DOI: 10.21005/AAPZ2016.40.4.01

FOLIA POMERANAE UNIVERSITATIS TECHNOLOGIAE STETINENSIS
Folia Pomer. Univ. Technol. Stetin., Agric., Aliment., Pisc., Zootech. 2016, 330(40)4, 7–18

Iwona ADAMSKA, Magdalena DZIĘGIELEWSKA[1]

COLONIZATION OF SELECTED ROSE VARIETIES BY PESTS AND PATHOGENS

ZASIEDLENIE WYBRANYCH ODMIAN RÓŻ PRZEZ SZKODNIKI I PATOGENY

Department of Ecology, Environmental Protection and Development, West Pomeranian University of Technology, Szczecin, Poland
[1]Department of Plant Physiology and Biochemistry, West Pomeranian University of Technology, Szczecin, Poland

Streszczenie. W latach 2014–2015 przeprowadzono badania nad występowaniem szkodników i grzybów mikroskopowych zasiedlających róże Ogrodu Miejskiego „Różanka" w Szczecinie. Monitoringiem objęto wybrane taksony róż: *Rosa thea hybrida* (odmiany 'Alchymist', 'Aspirin Rose', 'Blaze Superior', 'Carina', 'Die Welt', 'Fairy', 'Flamingo', 'Flammentanz', 'Gloria Dei', 'Goldstern', 'Ingrid Bergman', 'Mr Lincoln', 'Muttertag Orange', 'Santana' i 'Sommerwind'), *R.* x *centifolia* (odmianę 'Petit De Holand') oraz na *R. rugosa***.** Określono skład gatunkowy szkodników i grzybów mikroskopijnych oraz preferowanych żywicieli. Stwierdzono, że występowanie szkodników i grzybów zależało od odmiany róży, terminu prowadzonych obserwacji i od obecności innych czynników biologicznych. Odnotowano występowanie antagonistycznych zależności pomiędzy szkodnikami a grzybami zasiedlającymi badane odmiany róż. Najmniejszym stopniem zasiedlenia zarówno przez szkodniki, jak i grzyby cechowała się odmiana *R.* 'Ingrid Bergman'.

Key words: rose, fungi, diseases, pests, susceptibility to diseases, susceptibility to pests, rose varieties.
Słowa kluczowe: róża, grzyby, choroby, szkodniki, podatność na choroby, podatność na szkodniki, odmiany róż.

INTRODUCTION

High aesthetic value and resistance to pollution, especially exhaust fumes, make roses particularly suitable for urban planting. The genus *Rosa* is rich in species [their number is estimated to range from 120 (Seneta and Dolatowski 2005) to 200 (Bugała 2000), with some sources reporting as many as 400 species (Popek 2002) and varieties (estimated at ca. 20 000). Its representatives are widely distributed throughout the world occurring both naturally and as cultivations (Popek 2002). The appearance of the flowers, leaves and fruit determines the value of roses as ornamentals. However, these plant structures are often damaged by pests or pathogenic infections that considerably affect their landscape-forming quality. The diversity of species and varieties belonging to the genus is high and individual resistance to colonization by pathogens and pests varies (Blechert and Debener 2005; Carlson-Nilsson

Corresponding author – Adres do korespondencji: Iwona Adamska, Department of Ecology, Environmental Protection and Development, West Pomeranian University of Technology, Szczecin, Juliusza Słowackiego 17, 71-434 Szczecin, Poland, e-mail: iwona.adamska@zut.edu.pl

and Davidson 2006; Whitaker et al. 2007). This spectrum of resistance is evident in dendrological gardens and rosaria where plants are exposed to the same environmental factors acting with similar intensity and the development and vigour of different varieties can easily be evaluated under these conditions.

Black spot is the most serious disease of the majority of rose species and varieties. It is caused by a fungus *Marssonina rosae* (Lib.) Diet., which is the perfect stage of the fungus *Diplocarpon rosae* F. A. Wolf. Other persistent diseases include rose powdery mildew caused by *Podosphaera pannosa* (Wallr.) de Bary (Wojdyła et al. 2007) and rust whose causative agents may include four species of fungi of the genus *Phragmidium*: *P. fusiforme* Schröt., *P. mucronatum* (Pers.) Schltdl., *P. rosae-pimpinellifoliae* Dietel and *P. tuberculatum* Jul. Müll. (Majewski 1977). These phytophages mostly feed on leaves and/or shoots considerably weakening the plant.

Breeding work aims to produce varieties resistant to disease and damage by pests (Vukosavljev et al. 2013; Debener and Byrne 2014). Research into ornamental properties, vigour and resistance to abiotic and biotic factors of selected varieties is conducted in eleven Bund deutscher Baumschulen research centres in Germany. Roses are tested for three years and those plants that meet a range of criteria are awarded the Allgemeine Deutsche Rosenneuheitenprüfung (ADR) certificate confirming their high quality. Only a few roses receive the laureate status and the certificate may be withdrawn if a cultivar's resistance is found to have decreased upon subsequent test (Performance testing of…, http://www.adr--rose.de/englisch/e_index.htm).

Species richness and species composition of microscopic fungi colonizing selected host species (roses, maples and apple trees) were evaluated during preliminary investigations into plant vigour in the "Różanka" City Garden in Szczecin in the years 2010–2011 (Adamska et al. 2012). The diversity of species and varieties of the genus Rosa was not examined at that time. The present study aims to determine the colonization of selected rose taxa cultivated in the ground to major pests and pathogens.

MATERIAL AND METHODS

Investigations were conducted in the „Różanka" City Garden in Szczecin in the years 2014–2015. The plant material was observed and sampled every two weeks from the first week of May until the last week of October each year. Overground parts (leaves and stems) of selected species and varieties of roses were sampled. The following taxa were selected for analysis: *Rosa thea hybrida* (varieties: *R*. 'Aspirin Rose', *R*. 'Fairy', *R*. 'Sommerwind', *R*. 'Alchymist', *R*. 'Blaze Superior', *R*. 'Flammentanz', *R*. 'Goldstern', *R*. 'Santana', *R*. 'Carina', *R*. 'Die Welt', *R*. 'Flamingo', *R*. 'Gloria Dei', *R*. 'Ingrid Bergman', *R*. 'Mr Lincoln' and *R*. 'Muttertag Orange'), *R.* x *centifolia* (variety: 'Petit De Holand') and *R. rugosa*. The plants were surveyed and only fragments colonized or damaged by pathogens or pests were collected for laboratory examinations.

Examined 20 randomly selected shrubs of each variety, exceptions to roses *R*. 'Alchymist', *R*. 'Blaze Superior', *R*. 'Goldstern', *R*. 'Flammentanz', *R*. 'Santana' and *R.* x *centifolia* 'Petit De Holand' and *R. rugosa*, which numbers in the garden 'Różanka' is too small (the data on these varieties not included in the statistical analysis of results).

Taxa of pathogens and pests were identified in laboratory conditions based on morphological and morphometric characters. Taxa of microscopic fungi were determined using structures formed by them (spores and stems) revealed in cut and scraped preparations derived from fresh study material. Guides and keys to pathogens were used for identification (Brandenburger 1985; Braun 1987; Kochman and Majewski 1970; Majewski 1977). Pest species were determined based on entomological keys available (Boczek 2001).

The pests were identified to species based on morphological and morphometric features and the symptoms of damage of the leaves. Adopted the following scale damage for pests without aphids: 0 – no visible damage of the leaves; 1 – to 10% surface of the leaves damaged by pests; 2 – from 10% to 25% surface of the leaves damaged by pests; 3 – from 25% to 70% surface of the leaves damaged by pests; 4 – more than 70% surface of the leaves damaged by pests. The scale of damage for aphids: 0 – the leaves without aphids; 1 – to 10% of the leaves with aphids; 2 – from 10% to 25% of the leaves with aphids; 3 – from 25% to 70% surface of the leaves with aphids; 4 – more than 70% surface of the leaves with aphids.

The degree of damage caused by pathogens determined according to the scale: 0 – no symptoms and structures of pathogen on leaves and flowers; 1 – from 0,1 to 5% leaves or flowers with symptoms and structures of pathogen; 2 – from 6 to 15% leaves or flowers with symptoms and structures of pathogen; 3 – form 16 to 25% leaves or flowers with symptoms and structures of pathogen; 4 – from 26 to 40% leaves or flowers with symptoms and structures of pathogen; 5 – more than 40% leaves or flowers with symptoms and structures of pathogen.

The diversity of susceptibility of rose species and varieties to pests and pathogens was evaluated according to the principle of Łabanowski and Soika (2008). The richness of species occupying and damaging the species and varieties of roses in both years of study was recognized as the main criterion. Rose taxa were divided by pathogen- and pest preference into four groups. Group I consisted of species and varieties on which no or only one taxon of pathogen and/or pest was found (very low colonization degree). Group II comprised species and varieties of roses inhabited and damaged by 2–3 taxa of pathogens and/or pests (low colonization degree). Group III was formed by roses colonized and damaged by 4–5 taxa of pathogens and/or pests (medium colonization degree) and Group IV was composed by roses colonized and damaged by over 5 taxa of pathogens and/or pests (high colonization degree).

Determined the relationship between the presence of pathogens and pests on the plants and the influence of some environmental conditions on the occurrence of pests and pathogens (calculated correlation coefficient between the number of pest species and number of fungal species, and the correlation coefficients between the humidity and the air temperature and the number of fungal and pest species; Statistica 12.5).

RESULTS AND DISCUSSION

A total of ten taxa of pathogens and nine species of pests colonizing overground shoots of roses were recorded in the study conducted in the years 2014–2015 (Table 1, 2). Different numbers of pathogens and pests occurring on specific species and varieties of roses were detected in the analysis (Fig. 1).

Table 1. List of pests and pathogens
Tabela 1. Lista szkodników i patogenów

Pests – Szkodniki	Fungi and fungus-like organisms Grzyby i organizmy grzybopodobne (FLO)
Arachnida, Acari, Tetranychidae: *Tetranychus urticae* Koch Insecta, Homoptera, Aphididae: *Macrosiphum rosae* L. Insecta, Homoptera, Cicadellidae: *Edwardsiana rosae* L. Insecta, Hymenoptera, Tenthredinidae: *Allantus viennensis* Schrank, *Ardis brunniventris* Htg., *Blennocampa pusilla* Klg, *Endelomyia aethiops* Gmelin Insecta, Lepidoptera, Geometridae: *Operophtera brumata* L. Insecta, Lepidoptera: *Tortricidae*	*Chromista, Oomycota* (FLO)*: Peronospora sparsa* Berk. *Fungi, Basidiomycota: Phragmidium mucronatum* (Pers.) Schltdl. *Fungi, Ascomycota: Alternaria alternata* (Fr.) Keissl., *A. brassicae* (Berk.) Sacc., *Botrytis cinerea* Pers., *Cladosporium* spp., *Epicoccum nigrum* Link., *Marssonina rosae* (Lib.) Died., *Oidium* spp., *Sphaceloma rosarum* (Pass.) Jenkins

Table 2. Colonization degree of roses by pests and pathogens
Tabela 2. Stopień zasiedlenia róż przez szkodniki i patogeny

Colonization degree[a] Stopień zasiedlenia	Rose varieties Odmiany róż	
	colonization by pests zasiedlenie przez szkodniki	colonization by pathogens zasiedlenie przez patogeny
I	–	*R.* 'Blaze Superior'
II	*R.* 'Fairy', *R.* 'Flamingo', *R.* 'Gloria Dei', ***R.* 'Ingrid Bergman'**	*R.* 'Alchymist', *R.* 'Flammentanz', *R.* 'Goldstern', ***R.* 'Ingrid Bergman'**, *R.* 'Santana', *R.* 'Sommer--wind', *R.* x *centifolia* 'Petit De Holand', *Rosa rugosa*
III	***R.* 'Aspirin Rose'**, *R.* 'Carina', *R.* 'Die Welt', *R.* 'Flammentanz', *R.* 'Goldstern', ***R.* 'Mr Lincoln'**, ***R.* 'Muttertag Orange'**, *R.* 'Santana', *R.* 'Sommerwind', *R. rugosa*	***R.* 'Aspirin Rose',** *R.* 'Die Welt', *R.* 'Fairy', *R.* 'Flamingo', ***R.* 'Mr Lincoln', *R.* 'Muttertag Orange'**
IV	*R.* 'Alchymist', *R.* 'Blaze Superior', *R.* x *centifolia* 'Petit De Holand'	*R.* 'Carina', *R.* 'Gloria Dei'

[a]Colonization degree – Stopień zasiedlenia: I – very low – bardzo niski, II – low – niski, III – medium – średni, IV – high – wysoki.
Varieties which were equally colonized by pests and by pathogens are given in bold in the table – Odmiany, w przypadku których stopień zasiedlenia przez szkodniki był równy stopniowi zasiedlenia przez patogeny, wyróżniono pogrubionymi literami.

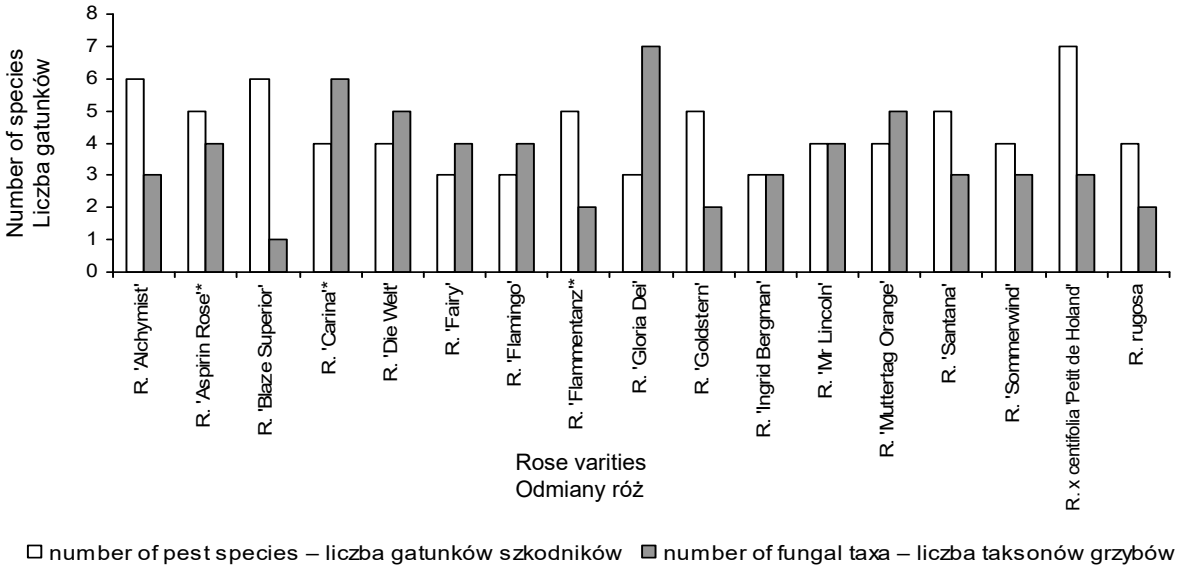

Fig. 1. The number of pests and fungal species on selected varieties of roses in the season 2014–2015. *ADR – certified varieties
Ryc. 1. Liczba gatunków szkodników i grzybów stwierdzonych na różach wybranych odmian w latach 2014–2015. *Odmiany posiadające certyfikat ADR

The present observations show that rose colonization by pests depended on the rose variety (Fig. 1), observation date (May-October) and the occurrence of fungal pathogens which often acted antagonistically on pests (Fig. 2–3). The greatest number of pest species was observed on overground parts of a *R.* x *centifolia* variety, 'Petit de Holand' (7), while that of fungal taxa on 'Gloria Dei' (7). Leaves and shoots of the latter ('Gloria Dei') were also least frequently occupied by pests (three species) while the smallest richness of fungal taxa was noted for the climber *R*. 'Blaze Superior' (one species). Shoots and leaves of ADR-certified varieties that and are tested for resistance to biotic factors (*R*. 'Aspirin Rose', *R*. 'Carina' and *R*. 'Flammentanz') were both infected by microscopic fungi and damaged by insects (Fig. 1).

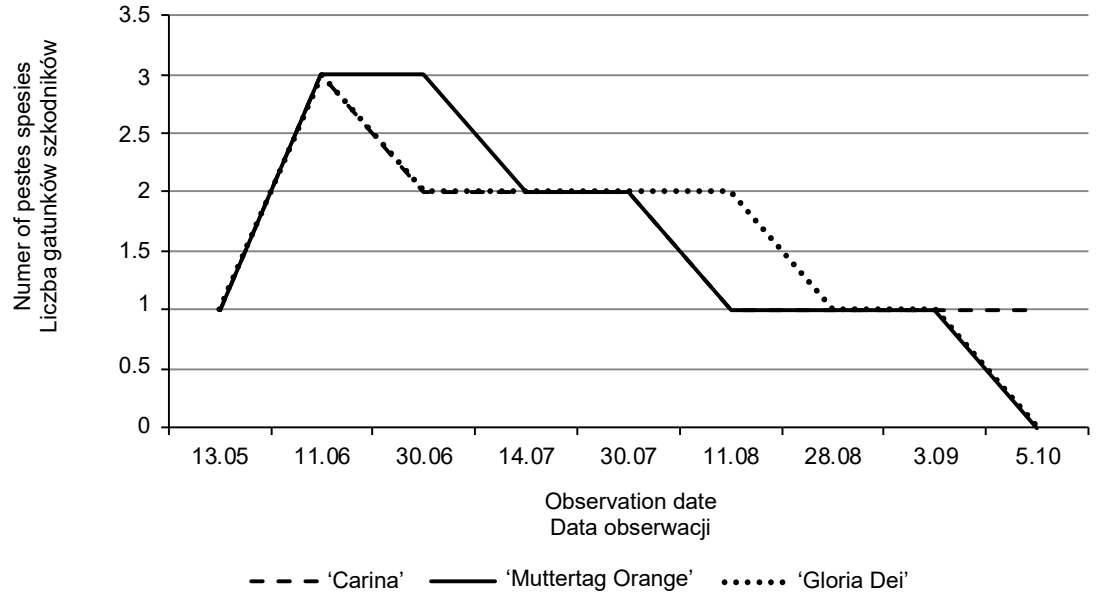

Fig. 2. The presence of pests on selected varieties of roses in season 2015
Ryc. 2. Występowanie szkodników na różach wybranych odmian w sezonie 2015

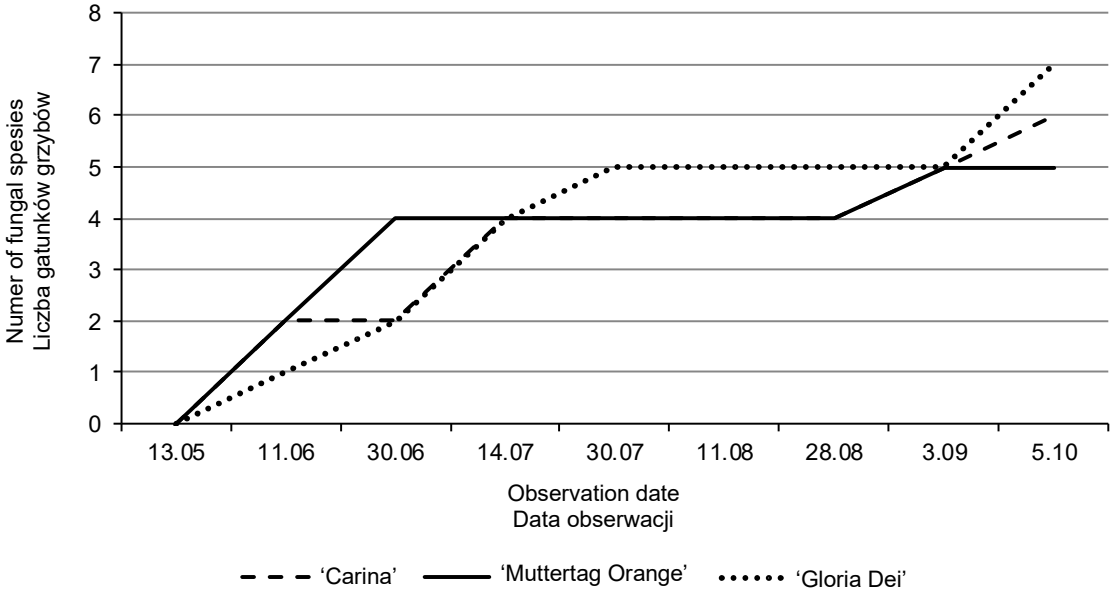

Fig. 3. The presence of fungi on selected varieties of roses in season 2015
Ryc. 3. Występowanie grzybów na różach wybranych odmian w sezonie 2015

Thirty six species of insects are estimated to colonize rose plants (Wojdyła et al 2007). Eight species of the phytophages occurring on the roses belonged to Insecta. One species was classified in Acari, i.e. the red spider mite *Tetranychus urticae* Koch. The species of insects identified in the study were classified in three genera: Homoptera (2 species), Hymenoptera (4 species), Lepidoptera (2 species). Phytophages exhibited different preferences for individual roses (Table 2–3). None of the varieties was resistant to colonization by the rose-tip infesting sawfly *Ardis brunniventris* Hartig and winter moth *Operophtera brumata* Linnaeus. Rosa 'Petit De Holand' roses were particularly susceptible to *A. brunniventris* while *R*. 'Flammentanz' roses were especially affected by *O. brumata*. During the spring-summer season, the majority of rose varieties were colonized by the rose aphid *Macrosiphum rosae* Linnaeus (Table 3). The rose leafhopper *Edwardsiana rosae* Linnaeus was the least frequently recorded typical rose pest and it occurred only on the varieties *R*. 'Blaze Superior' and *R*. 'Santana'. Of the 17 varieties, three: *Rosa* x *centifolia* 'Petit De Holand' (7 species of phytophages), *R*. 'Alchymist' (6 species of phytophages) and *R*. 'Blaze Superior' (6 species of phytophages), were the most susceptible varieties to pests. *R*. 'Fairy' and *R*. 'Gloria Dei' on which only three of the nine phytophages were recorded (Fig. 1) were the most resistant varieties. ADR-certified roses *R*. 'Flammentanz' and *R*. 'Aspirin Rose' were found in the present study to have low resistance to pests (five species of phytophages recorded) and fungal pathogens (two and four fungal species, respectively).

Of *micromycetes* isolated from pathogenically changed tissue, the greatest number of species was recorded for anamorphic stages of Ascomycetes (Fungi, Ascomycota) and only one (*Peronospora sparsa* Berk.) was a fungus-like organism (Chromista, Oomycota). The greatest number of rose taxa (94.1%) was colonized by the fungus *Marssonina rosae* (perfect stage *Diplocarpon rosae* F. A. Wolf) and only *R.* x *centifolia* 'Petit De Holand' was free from it (Table 4). The majority of the roses (88.2% taxa) were infected by the causative agent of anthracnose, *Sphaceloma rosarum* (Pass.) Jenkins (perfect stage *Elsinoë rosarum* Jenkins & Bitanc.). It clearly preferred leaves and petals of *R*. 'Fairy', *R*. 'Gloria Dei', *R.* x *centifolia* 'Petit De Holand' and *R. rugosa*. The fungus was not recorded on *R.* 'Goldstern' and *R*. 'Blaze Superior'.

Botrytis cinerea Pers. [perfect stage *Botryotinia fuckeliana* (de Bary) Whetzel] colonized 64.7% of all the species and varieties of roses. The greatest preference was noted for the flowers of the varieties *R.* 'Alchymist', *R.* 'Flamingo' and *R.* 'Muttertag Orange'. The fungus *Oidium* spp. [perfect stage *Podosphaera pannosa* (Wallr.) de Bary] occurred on overground elements of 47.1% of the species and varieties; however, foliar damage exceeding 50% was detected only in five varieties (*R*. 'Carina', *R*. 'Die Welt', *R*. 'Flamingo', *R*. 'Goldstern' and *R*. 'Muttertag Orange') (Table 4). The occurrence of telia with teliospores of *Phragmidium mucronatum* was noted only on 29.4% of the plant taxa (*R*. 'Aspirin Rose', *R*. 'Carina', *R*. 'Gloria Dei', *R*. 'Mr. Lincoln' and *R*. 'Santana') and the weakest spread was recorded for *Peronospora sparsa*, which was found only on two variety, *R*. 'Gloria Dei' and R. 'Flamingo'.

The greatest species richness of microscopic fungi was recorded on roses *R*. 'Gloria Dei' and *R*. 'Carina' (Fig. 1). The simultaneous occurrence of black spot, rust, powdery mildew and anthracnose was recorded only on three varieties: *R.* 'Carina', *R*. 'Gloria Dei' and *R*. 'Mr. Lincoln' (Table 4). This may suggest these varieties have a relatively low resistance to pathogens, including *R*. 'Carina', which is ADR-certified.

Table 3. Degree of damage of roses[a] by selected pests
Tabela 3. Stopień uszkodzenia róż[a] przez wybrane szkodniki

Variety of rose Odmiana róży	Pests Szkodniki											
	Macrosiphum rosae L.[a]		*Edwardsiana rosae* L.[b]		*Blennocampa pusilla* Klg[b]		*Ardis brunniventris* Htg.[b]		*Allanthus vinensis* L.[b]		*Operophtera brumata* L.[b]	
	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
R. 'Alchymist'	1	1	0	0	1	2	2	3	1	1	2	3
R. 'Aspiryn Rose'	1	1	0	0	1	1	1	1	0	0	1	1
R. 'Blaze Superior'	1	2	2	3	1	1	2	3	1	1	2	2
R. 'Carina'	1	1	0	0	0	0	2	2	0	0	1	1
R. 'Die Welt'	0	1	0	0	0	1	2	2	0	0	1	2
R. 'Fairy'	1	1	0	0	0	0	2	3	0	0	1	1
R. 'Flamingo'	1	1	0	0	0	0	1	1	0	0	1	1
R. 'Flammentanz'	2	2	0	0	0	0	1	1	1	2	2	3
R. 'Gloria Dei'	0	0	0	0	0	0	3	3	0	0	1	1
R. 'Goldstern'	2	2	1	1	1	2	0	0	0	0	1	1
R. 'Ingrid Bergman'	1	1	0	0	0	0	2	2	0	0	0	1
R. 'Mr Lincoln'	1	1	0	0	0	0	2	2	0	0	1	1
R. 'Muttertag Orange'	1	2	0	0	0	0	2	3	0	0	1	1
R. 'Santana'	0	1	1	1	0	0	3	3	1	1	2	3
R. 'Sommerwind'	1	1	0	0	0	0	3	4	1	1	0	1
R. x *centifolia* 'Petit De Holand'	2	2	0	0	1	1	1	1	1	1	2	2
Rosa rugosa	3	4	1	0	2	2	1	1	0	0	1	1

[a]The percentage infested of the leaves – Procent liści zasiedlonych przez mszyce: 0 – the leaves without aphids – liście bez mszyc; 1 – to 10% of the leaves with aphids – do 10% liści z mszycami; 2 – from 10 to 25% of the leaves with aphids – od 10 do 25% liści z mszycami; 3 – from 25 to 70% surface of the leaves with aphids – od 25 do 70% liści z mszycami; 4 – more than 70% surface of the leaves with aphids – powyżej 70% liści z mszycami.

[b]The percentage damage of the leaves – Procent uszkodzenia liści: 0 – no visible damage of the leaves – liście bez uszkodzeń; 1 – to 10% surface of the leaves damaged by pests – do 10% uszkodzonej powierzchni liścia przez szkodniki; 2 – from 10% to 25% surface of the leaves damaged by pests – od 10 do 25% powierzchni liścia uszkodzonej przez szkodniki; 3 – from 25% to 70% surface of the leaves damaged by pests – od 25 do 70% powierzchni liścia uszkodzonej przez szkodniki; 4 – more than 70% surface of the leaves damaged by pests – powyżej 70% powierzchni liścia uszkodzonej przez szkodniki.

Table 4. Degree of damage of roses[a] by selected pathogens
Tabela 4. Stopień uszkodzenia róż[a] przez wybrane patogeny

Variety of rose Odmiana róży	Pathogens Patogeny											
	Oidium spp.		*Phragmidium mucronatum* (Pers.) Schltdl.		*Marssonina rosae* (Lib.) Died.		*Sphaceloma rosarum* (Pass.) Jenkins		*Botrytis cinerea* Pers.		*Peronospora sparsa* Berk.	
	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
R. 'Alchymist'	0	0	0	0	5	5	1	1	3	4	0	0
R. 'Aspiryn Rose'	0	0	3	4	5	5	3	4	3	3	0	0
R. 'Blaze Superior'	0	0	0	0	2	2	0	0	0	0	0	0
R. 'Carina'	5	5	5	5	5	5	1	2	2	3	0	0
R. 'Die Welt'	5	5	0	0	5	5	3	3	0	0	0	0
R. 'Fairy'	1	1	0	0	5	5	5	5	3	3	0	0
R. 'Flamingo'	5	5	0	0	4	5	3	4	3	5	1	2
R. 'Flammentanz'	0	0	0	0	1	1	0	1	0	0	0	0
R. 'Gloria Dei'	1	2	3	4	5	5	5	5	3	3	1	1
R. 'Goldstern'	4	5	0	0	3	2	0	0	1	0	0	0
R. 'Ingrid Bergman'	0	0	0	0	4	5	3	3	1	2	0	0
R. 'Mr Lincoln'	0	1	3	3	5	5	1	2	0	0	0	0
R. 'Muttertag Orange'	5	5	0	0	5	5	2	3	3	4	0	0
R. 'Santana'	0	0	2	2	5	5	1	1	0	0	0	0
R. 'Sommerwind'	0	0	0	0	5	5	0	1	2	3	0	0
R. x *centifolia* 'Petit De Holand'	0	0	0	0	0	0	5	5	2	3	0	0
Rosa rugosa	0	0	0	0	5	5	5	5	0	0	0	0

[a]The scale of damage by pathogens – Skala uszkodzenia przez patogeny: 0 – no symptoms and structures of fungi on leaves and flowers – brak objawów chorobowych i struktur grzybów na liściach i kwiatach; 1 – from 0.1 to 5% leaves or flowers with symptoms and structures of pathogen – od 0,1 do 5% liści lub kwiatów z objawami choroby i strukturami patogenu; 2 – from 6 to 15% leaves or flowers with symptoms and structures of pathogen – od 6 do 15% liści lub kwiatów z objawami choroby i strukturami patogenu; 3 – form 16 to 25% leaves or flowers with symptoms and structures of pathogen – od 16 do 25% liści lub kwiatów z objawami choroby i strukturami patogenu; 4 – from 26 to 40% leaves or flowers with symptoms and structures of pathogen – od 26 do 40% liści lub kwiatów z objawami choroby i strukturami patogenu; 5 – more than 40% leaves or flowers with symptoms and structures of pathogen – powyżej 40% liści lub kwiatów z objawami choroby i strukturami patogenu.

Antagonistic interactions between harmful organisms with similar food preferences were noted. As observed repeatedly, the occurrence of pathogenic fungi fully or considerably inhibited the occurrence of pests (Fig. 1) (the correlation coefficient between the number of pest species and the number of fungal species $r = –0.484$). For instance, the occurrence of a few species of pests (six) on the variety 'Blaze Superior' considerably limited the percentage of pathogenic fungi (one species), which can be related to a considerable depletion or damage of plant tissue by phytophages. Conversely, the domination of fungi (seven species) on the variety 'Gloria Dei' reduced the attractiveness of the plants to pests (Fig. 1). Similar antagonistic reactions between pests and pathogens were observed in rose varieties for leaf black spot and the red spider mite (Sady et al. 2015).

Plants colonized by fungi seem to be a less attractive feeding site for insects. This may be attributed to structural changes taking place in the cells of leaves infected by pathogens (Czerpak and Piotrowska 2003; Kozłowska and Konieczny 2003; Grzebisz et al. 2007; Pilarska et al. 2015) or an increased synthesis of substances negatively affecting pathogens (Kozłowska and Konieczny 2003; Byczkowski et al. 2009; Płażek 2011) which most likely may also have an adverse impact on phytophages. Fungal structures (mycelium and spore clusters) developing on the surface of or inside infected tissue can also be a physical barrier to insects.

Relationships between the number of fungal and pests species and climatic conditions were observed, however, favorable conditions for the occurrence of these two groups of taxa were different. With the increase of humidity occurred more species of pathogens (correlation coefficient $r = 0.611$), whereas higher temperatures limited the spread of fungi and fungus-like organisms ($r = –0.290$). An increase in the number of pest species occurred at lower humidity ($r = –0.450$), and inceasing temperature ($r = 0.139$).

Temperature is one of the most critical environmental factors influencing rate of insect growth and development (Taylor 1981). Warmer temperatures are likely to have complex effects on insects, influencing, among other things, development rate and the seasonal timing of life-cycle events, while also affecting their host trees and natural enemie (Zheng et al. 2008; Yadav and Chang 2014). For example aphids may disperse long distances on air currents and so are often widespread pests. They give birth to live young and have multiple generations each year and so are likely to respond strongly to increasing temperatures, resulting in a significant increase in abundance and damage (Davis et al. 2006). The ability of fungi to cause diseases of plants depends on temperature and humidity. High humidity is a necessary factor to infect the plant by FLO and anamorphic fungi (Filgueira and Velasquez 2014; Kowalik et al. 2015; Wyenandt et al. 2015), while taxa of *Uredinales* and *Erysiphales* characterized by the ability to infect plants over a wide range of humidity (Sucharzewska 2010; Pap et al. 2013; Helfer 2014; Kanade et al. 2015).

CONCLUSIONS

1. Colonization degree of roses by pests and pathogens recorded in this study varied and directly depended on the rose variety and the presence of other biological factors that often entered mutually antagonistic relationships.

2. Rose taxa of groups I and II should be introduced to cultivations in sites where environmental conditions are adverse to plant development (urban agglomerations, unfavourable exposure or microclimate). The degree of colonization by both pests and pathogens was particularly low for the variety 'Ingrid Bergman'.

REFERENCES

Adamska I., Zioło E., Kocanowski J. 2012. Stan zdrowotny roślin Ogrodu Miejskiego „Różanka" w Szczecinie [Health state of plants in the urban garden „Różanka" in Szczecin]. Prog. Plant Prot. 52(3), 609–613. [in Polish]

Blechert O., Debener T. 2005. Morphological characterization of the interaction between *Diplocarpon rosae* and various rose species. Plant Pathol. 54, 8–90.

Brandenburger W. 1985. Parasitische Pilze an Gefäβpflanzen in Europa. Stuttgart, Fischer.

Braun U. 1987. A monograph of the *Erysiphales* (powdery mildews). Berlin, Nova Hedwigia.

Bugała W. 2000. Drzewa i krzewy. Warszawa, PWRiL. [in Polish]

Byczkowski B., Macioszek V.K., Kononowicz A.K. 2009. Roślinne białka PR w odpowiedzi obronnej na atak grzybów nekrotroficznych [Plant PR proteins in the defense response to the necrotrophic fungi]. Post. Biol. Kom. 36(1), 121–134. [in Polish]

Carlson-Nilsson B., Davidson C.G. 2006. Variation in resistance to *Marssonina rosae* (Lib.) Died. among different *Rosa* L. cultivars and species including three dogrose species (*Rosa* sect. *Caninae*). Hort. Sci. 109(4), 353**–**360.

Czerpak R., Piotrowska A. 2003. Cytokininy, ich struktura, metabolizm i aktywność biologiczna [Cytokinins, their structure, metabolism and biological activity]. Kosmos 52(2–3), 203–215. [in Polish]

Davis J.A., Radcliffe E.B., Ragsdale D.W. 2006. Effects of high and fluctuating temperatures on *Myzus persicae* (*Hemiptera*: *Aphididae*). Environ. Entomol. 35, 1461–1468.

Debener T., Byrne D.H. 2014. Disease resistance breeding in rose: Current status and potential of biotechnological tools. Plant Sci. 228, 107–117.

Diagnostyka szkodników roślin i ich wrogów naturalnych. 2001. Red. J. Boczek. Tom IV. Warszawa, SGGW. [in Polish]

Filgueira J.J., Velasquez K. 2014. A dual model to predict the *Peronospora sprasa* sporulation in rose based on the plant microclimate. Rev. Fac. Cien. Basic. 1(10), 22–33.

Grzebisz W., Barłóg P., Waszak M., Łukowiak R. 2007. Homeostaza żywieniowa a odporność roślin uprawnych na stresy biotyczne [Nutritional homeostatis and plant crops resistance to biotic stresses]. Fragm. Agron. 24, 3(95), 136–143. [in Polish]

Helfer S. 2014. Rust fungi and global change. Research review. New Phytolog. 201, 770–780.

Kanade S.G., Shaikh A.A., Jadhav J.D., Chavan C.D. 2015. Influence of weather parameters on tikka (*Cercospora* spp.) and rust (*Puccinia arachidis*) of groundnut (*Arachis hypogea* L.). AJES 10(1), 39–49.

Kochman J., Majewski T. 1970. Grzyby (Mycota). 4: *Phycomycetes*, *Peronosorales*. Warszawa, PWN. [in Polish]

Kowalik M., Kierpiec-Baran B., Duda-Franiak K. 2015. Micromycetes colonizing and damaging leaves of evergreen rhododendron (*Rhododendron* L.) in nursery. Acta Agrobot. 68(2), 179–185.

Kozłowska M., Konieczny G. 2003. Biologia odporności roślin na patogeny i szkodniki. Poznań, Wydaw. AR. [in Polish]

Łabanowski G., Soika G. 2008. Zasiedlenie drzew i krzewów ozdobnych przez szkodliwe roztocze i owady w środowisku zurbanizowanym, w: Fauna miast. Ochronić różnorodność biotyczną w miastach. Red. P. Indykiewicz, L. Jerzak, T. Barczak. Bydgoszcz, SAR „Pomorze", 571–576. [in Polish]

Majewski T. 1977. Grzyby (Mycota). 9: Uredinales I, Basidiomycetes. Warszawa, PWN. [in Polish]

Pap P., Ranković B., Maširević S. 2013. Effect of temperature, relative humidity and light on conidial germination of oak powdery mildew (*Microsphaera alpithoides* Griff. et Maubl.) under controlled conditions. Arch. Biol. Sci. 65(3), 1069–1077.

Performance testing of new rose varieties in Germany. Berlin, Bund deutscher Baumschulen e.V./Allgemeine Deutsche Rosenneuheitenprüfung, http://www.adr-rose.de/englisch/e_index.htm, access: 16.12.2015.

Pilarska M., Skowron E., Niewiadomska E. 2015. Cytokininy a fotosynteza [Cytokinins and photosynthesis]. Post. Bioch. 61(1), 61–68. [in Polish]

Płażek A. 2011. Patofizjologia roślin. Kraków, Wydaw. Uniw. Rol. [in Polish]

Popek R. 2002. Róże dziko rosnące Polski. Klucz – Atlas. Kraków, Plantpress. [in Polish]

Sady E., Matuszczak M., Legutowska H. 2015. Ocena podatności wybranych odmian róż parkowych na szkodniki [Evaluation of susceptibility of selected park rose cultivars to pests]. Prog. Plant Prot. 55(3), 267–274. [in Polish]

Seneta W., Dolatowski J. 2005. Dendrologia. Warszawa, PWN. [in Polish]

Sucharzewska E. 2010. Key survival strategies of the *Sawadaea tulasnei* parasite on its *Acer platanoides* host under conditions of varied anthropopression. Pol. J. Environ. Stud. 19(5), 1013–1017.

Taylor F. 1981. Ecology and evolution of physiological time in insects. Am. Natur. 117, 1–23.

Vukosavljev M., Zhang J., Esselink G.D., Westende W.P.C. van't, Cox P., Visser R.G.F., Arens P., Smulders M.J.M. 2013. Genetic diversity and differentiation in roses: A garden rose perspective. Sci. Hortic. 162, 320–332.

Whitaker V.M., Hokanson S.C., Bradeen J. 2007. Distribution of rose black spot (*Diplocarpon rosae*) genetic diversity in Eastern North America using amplified fragment length polymorphism and implications for resistance screening. J. Amer. Soc. Hort. Sci. 132(4), 534–540.

Wojdyła A., Kamińska M., Łabanowski G., Orlikowski L. 2007. Ochrona róż. Kraków, Plantpress. [in Polish]

Wyenandt C.A., Simon J.E., Pyne R.M., Homa K., McGrath M.T., Zhang S., Raid R.N., Ma L.-J., Wick R., Guo L., Madeiras A. 2015. Basil downy mildew (*Peronospora belbahrii*): Discoveries and challenges relative to its control. Phytopathology 105, 885–894.

Yadav R. Chang N.T. 2014. Effects of temperature on the development and population growth of the melon thrips, *Thrips palmi*, on Eggplant, *Solanum melongena*. J. Insect. Sci. 14, 78. [online]. DOI: 10.1673/031.014.78.

Zheng F.S., Du Y.Z., Wang Z.J., Xu J.J. 2008. Effect of temperature on the demography of *Galerucella birmanica* (*Coleoptera*: *Chrysomelidae*). Insect Sci. 15, 375–380.

Abstract. The occurrence of pests and microscopic fungi on roses in the "Różanka" City Garden in Szczecin was investigated in the years 2014–2015. *Rosa thea hybrida* (varieties 'Alchymist', 'Aspirin Rose', 'Blaze Superior', 'Carina', 'Die Welt', 'Fairy', 'Flamingo', 'Flammentanz', 'Gloria Dei', 'Goldstern', 'Ingrid Bergman', 'Mr Lincoln', 'Muttertag Orange', 'Santana' and 'Sommerwind'), *R.* x *centifolia* ('Petit De Holand' variety) and *R. rugosa* were selected for analysis. Species composition and colonization degree by pests and by fungi were evaluated. Colonization degree depended on the rose variety, observation date and presence of other biological factors. An antagonism between pests and microscopic fungi was detected. *R.* 'Ingrid Bergman' was a variety least inhabited by pests and fungi.