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Plant extracts in protection of strawberry (*Fragaria vesca* L.) against *Botrytis cinerea* Pers. (Berg.)

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1. Introduction

Strawberry is cultivated in Poland on the area of about 50,000 ha, out of which 80% falls to the variety 'SENGA-SENGANA' (Cianciara 1991). It is a variety of low resistance to the infection with *Botrytis cinerea* Pers. (Berg.) – the fungus causing grey mould. A strong infection of plants caused by the pathogen can result in losses as high as 80%.

The pathogen infects all the plant organs, however the most severe impact on the yield has the infection of flowers and the fruit. Rebandel (1988) has observed that the infection of flowers ranging 1÷5% can reduce the fruit yield by 13÷20%, while flower infection ranging 5÷10% results in the yield drop of 17÷30%. Infection of strawberry flowers goes on very quickly, not only at a heavy rainfall. It is also promoted by a high air moisture level as well as night dews. That is why obtaining strawberry yields of good quality can be secured only by proper protective measures. Spraying with chemicals is very common.

The objective of the study was to determine the usefulness of plant extracts for protection of strawberry against *Botrytis cinerea*, a fungus causing grey mould. Their activity was compared with fungicides recommended for such treatments.

2. Materials and methods

The experiments were carried out under laboratory and field conditions. Laboratory experiment included:

- water extracts (macerates, brews) prepared from 13 plant species: *Poly-*

gonum sachalinense (F.Smidt), *P.hydropiper* (L.), *P.persicaria* (L.), *P.bistorta* (L.), *P.convolvulus* (L.), *P.aviculare* (L.), *Urtica dioica* (L.), *Levisticum officinale* (Koch.), *Allium sativum* (L.), *Pelargonium odoratissinum* (L.), *Humulus lupulus* (L.), *Agropyron repens* (L.), *Heracleum sphondylium* (L.)

- as well as alcohol and acetone extracts from *P.sachalinense*, *P.hydropiper*, *P.persicaria*, *P.bistorta*, *P.convolvulus*, *P.aviculare*.

The following chemical preparations were used: SUMILEX 50 WP (procimidone), ROVRAL 50 WP (iprodione), EUPAREN 50 WP (dichlofluanide), RONILAN 50 WP (winclozoline), SADOPLON 75 WP (thiram), THIRAM-GRANUFLO 80 WG (thiram).

The in vitro activity of the preparations against the fungus *Botrytis cinerea* Pers. (Berg.) was assessed in the laboratory by a diffusion in agar-agar (PDA). The evaluation criterion was the size of the zone of retarded growth of the fungal colony. The way of preparation of plant extracts for tests and description of experiments was described in the earlier papers (Sas-Piotrowska et al. 1996, Sas-Piotrowska and Piotrowski 1997). The experiment was carried out in two terms and four replications, six Petri dishes for each preparation.

The field experiment was carried out on a plantation of strawberry cv. 'SENGA-SENGANA' for three years. It was settled as randomised blocks with five replications. A plot had 20 plants in a row system with a distance of 25cm within it and 80cm between the rows. Spraying was done with:

Sadoplon 75 WP → Sumilex 50 WP → Euparen 50 WP

Polygonum persicaria	(alcohol extract)
Polygonum hydropiper	(alcohol extract)
Polygonum bistorta	(alcohol extract)
Polygonum aviculare	(acetone extract)
Allium sativum	(macerate)
Levisticum officinale	(macerate)
Urtica dioica	(brew)

The treatment was performed in three terms recommended by the Institute for Plant Protection in Poznań, i.e. at the moment when about 10% flowers were developed in an inflorescence. Non-sprayed plants were the control.

The fruit were harvested in dependence of the weather (8 – 10 times) in two-days intervals. Weight of healthy fruit (g per plant) as well as the percentage of fruit infected with B. cinerea were evaluated each time.

The results of both experiments were analysed statistically by variation analysis and Duncan test at P=95%.

3. Results

3.1. Laboratory experiment

The in vitro activity of the preparations against *Botrytis cinerea* was significally differentiated (Table 1). Sadoplon 75 WP and Thiram-Granuflo 80 WG were the most active fungicides limiting the growth of *B.cinerea*, while Euparen 50 WP was not very active. Out of 38 plant extracts under study only 25 (65.8%) reduced more or less the growth rate of pathogen colony.

Alcohol extracts from *P.persicaria* and *P.bistorta* as well as acetone extract from *P.aviculare* were active to an extent similar to Euparen, while somewhat less active were alcohol extracts from *P.aviculare* and *P.hydropiper*, acetone extract from *P.convolvulus* and a brew from *Urtica dioica*. Activity of the remaining 13 extracts not mentioned in the Table 1 was similar to the control.

It is worth mentioning that the way of plant extracts preparation was very important for their activity. Macerates prepared from polygonum plants, lovage, spear-grass and geranium were more active than the respective brews (Fig. 1). However, in case of nettle, garlic, chops and hogweed brews were better, while substances extracted with alcohol and acetone from polygonum plants were more active than brews (Fig. 2).

3.2. Field experiment

Thermal and moisture conditions of the study period were benevolent for the *B.cinerea* growth.

In the first year rainfall was lower and mean air temperature higher than multi-year mean. Fruit harvest started on 23rd June. In the first two terms fruit infection reached about 30%, gradually decreasing to 5%. In the last term 23% of the total fruit number was infected.

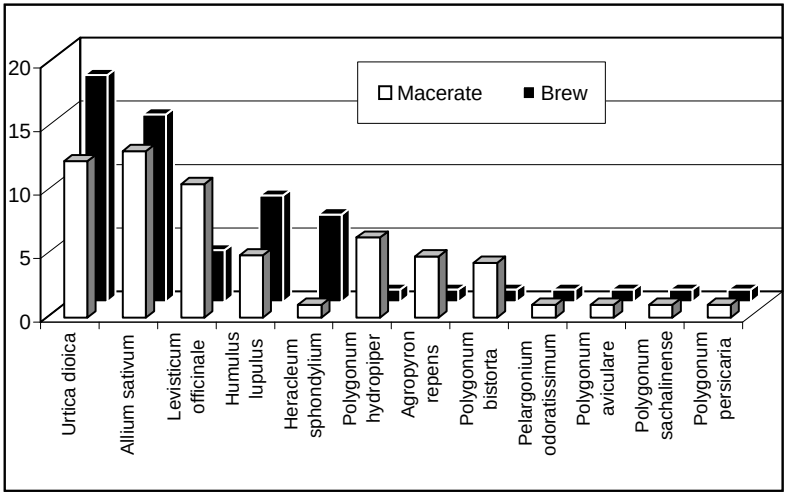
In the second year rainfall was much higher than the multi-year mean. Frequent and abundant rainfalls caused a permanent wetting of the plants. Mean month temperature was close to the multi-year mean. The first harvest was done on 19th June. Fruit infection was the highest at that time and reached almost 100%. In the following terms the infection degree was decreasing reaching about 33%.

Similarly, in the third year of the study the rainfall sum was higher than the average, while air temperature was a great deal lower. The harvest started on 14th June. Infection was evaluated for 11.5% at the beginning, reaching 41% of the collected fruit at the end of harvest.

Table 1. Zone of retarded growth of *B.cinerea* as affected by fungicides and plant extracts
Tabela 1. Strefa zahamowania wzrostu *B.cinerea* pod wpływem fungicydów i wyciągów roślinnych

Preparations preparaty	Extracts Ekstrakty	Ø in mm Ø w mm	Duncan's test Test Duncan'a
Sadoplon 75 WP	-	59,5	a
Thiram-Granuflo 80 WG	-	52,9	ab
Sumilex 50 WP	-	45,0	bc
Ronilan 50 WP	-	38,6	cd.
Rovral 50 WP	-	38,1	cde
Euparen 50 WP	-	33,0	de**f**
Polygonum persicaria	Alcohol	27,4	**f**g
Polygonum avivulare	Acetone	26,0	**f**gh
Polygonum bistorta	Alcohol	24,9	**f**gh
Polygonum avivulare	Alcohol	20,0	ghi
Polygonum hydropiper	Alcohol	18,5	ghi
Urtica dioica	Brew	17,9	hi
Polygonum convolvulus	Acetone	17,0	hi
Allium sativum	Macerate	14,8	i
Polygonum bistorta	Acetone	14,6	i
Allium sativum	Brew	13,1	ij
Polygonum persicaria	Acetone	12,5	ij
Urticas dioica	Macerate	12,3	ij
Polygonum convolvulus	Alcohol	12,0	ij
Levisticum officinale	Macerate	10,5	ij
Polygonum hydropiper	Acetone	10,1	ij
Humulus lupulus	Brew	8,4	j
Polygonum sachalinense	Acetone	7,6	j
Heracleum sphondylium	Brew	6,9	j
Polygonum sachalinense	Alcohol	6,8	j
Polygonum hydropiper	Macerate	6,3	j
Polygonum convolvulus	Macerate	5,6	j
Humulus lupulus	Macerate	4,9	j
Agropyron repens	Macerate	4,8	j
Polygonum bistorta	Macerate	4,3	j
Levisticum officinale	Brew	4,1	j
Control*	-	0,0	j

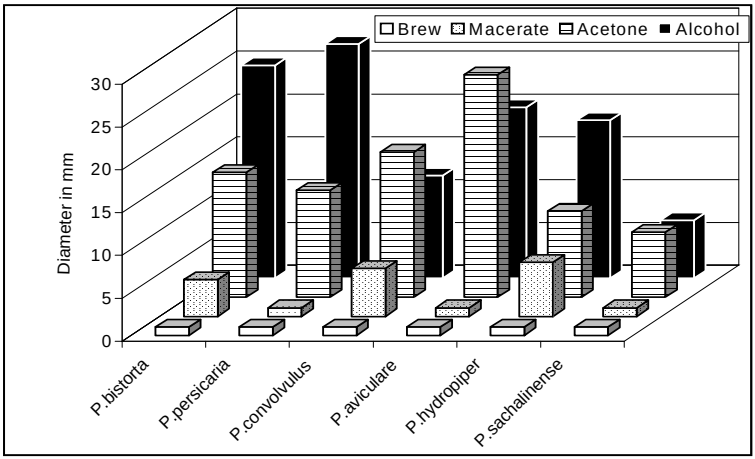
* – activity of the remaining 13 extracts was on the control level
* – aktywność pozostałych 13 wyciągów na poziomie kontroli



Macerate – macerat; brew - napar

Fig. 1. Zone of retarded growth of *Botrytis cinerea* colonies caused by plant macerates and brews (diameter in mm)

Rys. 1. Strefa zahamowania wzrostu kolonii *Botrytis cinerea* przez maceraty i napary roślinne (średnica w mm)



brew – napar; macerate – macerat; acetone – aceton; alkohol – alkohol

Fig. 2. Zone of retarded growth of *Botrytis cinerea* colonies caused by polygonum plants extracts

Rys. 2. Strefa zahamowania wzrostu kolonii *Botrytis cinerea* przez wyciągi z roślin rdestowatych

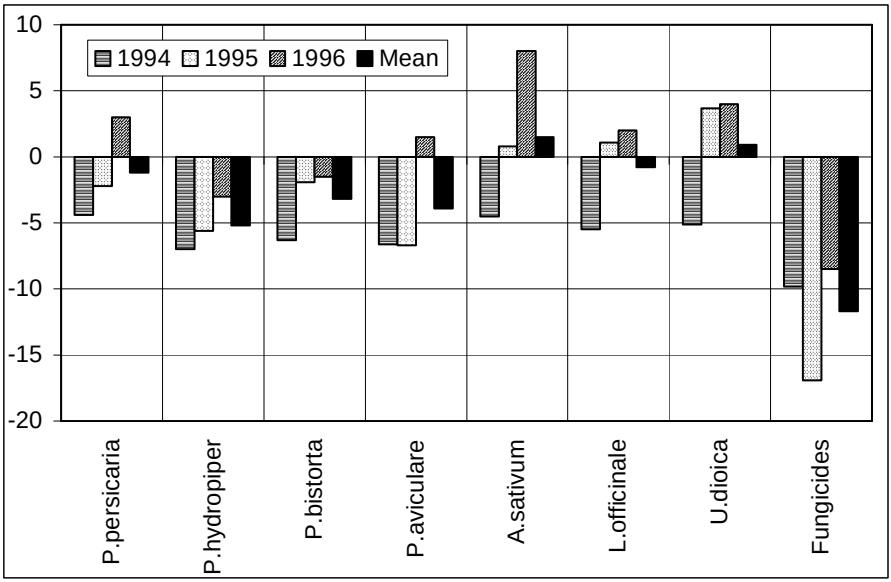


Fig. 3. Number of strawberry fruit infected with *Botrytis cinerea* (deviation from the control [%])

Rys. 3. Liczba owoców truskawki porażonych przez *Botrytis cinerea* (odchylenie od kontroli w %)

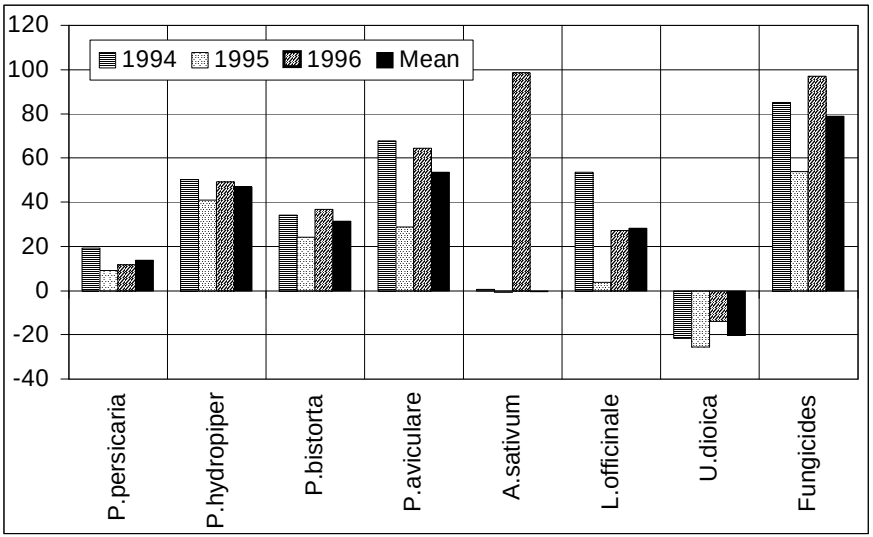


Fig. 4. Yield of healthy strawberry fruit (deviation from the control per plant)

Rys. 4. Plon zdrowych owoców truskawki (odchylenie od kontroli w gramach/roślinę)

The effects of the preparations on fruit health differed a lot. Alternative spraying with Sadoplon 75 WP, Sumilex 50 WP and Euparen 50 WP limited the infection level of fruit the most strongly (Fig. 3). Fruit collected from plants of this combination were the most healthy (Fig. 4). The effectiveness of plant extracts was lower than that of fungicides. Extracts from *P.aviculare*, *P.hydropiper* and *P.bistorta* limited the number of infected fruit and increased the yield of healthy fruit. Substances contained in the *Urtica dioica* brew promoted infection of the fruit with *B.cinerea*, therefore causing also a drop in the yield of healthy fruit.

4. Discussion

Fighting diseases and pests of strawberry is one of the most basic treatments on a plantation. Plant protection against the fungus *Botrytis cinerea* is apparently simple because of numerous fungicides on the market recommended in this case. However, considering their phytotoxicity, formation of fungus strains resistant to them, and last but not least environmental issues, a need for alternative solutions for protection of plantations arises.

The results have indicated that Sadoplon 75 WP and Thiram-Granuflo 80 WG were the most effective fungicides. However, this finding is in a discrepancy with the results of in vitro studies reported by Machowicz-Stefaniak (1994). The author has found that Sadoplon 75 WP, Sumilex 50 WP, Euparen 50 WP should be included into a fungicide group of poor anti-fungal activity against *B.cinerea*. The most active ones were Ronilan 50 WP and Rovral 50 WP. According to Meszka and Bielenin (1997) Sumilex 50 WP and Sumico 50 WP are very effective preparations in the protection of strawberry fruit against grey mould.

Considering biological effectiveness of the treatment and limiting the possibility of creation of resistant fungal strains Goszczyński (1994) has recommended the use of mixtures of dicarboxymide preparations with Thiram-Granuflo in the ratio 1 : 2. An important problem is also lowering the rates of chemical preparations, what improves the healthiness of edible fruit (Kaniuczuk 1989) and reduced the concentration of pesticide residues (Makosz and Karpiel 1994), especially those which cumulate easily: dichlofluanide (Euparen 50 WP) and iprodione (Rovral 50 WP).

The facts mentioned above indicate the need for a complex protection of strawberry plantations comprising chemical, mechanical and biological methods (Żurawicz 1994). One of the latter is utilisation of fungicidal properties of plant extracts (Sas-Piotrowska and Piotrowski 1995). Roughly 85% plants excrete to the environment chemical compounds side-affecting other organisms.

Some of them or their synthetic analogues found practical application in plant protection (nicotine, garlic, pyretroids).

As has been shown in this study, alcohol extracts from *Polygonum persicaria* and *P.bistorta* as well acetone extract from *P.aviculare* limited the in vitro growth of *B.cinerea* most efficiently. On the other hand, in the field study alcohol extracts from *P.bistorta* and *P.hydropiper* were most active. It corroborates with earlier reports on a high fungicidal activity of *P.bistorta* (Sas-Piotrowska and Piotrowski 1995, 1996). This plant contains about 25% hydrolysing (derivatives of gallic acid) and non-hydrolysing (derivatives of pyrocatechine) tannins, a high concentration of free phenolic acids, the compounds considered fungal growth inhibitors. Besides, tannins found in this plant have a disinfective activity destroying various bacterial strains (Ożarowki 1976).

Results of laboratory experiments were somewhat contradictory to those of field experiments. In the in vitro investigations garlic and nettle extracts strongly inhibited the growth of *B.cinerea* colonies, while in the in vivo experiments the same extracts were not very active. Therefore, these findings are in a discrepancy with the data of Schmidtke (1995).

Some effects of the in vitro activity of the extracts (*P.persicaria*, *P.aviculare*, *P.bistorta*) were similar to those of classic fungicides (Euparen 50 WP). Their activity in the field experiments was lower than that of fungicides used alternatively. However, an important factor is that the extracts tested did not contain any assisting substances, such as stabilisers, synergetics, etc., usually added to classic fungicide preparations.

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Wyciągi roślinne w ochronie truskawki (*Fragaria vesca* L.) przed *Botrytis cinerea* Pers. (Berg.)

Streszczenie

Celem badań było określenie przydatności wyciągów (wodnych, acetonowych i alkoholowych) sporządzonych z 13 gatunków roślin do ochrony plantacji truskawki (Fragaria vesca L.) przed sprawcą szarej pleśni (*Botrytis cinerea* Pers. (Berg.). Aktywność in vitro i in vivo wyciągów roślinnych porównywano z aktywnością fungicydów zalecanych do ochrony tej rośliny.

Wykazano, że aktywność in vitro wyciągów z *Polygonum persicaria* (L), *P.aviculare* (L) i *P.bistorta* (L) była porównywalna z aktywnością EUPARENU 50 WP. Skuteczność in vivo wyciągów była niższa aniżeli stosowanych przemiennie fungicydów Sadoplon, Sumilex i Euparen.

Niniejszy artykuł ukazał się w całości w języku polskim w Roczniku Ochrony Środowiska Tom 3 Rok 2001. W związku z licznymi zapytaniami ośrodków zagranicznych, do których dociera nasze czasopismo i zainteresowaniem pełną treścią tego artykułu, Redakcja postanowiła wydrukować go ponownie w niniejszym Tomie w języku angielskim.