International Journal of Horticultural Science 2007, 13 (4): 23–30
Agroinform Publishing House, Budapest, Printed in Hungary
ISSN 1585-0404

Impact of foliar fungi on dogroses

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Summary: Wild roses of the section *Caninae*, commonly known as dogroses, have been described as more disease tolerant than ornamental roses and could therefore become valuable for breeding improved rose cultivars. Two fields with dogroses, one with plants obtained by open pollination in wild populations, and one with plants obtained from intra- and interspecific crosses, were evaluated for blackspot, powdery mildew, rust and leafspots in the autumn of 2005. Symptoms of the different fungi on different dogrose species were carefully evaluated in a microscope and documented by photography. Interestingly, almost no symptoms of powdery mildew were found in either field, although the fungus infected wild roses of a different section in a field closeby. Surprisingly few symptoms were found also of blackspot, and they differed considerably from those found on ornamental cultivars, indicating a lower susceptibility in dogroses. The most important fungal disease in 2005 was rust, followed by leafspot symptoms. The latter were apparently caused by *Sphaceloma rosarum* and *Septoria rosae* which can be properly discriminated only in a microscope. The investigated dogrose species and their progeny groups varied significantly in disease susceptibility and in the appearance of encountered symptoms but there was no evidence of major resistance genes, except possibly in *Rosa rubiginosa* which did not show any symptoms of *Septoria*. In 2006, a subset of the plant material in Field 1 was evaluated to check for consistency between the years. Leafspots had overtaken rust as the most important disease but results were otherwise very similar to those of 2005.

Key words: *Caninae*, dogrose, *Marssonina rosae, Phragmidium, Rosa, Septoria rosae, Sphaceloma rosarum*

Introduction

Most of the wild roses in Europe belong to section *Caninae* in the genus *Rosa*. These so-called dogroses are used as rootstocks for ornamental roses, and their fruits, the rose hips, are sometimes harvested for culinary use because of their characteristic and highly appreciated flavour. A rose hip dessert soup, which used to be a major source of vitamin C in Scandinavia, is still very popular in Sweden. Other documented health benefits include, e.g., very high antioxidant activity (*Gao* et al., 2000) and anti-inflammatory properties that are useful in treating osteoarthritis (*Rein* et al., 2004). Domestication programs are now conducted in several countries, with research on cultivation and harvesting, and development of superior, disease-resistant plant material (*Nybom & Rumpunen*, 2005).

Dogroses may also have a potential as donors of disease resistance in ornamental rose breeding. Since increasingly fewer pesticides are permitted both in commercial horticulture and for home garden use, many ornamental rose breeding programs are now focussing on the development of healthier cultivars. Major resistance genes are, however, scarce in the germplasm used in traditional rose breeding, which has led to an increased interest in wild rose species that are thought to be more healthy (*Boerema*, 1963; *Gudin*, 2003).

When using dogroses in plant breeding programs, the aberrant meiosis occurring in all species in section *Caninae* must be taken into consideration. The basic haploid chromosome number of roses is 7. Species in the *Caninae* section are polyploid with 2n = 28, 35 or 42. In the meiosis, only 7 bivalents are formed and the rest occur as univalents. Fertile pollen grains have only 7 chromosomes whereas fertile egg-cells have 21, 28 or 35 chromosomes, depending on the species (*Täckholm*, 1920). This results in matroclinal inheritance with only a minor contribution from the pollen parent (*Werlemark & Nybom*, 2001).

In the present study, 6 dogrose species and some progeny groups derived by interspecific hybridizations were screened to investigate their suitability as donors of resistance against 5 different foliar fungi; three very common and well-known, namely blackspot (*Diplocarpon rosae* Wolf. in its perfect stage and *Marssonina rosae* (Lib.) Lind in the imperfect), powdery mildew (*Sphaerotheca pannosa* (Wallr. ex Fr.) Lév.) and rust (*Phragmidium* spp.), and two less well-known fungi causing leafspots, here called *Sphaceloma*-leafspot (*Sphaceloma rosarum* (Pass.) Jenk. in its imperfect stage and *Elsinoe rosarum* Jenk. and Bitanc. in its perfect stage) and *Septoria*-leafspot (*Septoria rosae* Desm., teliomorph *Sphaerulina rehmiana* Jaap) that may have only regional importance or has perhaps been overlooked.

Material and method

In 2005, 6 dogrose species were screened, using plants grown in a randomized order in two fields at Balsgård in S Sweden (*Table 1*). Plants in Field I originated from seeds

Table 1 Plant material used for the disease evaluations, the field in which the plants were grown and the number of screened plants in 2005 and 2006, with number of different cross combinations (progeny groups) in parentheses.

Species / cross	Field	No. plants 2005	No. plants 2006
subsection *Caninae*			
R. caesia	I	22	7
R. caesia X *R. sherardii*	II	8 (1	
R. canina	I	42	15
R. dumalis	I	98	52
R. dumalis X *R. caesia*	II	4 (1)	
R. dumalis X *R.dumalis*	II	80 (5)	
R. dumalis X *R. mollis*	II	21 (1)	
R. dumalis X *R. sherardii*	II	2 (1)	
subsection *Rubigineae*			
R. rubiginosa	I	122	90
R. rubiginosa X *R. rubiginosa*	II	90 (6)	
R. rubiginosa X *R. dumalis*	II	17 (1)	
R. rubiginosa X *R. sherardii*	II	32 (2)	
subsection *Vestitae*			
R. mollis	I	14	8
R. mollis X *R. mollis*	II	5 (1)	
R. mollis X *R. sherardii*	II	3 (1)	
R. sherardii	I	44	19
R. sherardii X *R. sherardii*	II	21 (1)	
R. sherardii X *R. mollis*	II	58 (1)	

collected in 1988 from wild rose populations in Scandinavia (*Nybom* et al., 1996), whereas Field II contained seedlings originating from intra- and interspecific crosses conducted in 1990 with plants that had been transplanted from wild populations. In 2006, a subset of the plants in Field I was screened again to check for consistency between years (*Table 1*).

Evaluation of all diseases was conducted with a method previously used by *Carlson-Nilsson & Davidson* (2006). The plants were divided into a lower and an upper level and both were rated as follows: A = free of disease, B = low occurrence (up to 20% infected foliage), C = moderate occurrence (21–50%), D = severe occurrence (more than 51%). The two resulting scores were transferred into a figure between 0 and 9 according to a key (*Table 2*). This method not only produces an estimate of the occurrence and severity of the disease, but also describes the infection pattern of each fungus. Due to anticipated problems with normality of data, only non-parametric statistical analyses were conducted; Kruskal-Wallis one-way analysis of variance and Spearman rank correlation coefficients were calculated with SYSTAT 5.2.

Table 2 Evaluation key and resulting rating for blackspot, leafspots and rust; and the four major disease incidence categories used for obtaining an overview. A = free of disease, B = low occurrence (up to 20% infected foliage), C = moderate occurrence (21-50%), D = severe occurrence (more than 51%).

level I	level II	final rating
A	A	0
A	B	1
B	B	2
C	A	3
C	B	4
C	C	5
D	A	6
D	B	7
D	C	8
D	D	9

Microscope investigations of disease symptoms were conducted in 2005 with a Leitz Wetzlar 1.6 X stereomicroscope and a Olympus CH binocular microscope. Photos were taken with a Conica Minolta Dimage X 31 camera, and Adobe Photoshop 7.0 was used for cropping and adjusting contrast and brightness.

Results

Field evaluations

Powdery mildew was found only on very few plants in both years, and then only on single fruits or leaves that were obviously suffering from mechanical damage. Therefore, no statistical evaluations were performed for this disease. For the other diseases, symptoms varied from low to severe, with considerable differences between species (*Table 3*). Blackspot was the least serious of these diseases, especially in 2005 when 74% of the plants in Field I were symptom-free and 53% in Field II, as compared to 48% (only Field I screened) in 2006. By contrast, rust was common, especially in 2005, and leafspots was very common, especially in 2006 when all plants were affected (*Table 3*). In 2005, overall values were somewhat higher in Field II (data not shown), where evaluations were carried out during the second half of September while evaluations in Field I were carried out during the first half. Regression analyses (data not shown) suggest that the difference between the two fields was caused mainly by an increase in symptom severity with time.

Analysis of variation between species in amount of disease symptoms yielded highly significant results for all three diseases (blackspot, leafspots and rust), with $p = 0.000$ in 2005, and similar results but a lower significance ($p = 0.036$) for blackspot in 2006. For blackspot, the lowest disease values in 2005 were encountered in *R. caesia, R. dumalis* and *R. canina*, all of which belong to subsection *Caninae* (*Table 3*). In 2006, low values were again found for *R. dumalis* and *R. canina* but also for *R. mollis* whereas *R. caesia* had the highest mean value but this was based on only 7 plants. For leafspots, the three species in subsection *Caninae* instead had the most severe symptoms in both years, while the lowest values were found in *R. rubiginosa*. Finally, for rust, the lowest values were found in both years for *R. caesia, R. sherardii* and *R. dumalis* while *R. rubiginosa* had the highest.

Table 3 Average disease score estimated for each of three diseases (blackspot, leafspots and rust) in Field I in 2005 and 2006 (for number of evaluated plants see Table 1).

Species	Blackspot		Leafspots		Rust	
	2005	2006	2005	2006	2005	2006
R. caesia	0.2	2.9	5.6	7.1	2.6	2.0
R. canina	0.4	1.1	5.4	8.2	4.1	3.5
R. dumalis	0.3	0.8	5.5	8.0	3.0	2.0
R. rubiginosa	1.3	1.5	3.9	4.8	2.5	2.0
R. mollis	0.9	0.9	4.4	6.0	3.4	2.4
R. sherardii	1.0	1.7	3.9	4.8	2.5	2.0

Analyses of interspecific variation including only the three taxa belonging to subsect. *Caninae* showed a significant difference only for rust in 2005 ($p = 0.025$) with *R. canina* having the most severe symptoms. The two species belonging to subsect. *Vestitae*, *R. sherardii* and *R. mollis*, did not differ for any of the three diseases.

Progeny groups resulting from intraspecific crosses were compared for each species separately with Kruskal-Wallis analyses of variance (data not shown). Only two groups deviated significantly from the remainder, progeny group 9007 in *R. dumalis* and progeny group 9025 in *R. rubiginosa*. Interestingly, the seed parents of the two deviating progeny groups probably differed genetically from the others; the seed parent of 9007 had been collected in population no. 1 whereas all the other progeny groups of *R. dumalis* had seed parents from population no. 4 (*Table 1*), and the 9025 was obtained by selfing a plant that had previously been noted as having a deviating leaflet shape (*Nybom* et al., 1998).

Microscope investigations

Blackspot – Initially, it was not easy to recognise *Marssonina rosae*, since the symptoms look very different on dogroses compared to the well-known symptoms on ornamentals. Smaller dark spots with an even and sometimes darker margin were most common (*Figure 1*). More typical symptoms with large areas covered by blotches with slightly feathery margins were found only on a few of the *R. dumalis* plants and on some plants in progeny groups with *R. dumalis* as seed parent (*Figure 1b*). Yellowing was less intense on leaves with atypical symptoms. In the microscope, mycelial strands were visible on the surface as well as acervuli, but not as densely as on the ornamental roses examined for comparison. Conidia were transferred to glass slides and used to verify the diagnosis.

Rust – In 2005, rust was found already in the beginning of September on virtually every leaf gathered from either field, as well as on some previously damaged shoots and fruits (*Figure 2*). At the end of the month, most leaves were completely covered either with orange urediospores or black teliospores or both. Only plants belonging to *R. rubiginosa* were slightly less affected. Typically, spores occurred mainly on the lower leaf surface, but some spores were found also on the upper surface on plants belonging to *R. sherardii* and *R. mollis* or to progeny groups with one of these species as seed parent. Sometimes the *R. sherardii* and *R. mollis* plants also had orange spots on the upper leaf surface. Similar spots but somewhat darker were sometimes found on plants belonging to *R. rubiginosa* or its progeny groups. By contrast, plants belonging to subsection *Caninae* never showed symptoms on the upper leaf surface. These differences were not very distinct and they did not correlate with the susceptibility data for the different species.

Leafspot – The round lesions with darker margin caused by *Sphaceloma rosarum* varied considerably in colour and size, and the pathogen was hard to distinguish from other leafspot fungi (*Figures 3–5*). In contrast to *Septoria rosae* (see below), no growth of the fungus was visible on the leaf surface, and the dead tissue in the center of the lesions often looked like it was peeling off. The lesions reached over the veins and were not restricted by them. Sometimes yellowing occurred, but a reddish discolouration of the leaves was more common. In general, the foliage stayed green only on *R. rubiginosa* and its progeny. The *Sphaceloma*-leafspots were almost white in the center on *R. canina*, *R. rubiginosa*, *R. dumalis* and plants belonging to progeny groups with these species as seed parents. Plants belonging to species with hairy leaves (*R. sherardii, R. mollis, R. caesia*) or to progeny

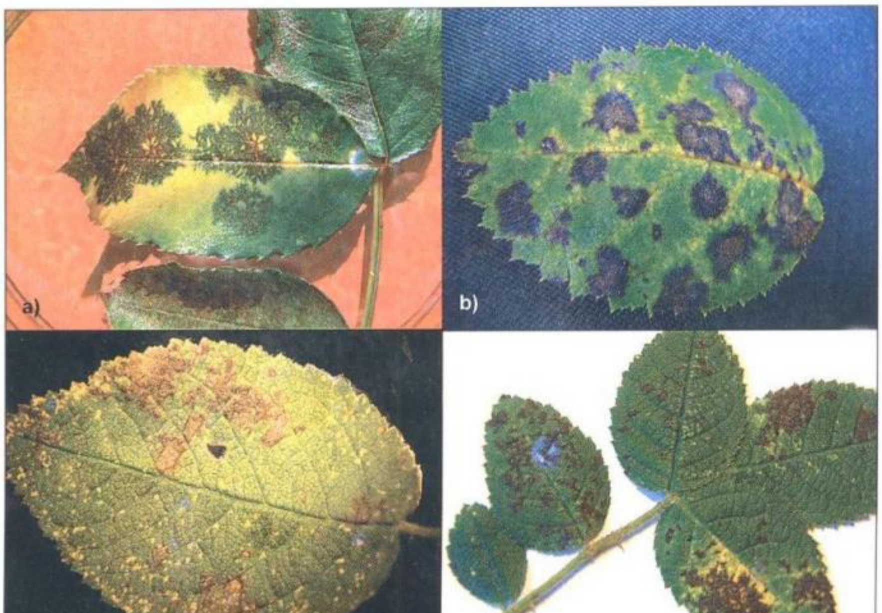

Figure 1 Symptoms of *Marssonina rosae* on ornamental and wild roses. a) typical symptoms on ornamental roses: lesions with feathery margins resulting in a star-like pattern, b) brown blotches with dark margin resembling leopard flecks on *R. rubiginosa*, c) light brown lesions on *R. sherardii* (the yellow spots are due to rust), d) very small black spots on *R. rubiginosa*

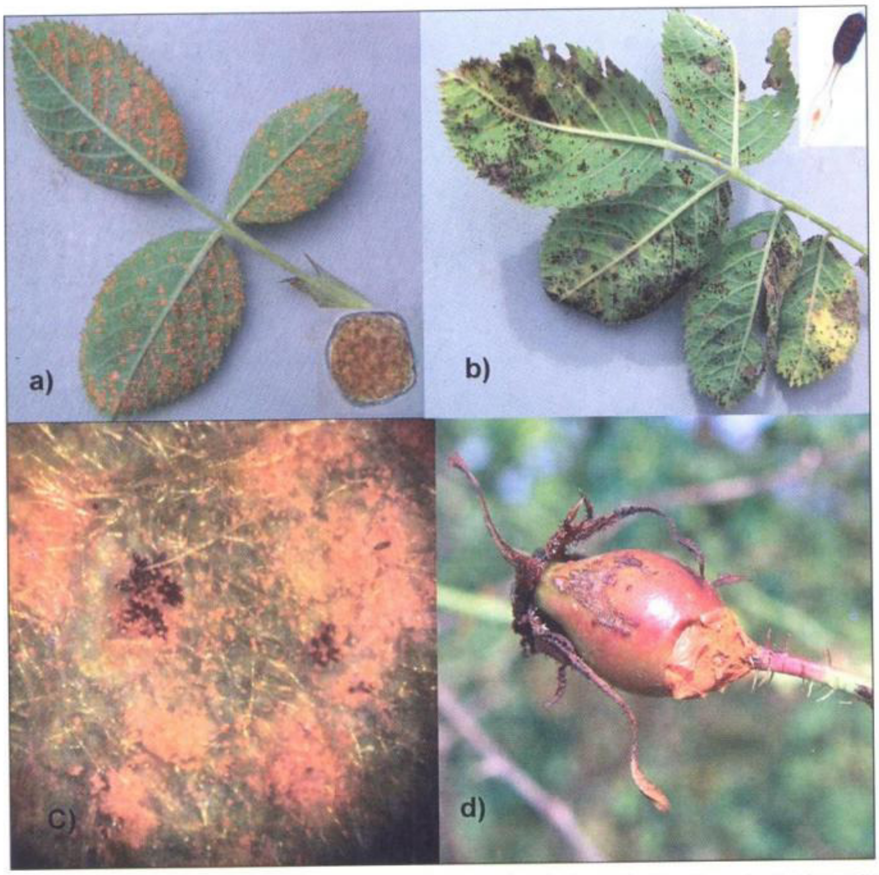

Figure 2 *Phragmidium* sp. a) orange urediospores covering the lower leaf surface of a *R. sherardii* X *R. villosa* hybrid (small picture: microscopic view of a spore, x400), b) black teliospores on a leaf of the same plant (small picture: microscopic view of a teliospore, x400), c) microscopic view (x1.6): orange urediospores and black teliospores in clusters on the hairy epidermis typical for *Tomentosa*-type plants, d) unusual case: rosehip with rust on an injury.

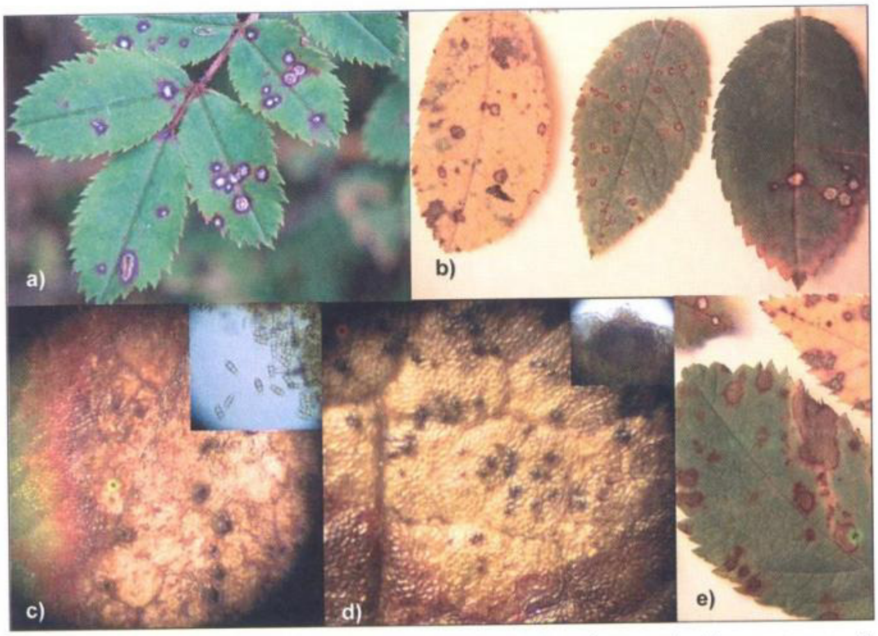

Figure 3 Leafspot caused by *Sphaceloma rosarum*, a) typical, easily recognizable symptoms on *R. spinosissima*: circular spots with a white centre and a dark purple margin, b) variable symptoms caused by *Sphaceloma rosarum* on roses of subsect. *Vestitae* and an ornamental cultivar: with strong yellowing, almost unchanged colour, turning reddish, respectively, c) microscopic view (x1.6): symptoms on *R. spinosissima*; the black fruiting bodies produce ascospores (small picture, x400), d) microscopic view (x1.6): leafspot on an ornamental rose (small picture: section through one of the tiny black acervuli with no spores, x100) e) coalescing spots, forming big blotches.

groups with these as seed parents, commonly had light brown spot centers instead, and the margins were dark brown rather than reddish. Ornamental cultivars, examined for comparison, similarly exhibited a range of different symptoms. In contrast to the wild species where asexual fruiting bodies were never found, acervuli were often clearly visible as black dots on ornamental roses (*Figure 3d*), but no conidia were found in them. In general, both sexual and asexual spores were very difficult to find on the leaves.

Especially plants belonging to *R. dumalis* and progeny groups with this species as seed parent, often suffered from severe defoliation possibly due to a fungal cane disease that produced dark spots on shoots and fruits. Two different types of black fruiting bodies were detected in the microscope; the smaller ones contained hyaline elliptic conidia and the larger ones four-celled ascospores (*Figure 5*). Most likely, these symptoms were also caused by *Sphaceloma rosarum* which has been reported to attack not only leaves but also stems, rosehips and pedicels (*Horst*, 1983).

Until recently, the only leafspot disease diagnosed in the dogrose fields at Balsgård was *Sphaceloma*-leafspot. Especially on plants belonging to subsect. *Vestitae*, leafspot symptoms were, however, often somewhat atypical, with small spots densely covering the leaves. Microscope studies showed the presence of a different fungus, determined as *Septoria rosae* by Professor Uwe Braun from Halle, Germany. The leafspots caused by *Septoria rosae* did not reach the size of those caused by *Sphaceloma rosarum* (*Figure 6*). On plants belonging to *R. canina*, *R. dumalis* and to progeny groups with *R. dumalis* as a seed parent, the purple margin of the lesions was sometimes very narrow and they therefore looked angular. On plants belonging to *R. caesia*, *R. mollis*, *R. sherardii* and to progeny groups with one of these species as seed parent, broader margins producing rounder spots were more common. The symptoms were clearly restricted by the veinlets and showed no peeling off in the centre, and the leaf surface stayed intact. The mycelium of this fungus is visible in a microscope (*Figure 6e*) and the worm-like creamy-white spore tendrils that emerge from the dark pycnidia are very typical (*Figure 6d, g, j*). Sometimes the centre of the spots appeared to be white, due to fluffy masses of conidia (*Figure 6f*) piling up around the

Table 4 Analyses of co-occurrence of the different diseases (blackspot, leafspots and rust) in the two fields, reported as a matrix of Spearman rank correlation coefficients with 2005 results in the upper line and 2006 results in the lower line.

	blackspot		leafspots	
	Field I	Field II	Field I	Field II
leafspots	-0.309**	-0.217**		
	-0.327**			
rust	-0.019	-0.196*	-0.062	0.476***
	0.134		-0.360**	

* $p < 0.05$
** $0.05<p<0.01$
*** $p<0.001$

Figure 4 Severe case of *Sphaceloma rosarum* causing heavy infection on *R. rubiginosa*; spots on leaves, fruits and bark, dead tip (topmost arrow).

pycnidia. Heavily infected leaves had big dull brown blotches with white spots caused by the spore tendrils and fungal growth. Both of these fungal structures could always be found after rain or high humidity and were also triggered by storing leaves for a few days in a moist Petri dish. Sometimes microconidia were formed in black stromata on areas with far advanced infection. *Septoria rosae* caused yellowing and leaf drop, especially on plants belonging to *R. sherardii*, *R. mollis* and progeny groups with one of these species as seed parent, where it seemed to be at least as serious as *Sphaceloma rosarum*.

Combined infections

Pairwise co-occurrence of diseases on the same plant was analysed for the two fields separately with Spearman correlation coefficients (*Table 4*). For both fields, a negative correlation was found between leafspots and blackspot. In Field II, a significant negative correlation was also found between rust and blackspot whereas rust and leafspots in this field showed a strong positive correlation. The only discrepancy between the two years was that in 2006, a negative correlation was found also between leafspots and rust. The negative correlations between blackspot and leafspots in both years suggests an antagonistic behaviour. The analyses involving rust yielded more variable results, with both positive and negative correlations with the other two diseases.

Occasionally different fungi even infected the same leaf. Especially rust was omnipresent in 2005 and there was no difference in the extent of rust infection between leaves that had only rust and those that were affected by one or two of the other fungi. Blackspot and *Sphaceloma*-leafspot could also be found together on the same leaves, sometimes the lesions were even in direct contact. On heavily affected leaflets, one of these two fungi was, however, always more prevalent. Probably the first arriving pathogen occupied most of the space without any further interactions. When both leafspot species were found on the same plant, attacks of *Sphaceloma*-leafspot were mostly confined to the upper parts, whereas symptoms of *Septoria*-leafspot often were more severe in the lower parts.

Discussion

Powdery mildew – The low incidence of powdery mildew in both fields both years is remarkable since wild roses of a different section growing very close to Field II were severly

Figure 5 Cane disease most likely caused by *Sphaceloma rosarum*, a) dead shoot with desiccated rosehips, b) almost defoliated plant in september with mostly dead shoots, frequently found especially in *R. dumalis*, c) microscopic view (x1.6): older lesion; the dry brownish tissue is bursting, e) microscopic view (x1.6): white area on dead shoot tip; fruiting bodies of the sexual stage (small picture: ascospore, x600), f) infected shoot: small purple spots as well as larger lesions visible, g) microscopic view (x1.6): emerging symptoms; minute, elevated spots with a light centre and a purple margin, h) microscopic view (x1.6): white area on dead shoot tip; fruiting bodies of the asexual stage (small picture: conidia, x600).

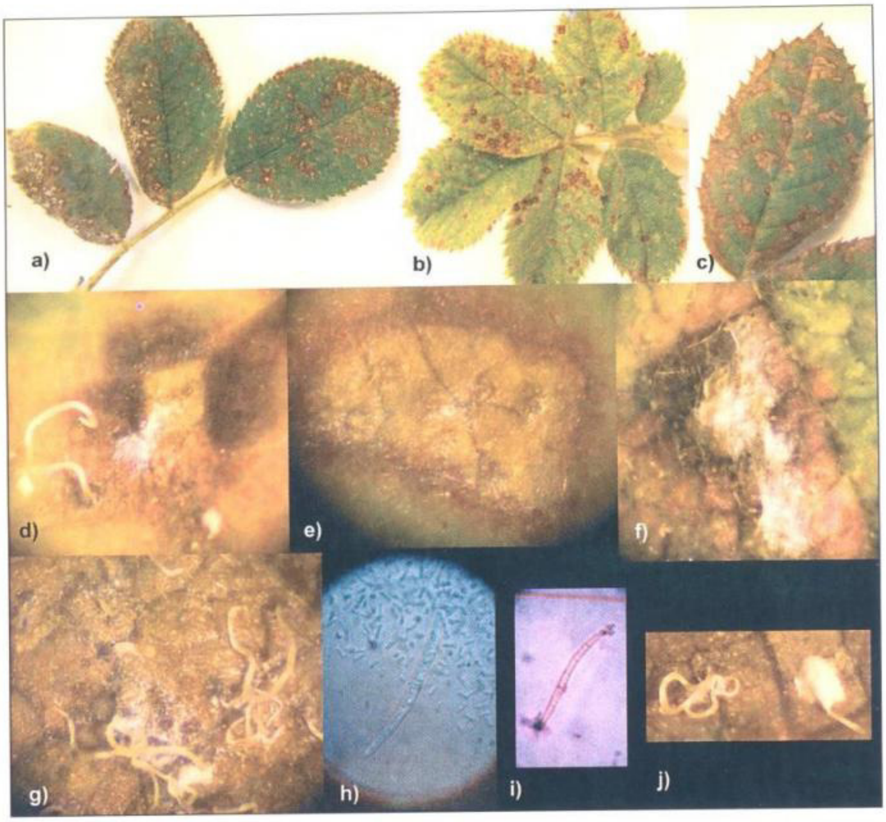

Figure 6 Leafspots caused by *Septoria rosae*. a) *Septoria rosae* on a seedling from an *R. sherardii* X *R. sherardii* cross: spots coalescing, forming grey areas with white structures, b) similar symptoms on *R. mollis*, c) angular spots on *R. dumalis*: lesions are restricted by the veinlets, d) microscopic view (x1.6): spot with broad purple margin in chlorotic tissue, white tendrils of conidia emerging from dark pycnidia, e) microscopic view (x1.6): spot with mycelium faintly visible on the surface, f) microscopic view (x1.6): leafspot covered with white masses of conidia, g) microscopic view (x1.6): heavily infected area covering a large part of the leaf, h) microscopic view (x400): long conidia together with numerous smaller, rod-shaped microconidia, i) microscopic view (x400): stained conidia with visible septae, j) microscopic view (x400): creamy-white tendrils of conidia and typical white heaps of conidia.

affected, suggesting that neither weather conditions nor availability of inoculum prevented mildew attacks. Even more puzzling is the fact that these particular dogrose plants were heavily affected by mildew some years earlier (*Werlemark* et al., 1999; *Olsson* et al., 2000; *Werlemark & Nybom*, 2001). Apparently a protecting mechanism is somehow acquired, possibly when the plant reaches a certain age or size, or when infection with other fungi is very severe.

Blackspot **–** Typically, blackspot symptoms are circular or irregularly coalescent spots, 2–12 mm in diameter with feathery margins but spots without feathery margins have also been reported (*Horst*, 1983; *Carlson-Nilsson*, 2002). *Blechert & Debener* (2005) defined 8 different interaction types between host and pathogen by screening different rose species for their reaction to a single-spore isolate. Of those 8 types, the first 5 make up the compatible reactions from fully to little susceptible. Only type 1 results in the commonly known symptoms, whereas the other 4 compatible reaction types lead to spots with increasingly even margins. The remaining three are incompatible reactions where resistance is achieved by apoptose or by blocking the fungal attack completely. Blackspot symptoms on dogrose plants fit well with these reaction types; the bigger blotches with a slightly feathery margin may represent reaction types 2 or 3, while the smaller spots on *R. rubiginosa* with even margins may represent type 4. Blackspot is probably not able to spread as intensely on dogroses as it does on most ornamental roses, since interaction types of lower compability lead to a decreasing ability of the pathogen to produce inoculum (*Blechert & Debener*, 2005).

Still, blackspot can be a problem also in dogroses as demonstrated in greenhouse-conducted inoculation tests (*Carlson-Nilsson & Davidson*, 2006) and it was the main disease recorded by *Uggla & Carlson-Nilsson* (2005) in progeny derived from intersectional crosses with *R. dumalis* and *R. rubiginosa* as seed parents. In the present study, blackspot symptoms increased on all investigated species later in the season, after the evaluations. Obviously, there is considerable seasonal variation; *Carlson-Nilsson* (2002) describes how the peak of the infection can be very late in one year due to less favourable conditions during the summer, but very early in another year, thus causing considerably more damage. In addition, late infections may be able to overcome the defence mechanisms of the plant more easily because of decreasing vigour in autumn. Thus, *Xue & Davidson* (1998) report that *Marssonina rosae* progresses faster on old leaves.

Rust **–** The rust symptoms were similar to those found on ornamental cultivars. 2005 was the first year that rust was a major problem on roses at Balsgård; *Uggla & Carlson-Nilsson* (2005) found almost no symptoms during their evaluations in 1997 and 1998. In the present study, the hairy leaves of plants belonging to subsect. *Vestitae* and to *R. caesia* seemed to be covered by spores, but since the glabrous-leaved *R. canina* and *R. dumalis* had rust to a similar extent, the hairs cannot be crucial for attaching the spores to the leaves. Ornamental rose cultivars exhibiting at least a high tolerance against rust are known, but regional cultivation recommendations are important since different species of the fungus may predominate in different areas (*Pscheidt*, 2005). The finding of teliospores with five to seven septae suggests that the pathogen is *Phragmidium mucronatum* provided that Swedish dogroses are attacked only by one (or several) of the four species reported from central Europe (*Gäumann*, 1959). Still, more than one species of *Phragmidium* could be present, and more research is therefore needed for a proper species determination.

Leafspots – The best description available of the symptoms caused by *Sphaceloma rosarum* was made by Jenkins in 1932. This fungus produced a considerable range of symptoms, and especially spots with centres that are not very light can easily be taken for blackspot. The disease is often called anthracnose and has spread all over the world. It can also affect canes and rosehips, but is only mentioned on foliage in most reports. *Sphaceloma*-leafspot was first found in 1996 in Balsgård (*Carlson-Nilsson*, 2000), but *Carlson-Nilsson & Uggla* (2005) report that it has become more serious in later years. More knowledge is needed about the severity of this disease and whether it causes substantial economical loss in rose production.

To identify resistant plants, a reliable method for infection tests must be developed but the fact that spores are difficult to find in the lesions renders future research difficult. However, leaves of *R. spinosissima* (sect. *Cinnamomeae*) which were evaluated for comparison, turned out to be very severely infected by *Sphaceloma rosarum* but had almost no other diseases, including *Septoria*-leafspot. The symptoms of *Sphaceloma*-leafspot were very clear and easy to recognize, making this species ideal for gathering spores in the field, and to use as a standard in infection trials.

Information about the second leafspot disease in this study, caused by *Septoria rosae,* is very scarce and the species is only mentioned without a description in the Compendium of Rose Diseases (*Horst*, 1983). In Sweden, this disease was reported by *Gram & Weber* (1946) as a leafspot disease, while *Nilsson & Åhman* (1987) describe the leafspots but also mention symptoms on the shoots. They state that the disease occurs mainly on certain types of *R. canina* but provide no further information in regard to this.

Septoria rosae is easily confused with *Spaceloma rosarum* or even with blackspot. Unfortunately, the two leafspot species could not be unambiguously distinguished in the field. *Septoria*-leafspot had never before been noted at Balsgård, and it is not clear how serious this disease is in general on dogroses. A reliable diagnosis can only be made with a microscope, preferably when plants have been exposed to moist conditions which trigger the release of characteristic spore tendrils. When spore tendrils are absent, the symptoms can resemble blackspot even under the microscope; some fungal growth is visible and the dark pycnidia can be taken for the black acervuli of *Marssonina rosae*. Conidia are often found in large amounts, indicating that it would be easier to develop an infection test for *Septoria rosae* than for *Sphaceloma rosarum*.

Plant breeding prospects

Dogroses unfortunately do not appear to be resistant to foliar fungi, and there was no evidence of dominantly inherited resistance genes, which could have been easily introduced into new rose cultivars. Still, significant variation in disease susceptibility was found among subsections, species and progeny groups, thus fulfilling a basic requirement for plant breeding: the existence of genetic variability.

The two species in subsect. *Vestitae*, *R. sherardii* and *R. mollis,* did not differ significantly for any of the three evaluated diseases when evaluated in Field I. Overall, they showed relatively high values for blackspot, and low to medium values for leafspots and rust compared to the other species. The high similarity between the two *Vestitae* species is in keeping with results obtained with microsatellite DNA analyses, which suggest that Swedish *R. mollis* can be regarded as a tetraploid form of *R. sherardii* (*Nybom* et al., 2006).

Rosa caesia, *R. canina* and *R. dumalis*, all belonging to subsect. *Caninae*, also had quite similar disease scores except that *R. canina* was significantly more susceptible to rust. In general, these three species had low values for blackspot, medium for rust and high for leafspots. DNA marker analysis on genetic differentiation has previously suggested that these three species overlap considerably but are well differentiated from species in other subsections (*Olsson* et al., 2000).

Finally, *R. rubiginosa* was the only species investigated in subsect. *Rubigineae*. This species had the lowest amount of leafspots as previosly reported also by Carlson-Nilsson & Uggla (2005), and showed no symptoms at all of *Septoria*-leafspot, for which it may be tolerant or even resistant. By contrast, *R. rubiginosa* had medium to high values for blackspot and the highest values for rust in Field I. However, analyses of progeny groups in Field II suggest that there was much less increase with time for these diseases in *R. rubiginosa* compared to the other species. *Ritz* et al. (2005) found the lowest incidence of rust on *R. rubiginosa* when compared to *R. canina* and *R. corymbifera*. They propose that this was due mainly to the fact that *R. rubiginosa* is less common in Germany than the other two species, and the pathogen might therefore be better adapted to those than to *R. rubiginosa*.

The large difference between progeny group 9007 and the other progeny groups derived by intraspecific crosses in *R. dumalis* shows that there is considerable intraspecific variation in disease resistance. In addition, the differences found between the progeny groups with *R. rubiginosa* as seed parent, and with either the same species or *R. dumalis* or *R. sherardii* as pollen parent, suggest that there is a considerable influence of the pollen parent in spite of the matroclinal inheritance in dogroses. A similar effect of pollen parent was reported also in investigations of inter-sectional crosses involving dogrose species (*Uggla & Carlson-Nilsson*, 2005).

Acknowledgements

Financial support was received from the Commission of the European Communities, specific Research programme 'Quality of Life and Management of Living Resources', QLRT-2001-01278 'Genetic evaluation of European rose resources for conservation and horticultural use'. It does not necessarily reflect its views and in no way anticipates the Commission's future policy in this area.

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