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EFFECT OF VEGETABLE AND MINERAL OILS ON THE DEVELOPMENT OF *Diplocarpon rosae* Wolf. – THE CAUSAL AGENT OF BLACK SPOT OF ROSE

WPŁYW OLEI ROŚLINNYCH I MINERALNYCH NA ROZWÓJ *Diplocarpon rosae* Wolf. SPRAWCĘ CZARNEJ PLAMISTOŚCI RÓŻY

Abstract: Experiments were carried out to determine the effect of vegetable oils: corn, olive, rapeseed, sunflower, soybean, and grape; vegetable oils recommended as adjuvants: Dedal 90 EC (90 % vegetable oil) and Olejan 80 EC (85 % rapeseed oil); and mineral oils: Atpolan 80 EC (76 % SN oil), Ikar 95 EC (95 % SAE petroleum oil), Olemix 84 EC (84 % DSA petroleum oil), Promanal 60 EC (60 % petroleum oil), used at a concentration of 1 % for spraying rose bushes 9 times at 7-day intervals in order to control the black spot disease caused by *Diplocarpon rosae*.

The results do not allow the drawing of a clear conclusion as to which of the tested vegetable or mineral oils showed the highest effectiveness in inhibiting the development of the symptoms of black spot and the fungus *D. rosae*. It was found that the percentage effectiveness of the tested oils relative to the control depended on the type of oil, the time of observation and the experiment. Depending on the experiment and the time of observation, different percentage rates of the inhibition in the development of disease symptoms were obtained. After spraying the roses 3 times, the effectiveness of the tested oils ranged from 35.8 % (sunflower oil) to 77.8 % (Atpolan 80 EC); after 6 applications, it was from 26.8 % (olive oil) to 55 % (Olejan 85 EC); and after a total of 9 treatments, it was from 29.5 % (corn oil, soybean oil and Olemix 84 EC) to 58.6 % (olive oil). There was no evidence of phytotoxicity of the tested oils to the variety of rose on which the experiments were conducted.

Keywords: *Diplocarpon rosae*, vegetable and mineral oils, control, rose

Introduction

In the cultivation of roses in open field and under cover, one of the most serious and most common diseases of *Rosa thea* × *hybrida* is the black spot disease caused by the fungus *Diplocarpon rosae* Wolf. In susceptible varieties, already in May, brown spots

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appear on the lower leaves, around which yellow tissues can be seen. Before long, the diseased leaves fall off, and, in the absence of protection, in the second half of summer the affected rose bushes can become completely devoid of foliage. In the commercially available plant material there are several varieties and species of roses that are low--susceptible or resistant to the pathogen. However, market demands in relation to the quality and quantity of cut flowers produced per unit surface area make it inevitable that the cultivated crops include a number of varieties and species susceptible or very susceptible to black spot [1]. The basic method of controlling the disease relies on the use of chemical plant protection products. Literature data on the control of black spot indicate high effectiveness of synthetic fungicides, biopreparations such as garlic juice, chitosan, grapefruit extract the product Atonik stimulating plant growth and foliar fertilizers.

In the last century, pesticides were largely adopted to counteract the action of pests and disease, and to increase plant health and yield. However, the continuous use of chemical fungicides for plant defence caused great environmental impact, the onset of resistance phenomena within some populations of fungal pathogens as well as acute and general toxicity to humans and non-target organisms [2]. Therefore, oils whose mechanism of action is different from that of the previously used means could prove highly useful for controlling plant pathogens. Natural oil-based fungicides have excellent spreading and leaf-surface adhesion characteristics, and because of their rapid biodegradation have a low toxicity to people and cause little environmental impact [2].

Adjuvants, among them vegetable and mineral oils, can be used as a means of enhancing the action of the active ingredients of herbicides [3, 4], fungicides [5–7], insecticides [8], and fertilizers [9–12]. However, any improvement in the effectiveness of fungicides may depend on their formulation [5].

The author's own experiments on ornamental plants, as well as those of other researchers on fruit plants or vegetables, have shown high effectiveness of oils in controlling the pathogens that are the causal agents of powdery mildew [13, 14], leaf spot [15, 16], rust [17, 18] and grey mould [19]. Therefore, in the protection of roses against black spot, vegetable and mineral oils may prove useful, in addition to the already mentioned fungicides and bio-preparations. Oils might be used as alternatives to conventional fungicides and integrated into programmes that already include other necessary materials, thereby reducing the frequency of use of all the fungicide groups in the programme and the risk of developing resistance to them [13]. Oils are considered to be the oldest natural pesticides, as documented by a Roman scholar in the 1st century [20] cited by Jee et al [21].

According to the literature, various oils have also been used to control insect and mite pests for hundreds of years. The following pests are good candidates for being controlled by oil sprays: pine needle scale, oystershell scale, euonymus scale, aphids, spider mites, and small pine sawfly larvae [22].

The mechanism of action of vegetable oils consists in acting directly and indirectly on pathogens. Mineral oils, on the other hand, act mainly in a direct way [7]. Direct action involves dehydration of fungal cells and often disintegration of the cell walls [7].

By contrast, indirect action is associated with the induction of resistance in the plants being protected.

Among the many elicitors of *induced systemic resistance* (ISR) in plants listed in the literature there are also oleic acid, linoleic acid, and linolenic acid – the main components of the vegetable oils used in the present experiments [23] (Table 1).

Table 1

Percent by weight of total fatty acids

Oil	Unsaturated/ saturated ratio	Saturated		Mono unsaturated	Poly unsaturated	
		Palmitic ccid C16:0	Stearic acid C18:0	Oleic acid C18:1	Linoleic acid (ω 6) C18:2	Alpha linolenic acid (ω3) C18:3
Canola oil	15.7	4	2	62	22	10
Corn oil (maize oil)	6.7	11	2	28	58	1
Grape seed oil	7.3	8	4	15	73	—
Olive oil	4.6	13	3	71	10	1
Soybean oil	5.7	11	4	24	54	7
Sunflower oil	7.3	11	5	28	51	5

Source: http://www.scientificpsychic.com/fitness/fattyacidsl.html

Studies conducted so far have shown that ISR is most effective against fungi, less effective against bacteria and least effective against systemic viruses [24]. In an experiment by Cohen et al [25], five unsaturated fatty acids were tested for their ability to induce systemic resistance in potato plants to the late blight fungus *Phytophthora infestans* (Mont.) de Bary. Linoleic acid, linolenic acid and oleic acid applied to leaves 1–3 of potato plants at a dose of about 1 mg per plant induced (provided) 82 %, 39 % and 42 % protection in leaves 4–11, respectively. Also Clayton et al [26] cited by Northover and Schneider [15] used multiple-spray programmes to protect tobacco seedlings from blue mould (*Peronospora tabacina* D.B. Adam) and found that vegetable oils with high proportions of linoleic acid ($C_{18:2}$) or other polyunsaturated acids were fungicidal, whereas oils with high proportions of the monounsaturated oleic acid ($C_{18:1}$) were nonfungicidal. These results have not always been confirmed by other researchers. In experiments by Northover and Schneider [15] there was no difference in fungicidal activity between two groups of oils with compositions either high or low in linoleic acid toward three foliar pathogens: *Podosphaera leucotricha* (Ell. et Ev.) Salmon, *Venturia inaequalis* (Cooke) Winter) and *Albugo occidentalis* G.W. Wils. Calpouzos [27] and Whiteside [28] considered it likely that oil exerted a therapeutic action not directly on the pathogens, but rather through an alteration in the physiology of the host. On the other hand, Northover and Schneider [13] found that the regrowth and reappearance of powdery mildew lesions after treatment with plant oils, and to a lesser extent with petroleum oils, showed that these oils had a fungistatic rather than fungicidal effect, possibly indicating a temporary effect on host physiology.

The effect of oils on the practical value of the resulting crop can also be very significant. Roszyk et al [29] found that rapeseed oil and the mineral oil Atpolan used as additions to the working solution of foliar fertilizers significantly increased the yield of greenhouse tomato. Oils have also been used in fruit and vegetable storage. Brooks et al [30] reported that fruit wrapped in tissue paper containing 15 % mineral oil developed much less scald after cold storage.

In case of a wrong selection of oils in relation to the time of year and the plant species to be protected, the problem of phytotoxicity may occur. The results of phytotoxicity tests obtained by different researchers may be contradictory, depending on the oils used, their concentrations and weather conditions during their application. Rongai et al [2] demonstrated that vegetable oils showed no phytotoxicity, while the formulations based on mineral oils showed a significantly lower fresh and dry weight of tomato plants. The use of oils for spraying plants during the growing season can affect plant photosynthesis and respiration. Wedding et al [31] found that the application of petroleum oil emulsions depressed the rate of photosynthesis in orange and lemon leaves. Some inhibition of the process persisted as long as determinations were made (59 days). A corresponding but smaller decrease in respiration was found in those oil-treated leaves. Other data suggested that at least part of the decrease in the percentage of soluble solids (sugars and citric acid) in the juice of fruits associated with oil-spray applications might be due to the inhibition of photosynthesis. Those results were not confirmed by later studies on rose. In experiments by Goszczynski and Tomczyk [32] on rose shrubs, the intensity of photosynthesis and dark respiration of leaves were measured 24 hours and 3 weeks after the application of Sunspray 850 EC (Ultra Fine) oil. No significant effect of 1 % and 2 % oil solutions on the intensity of photosynthesis in mature rose leaves was found 24 hours after spraying. The resistance of the stomata of oil-treated rose leaves remained unchanged.

The aim of the experiments was to determine the effect of vegetable and mineral oils on the development of Diplocarpon rosae Wolf. – the causal agent of black spot of rose.

Materials and methods

The following compounds were used in the experiments:

– **Vegetable oils used as food:** corn seed oil, olive (fruit) oil, rapeseed oil (canola oil), soya seed oil, and sunflower (seed) oil.

– **Vegetable oils recommended for plant protection:** Dedal 90 EC (90 % vegetable oil) – produced by Danmark Lodz Poland, Olejan 80 EC (85 % rapeseed oil) – produced by Danmark Lodz Poland.

– **Mineral oils:** Atpolan 80 EC (76 % SN oil) – produced by Agromix Niepołomice Poland, Ikar 95 EC (95 % SAE petroleum oil) – produced by Danmark Lodz Poland, Olemix 84 EC (84 % DSA petroleum oil) – produced by Danmark Lodz Poland, Promanal 60 EC (60 % petroleum oil) – produced by Neudorff GmbH KG Germany, Sunspray 850 EC (85 % mineral oil) – produced by Sun Oil Company (Belgium).

– **Fungicides:** Saprol 190 EC (190 g triforine per dm^3) produced by American Cyanamid Company USA, and Score 250 EC (250 g difenoconazole per dm^3) produced by Syngenta Crop Protection AG, Switzerland.

– **Surfactant:** Tergitol™ 15 – S-9) produced by DOW Chemical Co.

The experiments were carried out on roses cv. 'Red Berlin', grown in an open field and susceptible to black spot. During the course of the experiments the roses were watered using a capillary system to prevent the applied agents from being washed off the surface of the plants during sprinkling. When the symptoms of black spot (*D. rosae*) were found on the plants, a total of 9 spray treatments were carried out at 7-day intervals with oils at a concentration of 1 %. In all the experiments, shrubs were sprayed in the morning using 1 dm^3 of working solution per 10 m^2 of surface area. Both the upper and lower surface of the leaf blade was thoroughly covered. Tergitol™, at a concentration of 0.3 %, was added to the spray mixtures of the vegetable oils used. The effectiveness of the tested oils (the severity of infection) was determined using a ranking scale before the experiment and after 3 days from the execution of the 3rd, 6th and 9th spray treatment (Table 2).

A total of three series of experiments were carried out in consecutive years at different initial severity of disease symptoms and different weather conditions. Score 250 EC (difenoconazole) or Saprol 190 EC (triforine) was used as the standard (reference) fungicide. Using a formula, the percentage effectiveness of the oils in inhibiting the development of black spot was calculated [33].

The experiment was set up in a randomised block design with 4 replications, each replication consisting of 5 plants.

Results

In 2004, after the 3rd spray treatment of the roses, the percentage effectiveness of the tested oils ranged from 59.3 % (corn oil) to 77.8 % (Atpolan 80 EC). After spraying the shrubs 6 times, the effectiveness of the tested oils decreased slightly and ranged from 40 % (Promanal 60 EC) to 55 % (Olejan 80 EC). After the 9th treatment, the effectiveness of the tested oils relative to the control roses was similar and ranged from 34.6 % (grape seed oil) to 55.8 % (corn oil, sunflower oil). Neither after the 3rd nor after the 6th treatment was there any leaf drop observed, meaning there was no drastic decrease in the decorative value of the shrubs. The tested vegetable and mineral oils showed a significantly lower rate of effectiveness compared with the fungicide Saprol 190 EC (Table 2).

In 2005, after spraying the roses 3 times, the percentage effectiveness of the tested oils was from 37 % (Ikar 95 EC, Promanal 60 EC) to 62.9 % (canola oil). After the 6th treatment, the effectiveness of the tested oils decreased slightly and ranged from 35.5 % (grape seed oil) to 51.6 % (Olejan 80 EC). After spraying the plants 9 times, the effectiveness of the tested oils relative to the control roses increased slightly and ranged from 47.1 % (Olemix 84 EC) to 58.6 % (corn oil and olive oil). There was no leaf drop observed after the 3rd and 6th treatment (except for grape seed oil) and consequently no drastic reduction in the decorative value of the plants. The tested vegetable and mineral oils showed a significantly lower effectiveness in comparison with the fungicide Saprol 190 EC (Table 3).

Table 2

Effectiveness of some oils in the control of *Diplocarpon rosae* Wolf.
on roses cv. Red Berlin. Mean degree of shoots infection.
Beginning of experiment and initial disease level: 2004.06.01 = 0.1

Treatment	Conc. in %	After sprayings		
		3	6	9
Control	—	1.35 f	3.00 g	5.20 g
Saprol 190 EC	0.15	0.15 a	0.40 a	1.00 a
Plant oils used as a food (Cooking oil)				
Corn oil (maize oil)	1.0	0.55 e	1.60 de	2.40 b
Grape seed oil	1.0	0.40 b–d	1.70 ef	3.40 f
Olive oil	1.0	0.35 bc	1.60 de	2.35 b
Rape oil (canola oil)	1.0	0.40 b–d	1.60 de	2.30 b
Soybean oil	1.0	0.35 bc	1.65 e	2.45 b
Sunflower oil	1.0	0.45 c–e	1.60 de	2.30 b
Plant oils recommended in plant protection				
Dedal 90 EC	1.0	0.55 e	1.45 bc	3.00 de
Olejan 80 EC	1.0	0.50 de	1.35 b	2.90 cd
Mineral oils				
Atpolan 80 EC	1.0	0.30 b	1.60 de	2.80 c
Ikar 95 EC	1.0	0.35 bc	1.50 cd	2.80 c
Olemix 84 EC	1.0	0.40 b–d	1.70 ef	3.15 e
Promanal 60 EC	1.0	0.55 e	1.80 f	3.15 e

Note: Mean values marked with the same letter in each observation do not differ at the significance level p = 0.05 according to the Duncan's test.
Disease index: 0 – no diseases symptoms, 1 – from 0.1 tp 25 % of leaves with disease symptoms, 2 – over 25 % of leaves with disease symptoms, 3 – up to 25 % of fallen leaves and the rest with disease symptoms, 4 – from 25 to 50 % of fallen leaves, 5 – from 50 to 90 % of fallen leaves, 6 – over 90 % of fallen leaves.

Table 3

Effectiveness of some oils in the control of *Diplocarpon rosae* Wolf.
on roses cv. Red Berlin. Mean degree of shoots infection.
Beginning of experiment and initial disease level: 2005.06.15 = 0.3

Treatment	Conc. in %	After sprayings		
		3	6	9
Control	—	1.35 f	3.10 h	5.80 f
Saprol 190 EC	0.15	0.25 a	0.70 a	1.45 a
Score 250 EC	0.05	0.15 a	0.60 a	1.45 a
Plant oils used as a food (Cooking oil)				
Corn oil (maize oil)	1.0	0.80 de	1.90 fg	2.40 b
Grape seed oil	1.0	0.80 de	2.00 g	2.70 d

Table 3 contd.

Treatment	Conc. in %	After sprayings		
		3	6	9
Olive oil	1.0	0.70 de	1.55 bc	2.40 b
Rape oil (canola oil)	1.0	0.50 b	1.55 bc	2.75 de
Soybean oil	1.0	0.75 de	1.70 c–e	2.80 de
Sunflower oil	1.0	0.55 bc	1.75 d–f	2.70 d
Plant oils recommended in plant protection				
Dedal 90 EC	1.0	0.75 de	1.60 b–d	2.70 d
Olejan 85 EC	1.0	0.75 de	1.50 b	2.70 d
Mineral oils				
Atpolan 80 EC	1.0	0.80 e	1.55 bc	2.80 de
Ikar 95 EC	1.0	0.85 e	1.85 e–g	2.55 c
Olemix 84 EC	1.0	0.75 de	1.85 e–g	2.85 e
Promanal 60 EC	1.0	0.85 e	1.70 c–e	2.80 de

Explanation – see Table 1.

Table 4

Effectiveness of some oils in the control of *Diplocarpon rosae* Wolf.
on roses cv. Red Berlin. Mean degree of shoots infection.
Beginning of experiment and initial disease level: 2006.05.30 = 0.45

Treatment	Conc. in %	After sprayings		
		3	6	9
Control	—	2.18 e	4.03 g	5.53 i
Control + water	—	2.30 e	4.20 h	5.70 j
Score 250 EC	0.05	0.60 a	1.40 a	2.75 a
Plant oils used as a food (Cooking oil)				
Corn oil	1.0	1.25 bc	2.70 e	3.90 gh
Olive oil	1.0	1.30 cd	2.95 f	3.75 d–f
Rape oil (canola oil)	1.0	1.30 cd	2.60 de	3.65 b–d
Soybean oil	1.0	1.30 cd	2.85 f	3.90 gh
Sunflower oil	1.0	1.40 d	2.85 f	3.55 b
Plant oils recommended in plant protection				
Dedal 90 EC	1.0	1.30 cd	2.35 b	3.70 c–e
Olejan 85 EC	1.0	1.20 bc	2.45 bc	3.60 bc
Mineral oils				
Atpolan 80 EC	1.0	1.15 b	2.45 bc	3.80 e–g
Ikar 95 EC	1.0	1.20 bc	2.45 bc	3.85 f–h
Olemix 84 EC	1.0	1.30 cd	2.40 bc	3.90 gh
Promanal 60 EC	1.0	1.20 bc	2.45 bc	3.80 e–g
Sunspray 840 EC	1.0	1.20 bc	2.50 cd	3.95 h

Explanation – see Table 1.

In 2006, after the 3rd spray treatment of the roses, the percentage effectiveness of the tested oils ranged from 35.8 % (sunflower oil) to 47.2 % (Atpolan 80 EC). After the 6th treatment, the effectiveness of the tested oils decreased slightly and ranged from 26.8 % (olive oil) to 41.7 % (Dedal 90 EC). After spraying the plants 9 times, the effectiveness of the tested oils relative to the control roses remained at a similar level and ranged from 29.5 % (corn oil and Olemix 84 EC) to 46.6 % (Sunspray 840 EC). After the 3rd treatment, the severity of infection of the shrubs was below 2.0. However, after 6 treatments, the severity of infection fluctuated already around 4.0, which was associated with severe dropping of leaves and a drastic decrease in the decorative value of the shrubs. The tested vegetable and mineral oils were significantly less effective in comparison with the fungicide Saprol 190 EC (Table 4).

Discussion

The results of the experiments do not make it possible to state clearly which of the tested vegetable or mineral oils showed the highest effectiveness in inhibiting the development of disease symptoms and the pathogen. The percentage effectiveness of the tested oils relative to the control depended on the oil being tested, the time of observation and the experiment. Our results contrast, therefore, with those of Vawdrey et al. [6], who, while conducting field experiments on controlling yellow Sigatoka of banana, demonstrated superior effectiveness of mineral oils over vegetable oils.

As the severity of disease symptoms during the growing season increased, the effectiveness of the tested oils decreased. It seems that during the initial period of vegetation, even on very susceptible varieties, the effectiveness of the tested oils was sufficiently high until the end of June. However, in the second half of July and in August, when the weather conditions changed (cool nights, dew), the development of *D. rosae* proceeded more quickly and the effectiveness of the oils decreased significantly. It should be emphasized that in the author's own experiments, the same oils used for spraying roses showed a significant inhibiting effect on the germination of *D. rosae* spores, and thus on inhibiting the development of disease symptoms. In addition, the deformation of spores caused by the application of the oils, which could be seen under the scanning electron microscope, did not explicitly translate into the inhibition of the germination of spores [34].

In the available literature, data on the effectiveness of oils in controlling *Diplocarpon rosae* on roses are very scarce. Horst et al. [9] showed that powdery mildew, caused by *Sphaerotheca pannosa* (Wallr. Ex Fr.) Lév. var. *rosae* Wor., and black spot, caused by *Diplocarpon rosae*, were significantly controlled by weekly sprays of 0.063 M aqueous solution of sodium bicarbonate plus 1.0 % (v/v) Sunspray ultrafine spray oil on *Rose* spp. Experiments by Osnaya-Gonzales et al [35] also confirmed the high effectiveness of oils in a mixture with sodium bicarbonate in controlling black spot. The authors demonstrated that formulated rapeseed oil (Telmion®) or neem oil in combination with $NaHCO_3$ gave more than 90 % effectiveness in the control of *Diplocarpon rosae*, the causal agent of black spot of rose. In their subsequent experiments, the authors also found that all vegetable oils (rapeseed, coconut, maize, olive, safflower, sesame, soybean, sunflower) in combination with $NaHCO_3$ affected the development of black spot on detached leaflets of *Rosa canina pollmeriana*, when applied as protective treatments. The necrotic lesions were smaller and the number of acervuli/lesions lower. In both experiments, maize and soybean oils were inferior to all the other oils [11]. Also, a significant increase in the fungicidal activity of potassium bicarbonate against apple scab (*Venturia inaequalis* (Cooke) Winter) was observed when salt was mixed with mineral oil. However, combining potassium bicarbonate with vegetable linseed oil and grapefruit seed extract did not increase its efficacy, whereas these two vegetable products used alone significantly reduced scab infections [10]. Northover and Schneider [15] demonstrated that sunflower, olive, canola, corn, soybean, and grapeseed oils showed only slight prophylactic activity against *Venturia inaequalis* under controlled conditions. A total of 10 applications of canola or soybean oil emulsified with Agral 90 and applied under orchard conditions reduced foliar and fruit infection with *V. inaequalis* by 66 and 81 %, respectively.

In view of the safety of vegetable oils to the environment and their almost 100 % effectiveness in controlling *S. pannosa* var. *rosae*, the main disease of roses, the possibility of inhibiting the development of *Botrytis cinerea* Pers., the causal agent of grey mould, and of *Phragmidium mucronatum* (Pers.) Schlecht. (although in other species of plants) [17, 36], these oils should certainly be included in the programme for the protection of roses from disease. It should be emphasized that the experiments on the effectiveness of the oils was carried out on a rose variety that is very susceptible to black spot. In practice, one can observe a tendency for planting those varieties that are low-susceptible or resistant to disease. In case of a need to protect low-susceptible varieties, the effectiveness of the tested oils will certainly be sufficient.

The results of the experiments have clearly shown that oils can play an important role as an alternative to synthetic fungicides in the protection of roses against black spot.

Conclusions

1. The obtained results do not make it possible to draw a clear conclusion as to which of the tested vegetable or mineral oils showed the highest effectiveness in inhibiting the development of the symptoms of black spot and the fungus *D. rosae*.

2. Depending on the experiment and the time of observation, the percentage inhibition of the development of disease symptoms was found to vary. After 3 spray treatments, the effectiveness of the tested oils varied between 35.8 % (sunflower oil) and 77.8 % (Atpolan 80 EC); after 6 applications, it was 26.8 % (olive oil) – 55 % (Olejan 85 EC); and after 9 applications, 29.5 % (corn oil, soybean oil and Olemix 84 EC) – 58.6 (olive oil).

3. There was no evidence of phytotoxicity of the tested oils to the rose plants.

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WPŁYW OLEI ROŚLINNYCH I MINERALNYCH NA ROZWÓJ *Diplocarpon rosae* Wolf. SPRAWCĘ CZARNEJ PLAMISTOŚCI RÓŻY

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Abstrakt: W przeprowadzonych badaniach polowych określano wpływ olei roślinnych (kukurydziany, olej z oliwek, rzepakowy, słonecznikowy, sojowy, winogronowy) lub olei roślinnych polecanych jako adjuwanty: Dedal 90 EC (90 % vegetable oil), Olejan 80 EC (85 % rape oil) oraz olei mineralnych Atpolan 80 EC (76 % SN oil), Ikar 95 EC (95 % SAE petroleum oil), Olemix 84 EC (84 % DSA petroleum oil), Promanal 60 EC

(60 % petroleum oil) stosowanych w stęż. 1 % do 9-krotnego opryskiwania krzewów róż w odstępach 7-dniowych w zwalczaniu czarnej plamistości powodowanej przez *Diplocarpon rosae*.

Uzyskane wyniki nie pozwalają na wyciągnięcie jednoznacznego wniosku, który z badanych olei roślinnych lub mineralnych wykazywał najwyższą skuteczność w ograniczaniu rozwoju objawów czarnej plamistości oraz grzyba *D. rosae*. Stwierdzono, że procentowa skuteczność badanych olei względem kontroli była uzależniona od rodzaju oleju, terminu obserwacji oraz doświadczenia. W zależności od doświadczenia i terminu obserwacji stwierdzono zróżnicowane procentowe ograniczanie rozwoju objawów chorobowych. Po 3-krotnym opryskiwaniu róż skuteczność badanych olei wahała się od 35,8 % (sunflower oil) do 77,8 % (Atpolan 80 EC), po 6-krotnym opryskiwaniu od 26,8 % (olive oil) do 55 % (Olejan 85 EC) oraz po 9-krotnym opryskiwaniu od 29,5 % (corn oil, soybean oil and Olemix 84 EC) do 58,6 % (olive oil). Nie stwierdzono fitotoksyczności badanych olei w stosunku do odmiany róż, na której prowadzono doświadczenia.

Słowa kluczowe: *Diplocarpon rosae*, oleje roślinne i mineralne, zwalczanie, róża