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EVALUATION OF THE EFFECTIVENESS OF AGRO-SORB FOLIUM AND ITS MIXTURES WITH FUNGICIDES IN THE PROTECTION OF ROSES AGAINST POWDERY MILDEW

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Summary. The study evaluated the effectiveness of the Agro-Sorb Folium plant growth stimulant and Domark 100 EC and Discus 500 WG fungicides used individually or in a mixture for spraying 4–6 times 'Aga' rose bushes grown in a greenhouse in the protection against powdery mildew (*Podosphaera pannosa*). Agro-Sorb Folium used at a concentration of 1% in a mixture with the fungicide Domark 100 EC at concentrations of 0.01%, 0.02%, 0.03%, 0.04% and 0.05%, showed, after four spray treatments, an efficacy of 93.2–100% depending on fungicide concentration. After spraying six times, Agro-Sorb Folium in a mixture with the same fungicide, depending on its concentration, showed an efficacy of 88–97.8%. By comparison, after forth spray treatments, Agro-Sorb Folium used at a concentration of 1% in a mixture with the fungicide Discus 500 WG at concentrations of 0.012%, 0.024% and 0.03% showed an efficacy of 96–100%. After spraying six times, Agro-Sorb Folium in a mixture with the same fungicide in the tested concentrations showed an efficacy of 93.2–96%. As the concentration of the fungicides increased, the effectiveness of the tested mixture also increased. The study showed the possibility of lowering the concentrations of the fungicides by up to 80% by using them in a mixture with Agro-Sorb Folium at a concentration of 1%, while maintaining, or even increasing, their efficacy compared to individual use. Agro-Sorb Folium at a concentration of 1% used in a mixture with the fungicides, depending on their concentration, caused an increase in fresh weight of 11.3–23.8%, compared to control plants. There were no symptoms of phytotoxicity on rose bushes after using the tested agents and their mixtures.

Key words: Agro-Sorb Folium, Domark 100 EC, Discus 500 WG, mixture, protection, *Podosphaera pannosa*

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INTRODUCTION

Since the early 1990s there has been in Poland an increased interest, on the part of both agricultural and horticultural producers, as well as manufacturers of products for agricultural production, in the possibility of combined use of agrochemicals, i.e. the simultaneous use of various plant protection products, or plant protection products combined with liquid fertilizers [Pruszyński et al. 2013]. Research on the possibility of mixing plant protection products has been carried out in various countries for many years due to the possibility of limiting in this way the risk of the development of resistance to the existing plant protection products, improving the effectiveness of the agents used, expanding the range of agrophages to be controlled, limiting the amount of work associated with spraying, overlapping dates of foliar fertilization with protection against agrophages, as well as reducing the risk of environmental contamination [Pruszyński et al. 2013]. Research to date has indicated mainly the possibility of mixing fungicides to increase their effectiveness by obtaining a synergistic effect [Scardavi 1966, Gisi et al. 1985, Grabski and Gisi 1987, Gisi 1996] or recommended them for preventing the emergence of resistance and for controlling strains of fungi resistant to the fungicides used so far [Grabski and Gisi 1985, Lalancette et al. 1987, Samoucha and Gisi 1987, Amoucha and Cohen 1988, Cohen and Levy 1990, Shaw 1993, Köller and Wilcox 2000, Emery et al. 2002, Mavroeidi and Shaw 2006, Holb and Schnabel 2007, Hobbelen et al. 2011, Hobbelen et al. 2013, van den Bosch et al. 2014, Mikaberidze et al. 2014]. From a practical point of view, new mixtures of products proposed for use should be evaluated for their effectiveness, since sometimes an antagonistic effect may occur, and the agents in mixtures may show reduced effectiveness [Couch and Smith 1991, De Waard 1996]. It should be remembered that the basic method of protecting roses against *Podosphaera pannosa* (Wall.) De Bary, the causal agent of powdery mildew, is the use of fungicides [Wojdyła 2018b]. The lack of a sufficient number of recommended fungicides with different mechanisms of action against pathogens is the reason that in recent years in Poland and Western Europe there has been an increase in pathogen resistance to fungicides [Wojdyła and Łazęcka 2014]. One of the possibilities of limiting the emergence of resistance to fungicides is the use of unconventional agents (plant growth stimulants, foliar fertilizers, oils, biopreparations) that show a different mechanism of action against pathogens compared to the recommended fungicides [Wojdyła 2016, 2017b, 2018a]. Apart from fungicides, products whose main ingredient is amino acids have been recommended for several years now to protect roses against powdery mildew. In research to date, products containing amino acids have shown high effectiveness in the protection of ornamental plants against powdery mildew, rust and leaf spot, as well as *Sclerotinia* rot in bean [Wojdyła and Sobolewski 2016, Wojdyła 2017a, 2018a]. The tested products containing amino acids also stimulated plant growth in terms of fresh and dry weight [Wojdyła 2017a, 2018a].

The aim of the present study was to determine the effectiveness of the plant growth stimulant Agro-Sorb Folium applied on its own or in a mixture with fungicides, in the recommended or reduced concentrations, in limiting the development of *Podosphaera pannosa* (Wall.) De Bary on rose bushes.

MATERIAL AND METHODS

The study involved the use of the plant growth stimulant Agro-Sorb Folium [total amino acids 12% (free amino acids 9.3% + peptides 2.7%) + total nitrogen (N) 2.1% + boron (B) 0.02% + manganese (Mn) 0.05% + zinc (Zn) 0.07%] and the fungicides Domark 100 EC (100 $g \cdot l^{-1}$ tetraconazole) and Discus 500 WG (50% kresoxim methyl), which were applied individually or in a mixture for spraying roses grown in a greenhouse to protect them against powdery mildew. The experiments were carried out on rose bushes of the cultivar Aga, which is very susceptible to powdery mildew, planted in 1 dm^3 containers placed on a windowsill in a greenhouse. During the experiments, the air humidity in the greenhouse was maintained around 70%, and the temperature ranged from 17 to 25°C. The plants were watered by directing a stream of water directly onto the substrate or the capillary mat on which the containers were placed. After the onset of powdery mildew symptoms, Agro-Sorb Folium and the fungicides Domark 100 EC and Discus 500 WG were used individually or in mixtures for spraying the plants six or four times every seven days at the various concentrations. Control plants were sprayed with water and the remaining plants with the products tested at various concentrations using 100 ml of liquid per 1 m^2. During the treatments, the spray nozzle was guided at a height of 30 cm above the plants and the top and bottom surfaces of leaf blades were thoroughly wetted. Observations of disease severity according to a six-point scale were made before the start of the experiment and three days after performing two, four and six treatments, or two and four treatments, and also two weeks after the completion of treatments. Observations regarding possible phytotoxicity of the tested products or their mixtures were carried out three days after spraying, according to an eight-point scale [Wojdyła 2018b].

At the end of the first experiment, the aerial part of the plant was separated from the underground part with a scalpel and weighed to determine the fresh weight for each replication. Dividing the total weight by the number of plants in the replication, the mean fresh weight of a single plant was obtained. Next, after placing the aerial parts from individual replications in envelopes, they were stored in forced-air incubators at 70°C for 24 h. After removal from the incubator, the plant material was again weighed with and without envelopes. The final dry weight for the aerial parts was divided by the number of plants in the replication (15) to obtain the results per single plant.

The experiment was established in a random block design with four replications of 15 bushes each. The obtained data were statistically analysed by analysis of variance, and the significance of the difference between means was assessed with Duncan's test at the level of $p = 0.05$. Next, the percentage reduction in the degree of infection of leaf and shoot surfaces was calculated for individual treatments in relation to the control treatment (unprotected) using the simplified Abbott's formula [Abbott 1925].

RESULTS AND DISCUSSION

In the first experiment, in the observations carried out three days after the second spraying of roses, Domark 100 EC (0.05%) and Discus 500 WG (0.03%) showed a 93.3% and 80% efficacy, respectively, in reducing the development of powdery mildew

symptoms (Table 1). Agro-Sorb Folium at a concentration of 1% showed an efficacy of 71.7%. Agro-Sorb Folium used at a concentration of 1% in a mixture with the fungicide Domark 100 EC at a concentration of 0.01–0.05% showed an efficacy of 83.3–96.3%. Even when the concentration of the fungicide in the tested mixture was reduced by 80%, the effectiveness of the mixture was higher than 83%. Similarly, Agro-Sorb Folium used at a concentration of 1% in a mixture with the fungicide Discus 500 WG at a reduced concentration of 0.024% and 0.012% showed an efficacy of 86.7% and 81.7%, respectively.

In the observations carried out three days after the fourth spraying of roses, Domark 100 EC and Discus 500 WG showed a 100% and 93.1% efficacy, respectively, in reducing the development of powdery mildew symptoms (Table 1). Agro-Sorb Folium at a concentration of 1% showed an efficiency of 84.5%. No symptoms of the disease were found on the roses sprayed with Agro-Sorb Folium at a concentration of 1% in a mixture with the fungicide Domark 100 EC at a concentration of 0.03–0.05%. By comparison, a mixture containing the Domark 100 EC fungicide at a concentration of 0.02% and 0.01% showed an efficacy of 98.8% and 97.4%, respectively. Similarly, Agro-Sorb Folium used at a concentration of 1% in a mixture with Discus 500 WG at a reduced concentration of 0.024% and 0.012% showed an efficacy of 100% and 97.4%, respectively.

In the last two weeks of the experiment, air temperature during the day and temperature drops during the night (even below 12°C), and also new shoot growth were favourable to the intensification of disease symptoms. Therefore, all the products used individually and in mixtures showed lower effectiveness than in the observations carried out after the forth spraying of the bushes (Table 1). In the observations carried out three days after the sixth spraying of roses, the fungicides Domark 100 EC and Discus 500 WG showed a 99% and 92% efficacy, respectively, in reducing the development of powdery mildew symptoms (Table 1). Agro-Sorb Folium at a concentration of 1% showed an efficacy of 61%. Agro-Sorb Folium used at a concentration of 1% in a mixture with the fungicide Domark 100 EC at a concentration of 0.01–0.05% showed an efficacy of 88–97.8%. Even when the fungicide concentration in the tested mixture was reduced by 80%, the effectiveness of the mixture was very high and amounted to 88%. Similarly, Agro-Sorb Folium used at a concentration of 1% in a mixture with Discus 500 WG at a reduced concentration of 0.024% and 0.012% showed an efficacy of 96% and 93.2%, respectively. In each observation, as the fungicide concentration increased, the effectiveness of the tested mixture also increased.

In the second experiment, in the observations carried out three days after the second spraying, the fungicide Domark 100 EC at a concentration of 0.01–0.04% showed, depending on the concentration, an efficacy of 94.9–99.8%. On the bushes sprayed with Domark 100 EC at a concentration of 0.05%, no symptoms of powdery mildew were found. By comparison, Discus 500 WG used at concentrations of 0.012%, 0.024% and 0.03% showed, depending on the concentration, an efficacy ranging from 95.1 to 98.5% in reducing the development of powdery mildew symptoms (Table 2). No symptoms of the disease were found on the bushes sprayed with Agro-Sorb Folium at a concentration of 1%. The Agro-Sorb Folium growth stimulant used at a concentration of 1% in a mixture with the fungicide Domark 100 EC at a concentration of 0.01% showed an efficacy of 98.5%. When higher concentrations of the fungicide were used, no powdery mildew

Table 1. Efficacy of agents and their mixtures in limiting the development of symptoms of powdery mildew on 'Aga' roses grown in a greenhouse

Tabela 1. Skuteczność środków i ich mieszanin w ograniczaniu rozwoju objawów mączniaka prawdziwego róż na odm. Aga uprawianej w szklarni

Treatment Kombinacja	Concentration Stężenie [%]	Mean degree of plant infection after spraying Stopień porażenia rośliny po opryskiwaniach			Effectiveness after spraying Skuteczność po opryskiwaniach [%]		
		2×	4×	6×	2×	4×	6×
Control – Kontrola	–	3.00 h	4.20 e	5.00 g	–	–	–
Domark 100 EC	0.05	0.20 ab	0.00 a	0.05 a	93.3	100	99.0
Discus 500 WG	0.03	0.60 f	0.29 c	0.40 de	80.0	93.1	92.0
Agro-Sorb Folium	1.0	0.85 g	0.65 d	1.95 f	71.7	84.5	61.0
Agro-Sorb Folium + Domark 100 EC	1.0 + 0.05	0.11 a	0.00 a	0.11 ab	96.3	100	97.8
Agro-Sorb Folium + Domark 100 EC	1.0 + 0.04	0.20 ab	0.00 a	0.34 cd	93.3	100	93.2
Agro-Sorb Folium + Domark 100 EC	1.0 + 0.03	0.24 bc	0.00 a	0.40 de	92.0	100	92.0
Agro-Sorb Folium + Domark 100 EC	1.0 + 0.02	0.34 cd	0.05 b	0.50 de	88.7	98.8	90.0
Agro-Sorb Folium + Domark 100 EC	1.0 + 0.01	0.50 d-f	0.11 b	0.60 e	83.3	97.4	88.0
Agro-Sorb Folium + Discus 500 WG	1.0 + 0.024	0.40 de	0.00 a	0.20 bc	86.7	100	96.0
Agro-Sorb Folium + Discus 500 WG	1.0 + 0.012	0.55 ef	0.11 b	0.34 cd	81.7	97.4	93.2

Experiment start date and initial degree of infection – Początek doświadczenia i porażenie wstępne: 18.05.2018 = 0.4.

Mean values marked with the same letter in each column do not differ at the significance level $p = 0.05$ according to Duncan's test – Średnie oznaczone tą samą literą w kolumnach nie różnią się istotnie ($p = 0,05$) według testu Duncana.

Disease index: 0 – no symptoms, 1 – up to 1% of shoot/leaf surface area covered with mycelium, 2 – from 1.1 up to 5%, 3 – from 5.1 up to 10%, 4 – from 10.1 up to 20%, 5 – over 20% of shoot/leaf surface area covered with mycelium – Skala porażenia: 0 – brak objawów, 1 – do 1% powierzchni pędów/liści pokrytej grzybnią, 2 – od 1,1 do 5%, 3 – od 5,1 do 10%, 4 – od 10,1 do 20%, 5 – powyżej 20% powierzchni pędów/liści pokrytej grzybnią.

symptoms were found on the roses. Similarly, the Agro-Sorb Folium growth stimulant used at a concentration of 1% in a mixture with the fungicide Discus 500 WG at a concentration of 0.012% showed an efficacy of 97.3%. When higher concentrations of the fungicide were used, no powdery mildew symptoms were found on the roses.

In the observations carried out three days after the forth spraying, the fungicide Domark 100 EC at a concentration of 0.01–0.04% showed, depending on the concentration, an efficacy of 92–99.8% (Table 2). No symptoms of powdery mildew were found on the bushes sprayed with Domark 100 EC at a concentration of 0.05%. By comparison, Discus 500 WG used at concentrations of 0.012%, 0.024% and 0.03% showed, depending on the concentration, an efficacy ranging from 94.2 to 97.8% in reducing the development of powdery mildew symptoms (Table 2). The Agro-Sorb Folium growth stimulant used at a concentration of 1% was 87% effective. In turn, Agro-Sorb Folium used at a concentration of 1% in a mixture with the fungicide Domark 100 EC at a concentration of 0.01% and 0.02% showed an efficacy of 93.2–97.8%. After using higher concentrations of the fungicide, no powdery mildew symptoms were found on the roses. Similarly, the Agro-Sorb Folium growth stimulant used at a concentration of 1% in a mixture with the fungicide Discus 500 WG at a concentration of 0.012% was 96% effective. When higher concentrations of the fungicide were used, no powdery mildew symptoms were found on the roses.

In the observations carried out 14 days after the last spraying of roses, the fungicide Domark 100 EC at a concentration of 0.01–0.03% showed, depending on its concentration, an efficacy of 80–99% (Table 2). No symptoms of powdery mildew were found on the bushes sprayed with Domark 100 EC at a concentration of 0.04% or higher. By comparison, Discus 500 WG showed, depending on its concentration, an efficacy ranging from 88 to 97.8% in reducing the development of powdery mildew symptoms (Table 2). The Agro-Sorb Folium growth stimulant used at a concentration of 1% was 80% effective. Agro-Sorb Folium used at a concentration of 1% in a mixture with the fungicide Domark 100 EC at a concentration of 0.01–0.03% showed an efficacy of 95.2–99%. When higher concentrations of the fungicide were used, no symptoms of powdery mildew were found on the roses. Similarly, the Agro-Sorb Folium growth stimulant used at a concentration of 1% in a mixture with the fungicide Discus 500 WG at a concentration of 0.012% and 0.024% showed, depending on the concentration, and efficacy of 96–99%. When the fungicide was used at a higher concentration, no symptoms of powdery mildew were found on the roses. In both cases, as the concentration of fungicide increased, the effectiveness of the tested mixture also increased.

Literature data indicate that the research conducted so far on the possibility of mixing plant protection products has mainly concerned the mixing of agents recommended for protection against various agrophages, or with fertilizers [Rae 2002, Pruszyński et al. 2013]. However, the research presented here has shown the possibility of mixing products containing amino acids with fungicides at the recommended or reduced dose to protect roses against powdery mildew. By using mixtures of conventional fungicides with a growth stimulant, the main ingredient of which is amino acids, it has been shown that the dose of fungicide can be reduced by up to 80% without reducing the effectiveness of the mixture, compared to the use of the fungicide alone at a dose in accordance

Table 2. Efficacy of agents and their mixtures in limiting the development of symptoms of powdery mildew on 'Aga' roses grown in a greenhouse

Tabela 2. Skuteczność środków i ich mieszanin w ograniczaniu rozwoju objawów mączniaka prawdziwego róż na odm. Aga uprawianej w szklarni

Treatment Kombinacja	Concentration Stężenie [%]	Mean degree of plant infection after spraying Stopień porażenia rośliny po opryskiwaniach		Degree of plant infection 14 days after 4× spraying Stopień porażenia rośliny po 14 dniach od wykonania 4× opryskiwania	Effectiveness after spraying Skuteczność po opryskiwaniach [%]		Effectiveness 14 days after 4× spraying Skuteczność po 14 dniach od wykonania 4× opryskiwania [%]
		2×	4×		2×	4×	
Control – Kontrola	–	4.05 e	5.00 f	5.00 f	–	–	–
Domark 100 EC	0.05	0.00 a	0.00 a	0.00 a	100	100	100
Domark 100 EC	0.04	0.01 ab	0.01 a	0.00 a	99.8	99.8	100
Domark 100 EC	0.03	0.11 cd	0.20 bc	0.05 b	97.3	96.0	99.0
Domark 100 EC	0.02	0.20 d	0.24 cd	0.24 c	95.1	95.2	95.2
Domark 100 EC	0.01	0.24 d	0.40 d	1.00 e	94.9	92.0	80.0
Discus 500 WG	0.03	0.05 bc	0.11 b	0.11 bc	98.5	97.8	97.8
Discus 500 WG	0.024	0.11 cd	0.20 bc	0.29 c	97.3	96.0	94.2
Discus 500 WG	0.012	0.20 d	0.29 cd	0.60 d	95.1	94.2	88.0
Agro-Sorb Folium	1.0	0.00 a	0.65 e	1.00 e	100	87.0	80.0
Agro-Sorb Folium + Domark 100 EC	1.0 + 0.05	0.00 a	0.00 a	0.00 a	100	100	100
Agro-Sorb Folium + Domark 100 EC	1.0 + 0.04	0.00 a	0.00 a	0.00 a	100	100	100
Agro-Sorb Folium + Domark 100 EC	1.0 + 0.03	0.00 a	0.00 a	0.05 b	100	100	99.0
Agro-Sorb Folium + Domark 100 EC	1.0 + 0.02	0.00 a	0.11 b	0.11 bc	100	97.8	97.8
Agro-Sorb Folium + Domark 100 EC	1.0 + 0.01	0.05 bc	0.34 cd	0.24 c	98.5	93.2	95.2
Agro-Sorb Folium + Discus 500 WG	1.0 + 0.03	0.00 a	0.00 a	0.00 a	100	100	100
Agro-Sorb Folium + Discus 500 WG	1.0 + 0.024	0.00 a	0.00 a	0.05 b	100	100	99.0
Agro-Sorb Folium + Discus 500 WG	1.0 + 0.012	0.11 cd	0.20 bc	0.20 c	97.3	96.0	96.0

Experiment start date and initial degree of infection – Początek doświadczenia i porażenie wstępne: 13.09.2018 = 0.3.

Note: see Table 1 – Uwaga: patrz tabela 1.

with the instructions-for-use label. The introduction of the Agro-Sorb Folium growth stimulant to the mixture resulted in an extension by other mechanisms of action against pathogens, compared to the use of fungicide on its own, and can improve the condition of plants by increasing fresh and dry weight [Wojdyła 2017a, 2018a]. Lowering the dose of fungicides used in a mixture with Agro-Sorb Folium can contribute to reducing the risk to human, animal and environmental health without decreasing the effectiveness of the treatment, while at the same time reducing the risk of pathogens becoming resistant to the fungicides used.

In the first experiment, after the completion of protective treatments, it was found that the rose plants sprayed with the growth stimulant Agro-Sorb Folium or its mixture with the fungicides Domark 100 EC and Discus 500 WG in the tested concentrations had a significantly higher fresh weight of the aerial parts, from 11.3 to 23.8% compared to the control plants (Table 3). The highest fresh weight of the aerial parts of roses was found for the plants sprayed with a mixture of Agro-Sorb Folium and Discus 500 WG at every concentration, with the fresh weight being higher than that of control plants by over 23%. By comparison, the rose plants sprayed with Agro-Sorb Folium at a concentration of 1% showed an increase in the fresh weight of aerial parts by 18.3% compared to the control. A similar relationship was found for the dry weight of the aerial parts of plants (Table 3). The roses sprayed with Agro-Sorb Folium or its mixture with the fungicides Domark 100 EC and Discus 500 WG in the tested concentrations had a significantly higher dry weight of aerial parts, from 5.8 to 14.1% in comparison with the control (Table 3). Only the plants sprayed with Agro-Sorb Folium in a mixture with the fungicide Domark 100 EC at a concentration of 0.01% had a dry weight of aerial parts similar to that of the control plants (Table 3).

For the plants sprayed with Agro-Sorb Folium at a concentration of 1%, an increase in dry weight of 17.3% was found, compared to the control roses. The obtained results are confirmation of previously conducted own research, in which Agro-Sorb Folium used for spraying roses or garden pansy caused significant stimulation of plant growth [Wojdyła 2017a, 2018a]. Explaining the mechanism of action of amino acids on pathogens, van Andel [1966] points out their fungicidal activity, reduction in pathogenicity, production of other compounds in soil or plant, disturbances in nitrogen metabolism, interference in the expression of symptoms, and increase in plant resistance to a specific pathogen. Hasabi et al. [2014], in a study of citrus bacterial canker (*Xanthomonas citri* subsp. *citri*), showed that amino acids (L-arginine, L-ornithine and L-methionine) used for spraying plants restricted the development of necrosis caused by that bacterium and affected the amounts in plant tissues of some enzymes such as catalase, peroxidase, phenylalanine ammonia-lyase, and 1,3-β glucanase. The role of phenylalanine ammonia-lyase in inducing plant defence mechanisms is associated with the biosynthesis of phytoalexins, with the conversion of phenolic compounds to lignin-like substances, and with the induction of salicylic acid, which is involved in the transmission of signals inducing local and systemic resistance of the plant. Therefore, the level of activity of this enzyme is correlated with the degree of plant resistance to infection and the aggressiveness of the pathogen [Gałązka 2013].

Table 3. Influence of Agro-Sorb Folium plant growth stimulant used in a mixture with fungicides on fresh and dry mass of aboveground parts of rose bushes. Observations after 14 days from the last spraying

Tabela 3. Wpływ stymulatora wzrostu roślin Agro-Sorb Folium stosowanego w mieszaninie z fungicydami na świeżą i suchą masę części nadziemnych krzewów różanych. Obserwacja po 14 dniach od wykonania ostatniego opryskiwania

Treatment Kombinacja	Concentration Stężenie [%]	Mean fresh weight of plant aboveground parts Średnia świeża masa części nadziemnych rośliny [g]	Increase in fresh weight of plant aboveground parts Wzrost świeżej masy części nadziemnych rośliny [%]	Mean dry weight of plant aboveground parts Średnia sucha masa części nadziemnych rośliny [g]	Increase in dry weight of plant aboveground parts Wzrost suchej masy części nadziemnych rośliny [%]
Control – Kontrola	–	5.67 a	–	1.56 b	–
Domark 100 EC	0.05	5.73 a	1.1	1.75 d	12.2
Discus 500 WG	0.03	5.36 a	–5.5	1.47 a	–5.8
Agro-Sorb Folium	1.0	6.71 bc	18.3	1.83 e	17.3
Agro-Sorb Folium + Domark 100 EC	1.0 + 0.05	6.82 bc	20.3	1.73 d	10.9
Agro-Sorb Folium + Domark 100 EC	1.0 + 0.04	6.82 bc	20.3	1.73 d	10.9
Agro-Sorb Folium + Domark 100 EC	1.0 + 0.03	6.60 bc	16.4	1.65 c	5.8
Agro-Sorb Folium + Domark 100 EC	1.0 + 0.02	6.48 bc	14.3	1.65 c	5.8
Agro-Sorb Folium + Domark 100 EC	1.0 + 0.01	6.31 b	11.3	1.53 b	–1.9
Agro-Sorb Folium + Discus 500 WG	1.0 + 0.024	7.02 c	23.8	1.77 d	13.5
Agro-Sorb Folium + Discus 500 WG	1.0 + 0.012	6.99 c	23.3	1.78 d	14.1

Experiment start date – Początek doświadczenia: 18.05.2018.

Note: see Table 1 – Uwaga: patrz tabela 1.

CONCLUSIONS

1. The tested product Agro-Sorb Folium, containing amino acids, used in a mixture with fungicides at reduced concentrations, due to its acting as plant growth stimulant and also as an inhibitor of the development of many foliar pathogens, can be used in the integrated protection of roses or other plant species for combined use with fungicides in order to reduce their concentrations.
2. The study showed the possibility of reducing the concentration of the fungicides by up to 80% by using them in a mixture with Agro-Sorb Folium at a concentration of 1%, while maintaining or even increasing the efficacy, compared to their individual use.
3. Agro-Sorb Folium used in a mixture with the fungicides Domark 100 EC and Discus 500 WG at a reduced concentration caused an increase in the fresh weight of the aerial parts of roses.
4. The tested growth promoter and fungicide used for spraying, did not cause any phytotoxicity and none changes in the appearance of rose plants were observed.

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OCENA SKUTECZNOŚCI ŚRODKA AGRO-SORB FOLIUM ORAZ JEGO MIESZANIN Z FUNGICYDAMI W OCHRONIE RÓŻ PRZED MĄCZNIAKIEM PRAWDZIWYM

Streszczenie. W badaniach oceniano skuteczność stymulatora wzrostu roślin Agro-Sorb Folium oraz fungicydów Domark 100 EC, Discus 500 WG stosowanych pojedynczo lub w mieszaninie do 4–6-krotnego opryskiwania róży odm. Aga uprawianej w szklarni w ochronie przed mączniakiem prawdziwym (*Podosphaera pannosa*). Czterokrotne opryskiwanie jednoprocentowym Agro-Sorb Folium w mieszaninie z fungicydem Domark 100 EC w stężeniach 0,01%, 0,02%, 0,03%, 0,04% i 0,05% ograniczyło rozwój objawów choroby w 93,2–100%. Zastosowanie w czterokrotnym zabiegu jednoprocentowego Agro-Sorb Folium w mieszaninie z fungicydem Discus 500 WG w stężeniach 0,012%, 0,024% i 0,03% miało skuteczność działania na poziomie 96–100%. Wraz ze wzrostem stężenia fungicydów notowano zwiększanie się skuteczności badanej mieszaniny. Badania wykazały możliwość obniżania stężeń fungicydów nawet o 80% poprzez ich stosowanie w mieszaninie z jednoprocentowym Agro-Sorb Folium przy zachowaniu, a nawet zwiększeniu skuteczności działania w porównaniu do przeprowadzenia pojedynczego zabiegu. Jednoprocentowy Agro-Sorb Folium stosowany w mieszaninie z fungicydami w zależności od ich stężenia powodował wzrost świeżej masy na poziomie 11,3–23,8% w porównaniu do roślin kontrolnych. Nie stwierdzono objawów fitotoksyczności na różach podczas stosowania badanych środków i ich mieszanin.

Słowa kluczowe: Agro-Sorb Folium, Domark 100 EC, Discus 500 WG, mieszanina, ochrona, *Podosphaera pannosa*