3).

Concerning the analysed plants, beetroot leaves revealed lower average degree of infection with *C.beticola* than parsley infection by *E. umbelliferarum* (Tab. 3). Applied plant water extracts, irrespectively of the application method, significantly diversified beetroot leaves infection by *C. beticola* and parsley by *E. umbelliferarum*. All tested kinds of plant water extracts contributed to a reduction of the development of the fungi causing the above mentioned diseases (Tab. 3, Fig. 1). Boligłowa [2] obtained similar results while testing plant water extracts in potato protection against fungal diseases. The Author's own studies confirmed the principle, that the effect of plant water extracts depended on the used plant material and the pathogenic organism [2]. Regarding Cercospora leaf spot (*C. beticola*) and powdery mildew (*E. umbelliferarum*), the extract of stinging nettle leaves revealed the highest efficiency. Plant protection with this extract led to a significant lowering of the degree and index of beetroot leaves infection with *C. beticola* and parsley infection by *E. umbelliferarum*. In case of beetroot, also extract of birch bark and extract of walnut leaves revealed good effect in protection against Cercospora leaf spot (considering average degree and index of infection). On the other hand, in parsley protection against powdery mildew, extract from nettle leaf extract markedly decreased an average degree and index of plant infection by *E. umbelliferarum*, but only in comparison with the control. Considering the analysed extracts, walnut leaf water extract and birch bark extract revealed a similar efficacy in limiting diseases development.

Table 3. The effect of kind and method of plant water extract application on average degree of beetroot and root parsley leaves infection by selected phytopathogenic fungi (2010-2011).

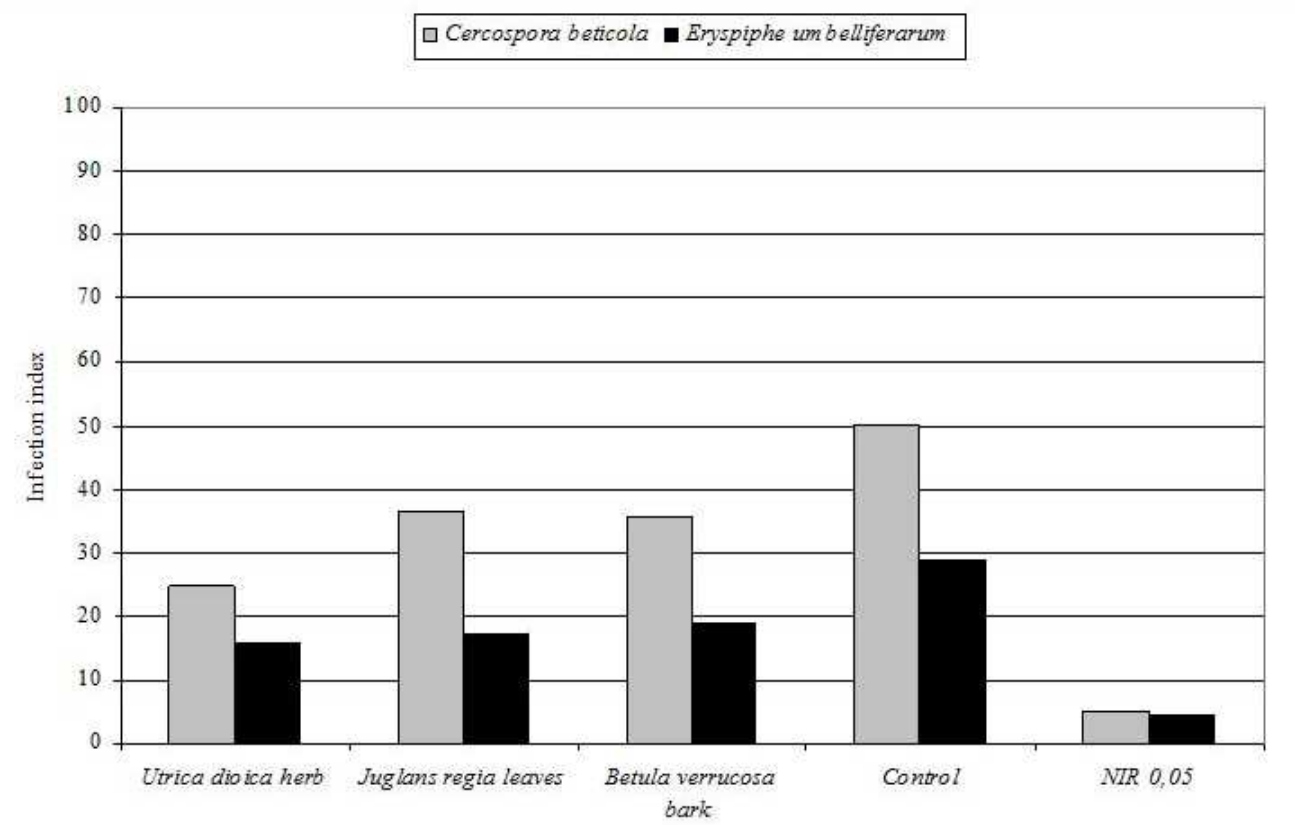
Tab. 3. Wpływ rodzaju i sposobu aplikacji wodnego wyciągu roślinnego na średni stopień porażenia liści buraka ćwikłowego i pietruszki korzeniowej przez wybrane grzyby chorobotwórcze (2010-2011)

Water plant extract	Application method		Mean	LSD $_{0,05}$
	foliar	the soil		
Cercospora leaf spot (*C. beticola)*				
Nettle herb	6.57	7.03	6.80	0.85
The leaves of walnut	5.77	5.67	5.72	
Birch bark papillary	5.50	6.10	5.80	
Control	4.17	4.87	4.52	
Mean	5.50	5.92	5.71	-
LSD $_{0,05}$	0.14		-	
Powdery mildew parsley (*E. umbelliferarum)*				
Nettle herb	7.27	7.87	7.57	0.48
The leaves of walnut	7.27	7.67	7.47	
Birch bark papillary	7.13	7.77	7.45	
Control	6.37	6.43	6.40	
Mean	7.01	7.43	7.22	-
LSD $_{0,05}$	0.20		-	

Source: own work / Źródło: opracowanie własne

In the Author's own studies the method of plant water extracts application also significantly diversified the degree and index of plants infection by analysed disease agents (Tab. 3, Fig. 2 and 3). All plant water extracts supplied to the soil much more strongly limited development of Cercospora leaf spot and powdery mildew on parsley than their foliar application. However, this form of application more efficiently protected parsley against powdery mildew (*E. umbelliferarum*). According to the literature reports [7].

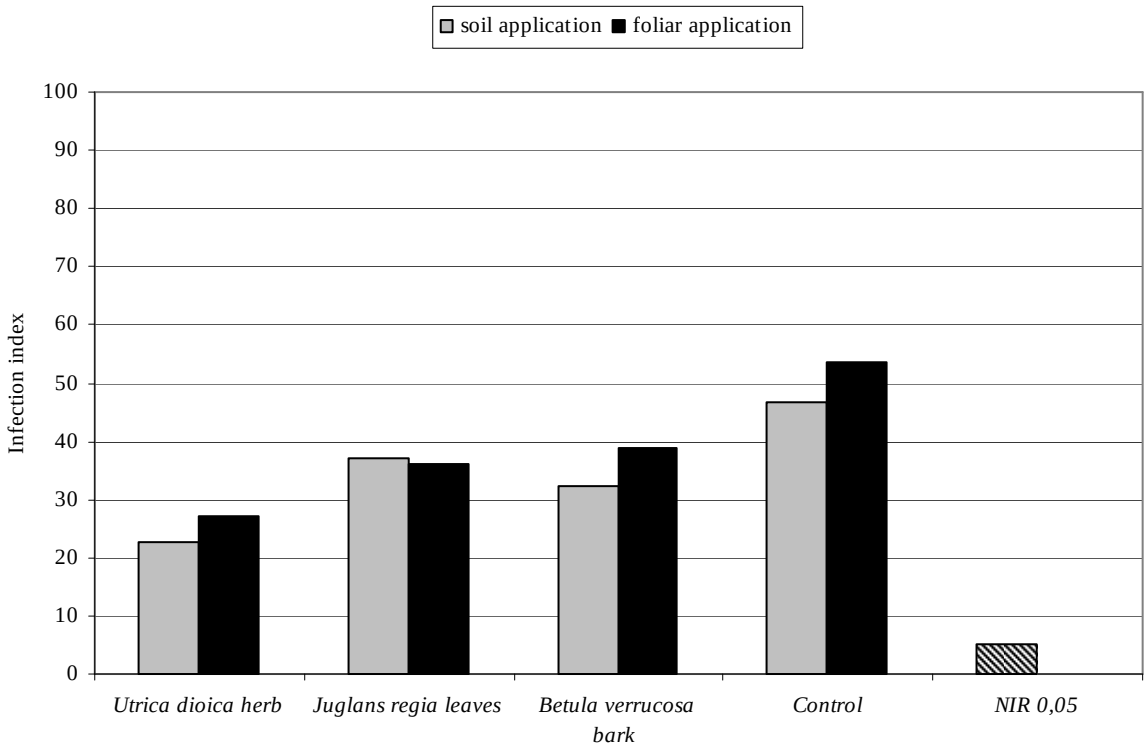
E. umbelliferarum fungus, unlike *C. beticola* is classified to ruthless pathogens developing inside plant cells. Therefore, the soil application of the water extracts proved more efficient because the components of these preparations were better absorbed by the root and strengthened the plant increasing its resistance to diseases (activated defensive mechanisms in this plant) [11]. Considering the compared extracts, water nettle leaf extract applied to the soil best protected beetroots against *C. beticola* (degree and index of infection). Good protective effects were obtained also in result of the plant treatment with other water extracts. water extracts. On the other hand, reduced development of powdery mildew (*E. umbelliferarum*) on parsley leaves was observed in effect of both nettle leaf and birch bark water extracts application to the soil. Generally, soil application of plant water extracts revealed a better efficiency in parsley protection against powdery mildew.



Source: own work / Źródło: opracowanie własne

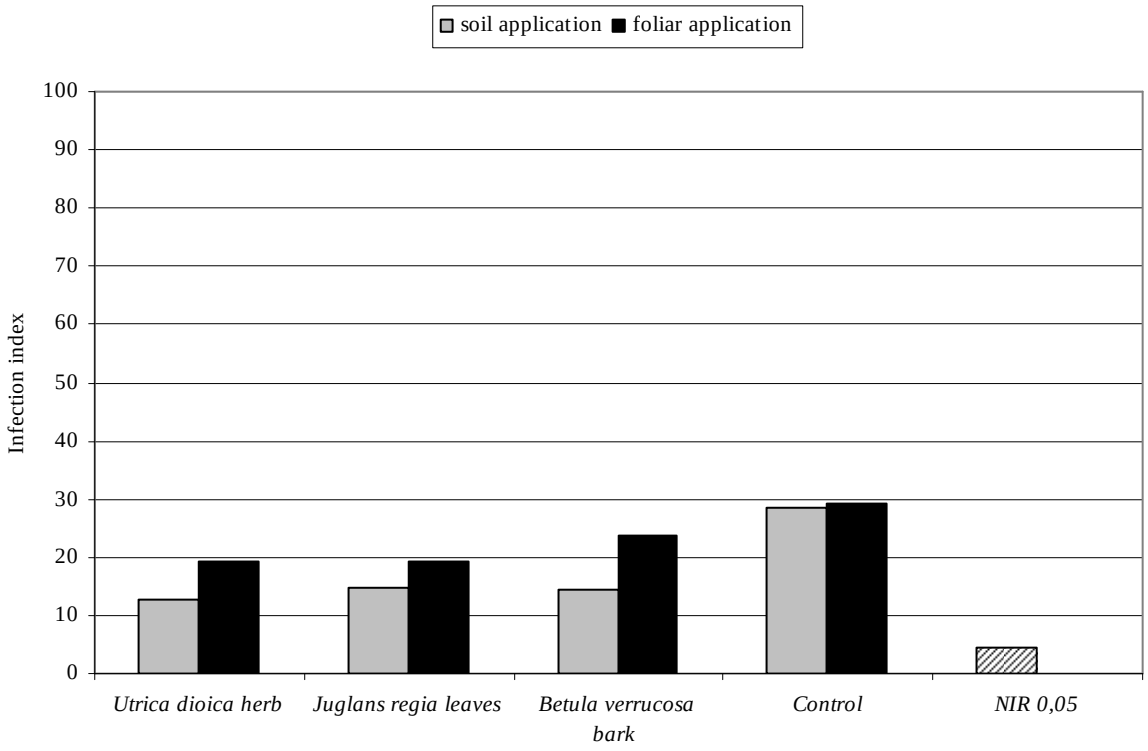
Fig. 1. Mean infection index (ip) of beetroot leaves by Cercospora leaf spot (*C. beticola*) and parsley with powdery mildew (*E. umbelliferarum*) corresponding to the plant water extracts application method (2010-2011)

Rys. 1. Średni indeks (ip) porażenia liści buraków ćwikłowych przez C. beticola (chwościk buraka) oraz pietruszki przez E. umbelliferarum (mączniak prawdziwy) w zależności od sposobu aplikacji wodnych wyciągów roślinnych (2010-2011)



Source: own work / Źródło: opracowanie własne

Fig. 2. Effect of the plant water extracts application method on mean infection index (ip) of beetroot leaves with *C. beticola* (2010-2011).
Rys. 2. Wpływ sposobu aplikacji wodnych wyciągów roślinnych na średni indeks porażenia (ip) liści buraków ćwikłowych przez C. beticola (2010-2011)



Source: own work / Źródło: opracowanie własne

Fig. 3. Effect of the plant water extracts application method on mean infection index (ip) of parsley leaves with *E. umbelliferarum* (2010-2011).
Rys. 3. Wpływ sposobu aplikacji wodnych wyciągów roślinnych na średni indeks porażenia (ip) liści pietruszki przez E. umbelliferarum (2010-2011)

4. Conclusions

1. Nettle leaf water extract revealed the best efficacy in limiting Cercospora leaf spot (*C.beticola*) and powdery mildew of parsley (*E. umbelliferarum*) development.

2. The plant water extracts used to the soil had a better protection effect on root crops (beetroot against Cercospora leaf spot and parsley against powdery mildew) than their foliar application.

3. Inhibitory effect of plant water extracts depended on the kind of used plant material, pathogenic fungus species and the weather conditions during the plant vegetation.

5. References

[1] Boligłowa E., Pisulewska E., Gleń K.: *In vitro* effect of peppermint (*Mentla xpiperita* L.var. *officinalis*) water extracts on Fusarium fungi. Herba Polonica, 2007, vol. 53, No.3: 33-40.

[2] Boligłowa E.: Ochrona ziemniak przed chorobami w uprawie ekologicznej. Wybrane zagadnienia ekologiczne we współczesnym rolnictwie, red. Z. Zbytek, Monograf., PIMR Poznań, 2004: 9-14.

[3] Burgieł Z.J.: Fungistyczna aktywność wodnych wyciągów z ziela pokrzywy zwyczajnej (*Urtica dioica)* i korzeni żywokostu lekarskiego (*Symphytium officinale*). Pestycydy, 1995, (4): 21-25.

[4] Burgieł Z. J.: Badania nad możliwością wykorzystania wybranych roślin z rodziny *Brassicaceae* w ochronie ogórka przed zgorzelą siewek powodowaną przez *Rhizoctonia solani* Kühn i *Fusarium culmorum (W.G. Smith) Sacc.* Acta Agrobotanica, 2005, Vol. 58. (2): 171-178.

[5] Chmura K., Chylińska E., Dmowski Z., Nowak L. Rola czynnika wodnego w kształtowaniu plonu wybranych roślin polowych. Infrastruktura i Ekologia Terenów Wiejskich, PAN, 2009, 9,: 33-35.

[6] Kodeks Dobrej Praktyki Rolniczej. MRiRW, 2004: ss.95.

[7] Kryczyński S., Weber Z.: Fitopatologia, T. 1, PWRiL Poznań, 2010, 206-294.

[8] Lipa J.J. 2003. Ochrona roślin w rolnictwie ekologicznym – możliwości a potrzeby. Post. w Ochr. Roślin Vol.43(1): 231-241.

[9] Łakota S., Kwiatkowski M., Czerwiński Z.: Możliwości wykorzystania związków pochodzenia roślinnego do zwalczania szkodników i patogenów roślin. Pestycydy, 1993, 1: 29-33.

[10] Matyjaszczyk E.: Dostępność środków ochrony roślin zawierających substancje pochodzenia naturalnego i biologicznych metod ochrony roślin w Polsce w przededniu wprowadzenia obowiązku stosowania integrowanej ochrony roślin. J. Res., Applicat. Agricult. Engineering, 2012, Vol. 57 (4), 38-43.

[11] Orlikowski L.B., Skrzypczak Cz., Wojdyła A., Jaworska-Marosz A.: Wyciągi roślinne i mikroorganizmy w ochronie roślin przed chorobami. Zesz. Nauk. AR w Krakowie , 2002, 387, Ses. Nauk. 82: 19-32.

[12] Ribera A., Cotoras M., Zúñiga G. E.: Effect of extracts from in vitro-grown shoots of *Quillaja saponaria* Mol. on *Bortytis cinerea* Pers. World Journal Microbiology and Biotechnology, 2008, Vol.24: 1803-1811.

[13] Sas-Piotrowska B., Puiotrowski W.: Oddziaływanie wyciągów roslinnych na żywotność i zdrowotność korzeni roślin strączkowych inokulowanych *Pytium debarynum* (Hesse). Rocznik Ochrony Środowiska, 2006: 263-278.

[14] Tomalak M.: Rolnictwo ekologiczne nowym wyzwaniem dla biologicznych metod ochrony roślin. Prog. Plant Protect./Post. Ochr. Roślin, 2005, Vol.45(1): 496-503.

[15] Wenzel H.: Zur Erfassung des Schadenausmasses in Pflanzenschutzversuchen. Pflanzenschuzberichte,1948, 15: 81-84.

This work was supported by the University of Agriculture in Krakow [DS3109/KOSR].
Praca finansowana w ramach środków DS3109/KOSR.