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EFFECT OF A MINERAL OIL ON *MYZUS PERSICAE* CAPABILITY TO SPREAD OF PVY AND PVM TO SUCCESSIVE POTATO PLANTS

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Abstract: The work involved assessment of the *Myzus persicae* (Sulz.) capability to infect successively potato plants with PVY and PVM after a Sunspray 850 EC mineral oil application. The tests were carried out in the greenhouse, with 4-week-old, healthy potato plants possessing low ressistance to viruses, derived from *in vitro* (test plants). Any time, for each combination and each virus, 10 successive plants were inoculated in 6 repetitions. Virus sources were potato plants infected with PVY or PVM, kept in isolated rooms. As a result of oil application, feeding of the *M. persicae* specimens on plants previously treated with this oil was delayed. The highest reduction as regards PVY and PVM transmission by *M. persicae* was obtained in the treatment where both plants constituting virus sources and test plants were protected, because only two of ten plants were infected with PVY, and only one with PVM. Mineral oil application only on potato test plants (healthy ones) reduced to a small degree *M. persicae* capability to transmit PVY to six successive plants (to seven in control), whereas it was much higher for PVM – to three (to six in control). In the case when only plants constituting virus sources were oil-protected, aphid's capability to transmit PVY was limited only to four plants, and PVM – to two. These results seem to confirm much more the hypothesis that mineral oil inactivates virus particles in the stylets of aphids while they attempt to acquire it from plants which have been previously protected with mineral oil.

Key words: *Myzus persicae*, mineral oil, PVY, PVM, potato, retention

INTRODUCTION

The results of many tests have proved that chemical control of aphids as vectors of *Potato virus Y* (PVY) and *Potato virus M* (PVM) did not significantly reduce seed-

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potato infection with these viruses. This has induced search for other, more effective substances, which has been carried out for a long time now. The possibility to use oil substances for protection against viruses, in particular PVY, was indicated already in the 60's (Bradley *et al.* 1962, 1966; Bradley 1963). Later research proved that certain oil substances, besides protection against PVY, may also protect potatoes against PVM (Kostiw and Iskrzycka 1976) and *Potato virus S* (PVS), and to less extent – against *Potato leafroll virus* (PLRV) (Turska 1984), while the oil protective mechanism has not been completely explained. In many studies the reduction in virus transmission was proved in these cases, when the aphid mouth parts contacted mineral oil both before taking the virus from plant, and during healthy plant inoculation (Bradley 1963; Simons *et al.* 1977; Qui and Pirone 1989; Powell 1992). The reason for reduction of this aphid capability may be direct disturbance of interactions between virus particles and their ability to remain on aphid stylets as a result of mineral oil application (Qui and Pirone 1989; Wang *et al.* 1996; Wang and Pirone 1996; Powell *et al.* 1998; Gibson *et al.* 1988; Powell 1992; Powell and Hardie 1994).

The purpose of this research was to learn about the effect of mineral oil protection for potato plants on the *Myzus persicae* (Sulz.) capability (as a virus vector) to infect successive healthy plants with PVY and PVM.

MATERIALS AND METHODS

The tests were carried out in the greenhouse, between May and July 2003. A virus-free apterae aphids clone of *M. persicae* kept on Chinese cabbage (*Brassica pekinensis* Rupr.) in insulators, in a separate room was used in the experiment. Only aphids being in good condition were selected for infection. Apterae *M. persicae* were put into glass vials and starved for approximately 2 hours, because according to Powell (1993), starved aphids start feeding faster, and besides that aphid starving contributes to the increase in virus acquisition by them, which as a consequence increases the probability of test plant infection. Four-week-old, healthy *in vitro* plants, Mila and Meduza varieties, were used as test plants. They were successively planted in pots in the greenhouse. The selection of varieties was determined by their low resistance to PVY (Mila variety – 5.5 in 1–9 scale, where 9 indicated extreme resistance), or PVM (Meduza variety – 2 in 1–9 scale). The Van Gogh variety potato plants were the source of PVY, while Meduza variety was the source of PVM. Source plants were kept in isolated rooms in the greenhouse. Recommended for potato seed crop protection, Sunspray 850 EC mineral oil (composition: 98.8 mineral oil +1.2% emulsifier) available on the market was used for test purposes. Depending on experimental treatment (Table 1), they were treated with mineral oil, concentration 3.75%, with a hand-held sprayer 24 hours before using the test plants and plants being a virus source.

The following experimental procedure was used:

After a 2-hour *M. persicae* starving, the insects were placed on virus source (PVY or PVM), where they were feeding for 2 minutes to acquire the viruses. In order to increase the pressure, and thus the probability for infection with the virus, two apterae were taken for each inoculation of a single plant. Then they were placed on a first test potato plant (plants at the age of 7 days from being planted), where they were kept for 2 minutes for inoculation purposes. After that time, the same aphids were transferred in the same way to another plant. Ten plants were inoculated with two

Table 1. Tested treatments

No.	Acquisition feed	Inoculation feed – successive plants									
		1	2	3	4	5	6	7	8	9	10
1	virus source without mineral oil protection	test plants without mineral oil protection – the check variant									
2	virus source without mineral oil protection	test plants pre-treated with mineral oil									
3	virus source protected with mineral oil	test plants without mineral oil protection									
4	virus source protected with mineral oil	test plants pre-treated with mineral oil									

M. persicae in a single series. As soon as the tenth plant had been inoculated, aphids were removed and destroyed. Acquisition times were controlled with a timer, while aphid behaviour, in particular stylet activity, was observed with a magnifying glass of power 5 or 12 times. Six repetitions (series) were made for each treatment (10 successively inoculated plants), separately for PVY and PVM.

After inoculation, the plants were left in the greenhouse until the end of vegetation, for tuber setting. After the end of vegetation, mini-tubers collected separately from each plant were put in separate, marked containers. The postharvest virus test in the greenhouse was performed in winter-spring season on collected mini-tubers. Three mini-tubers of each plant were planted, in order to reduce error related to unsteady relocation of viruses from the plant to descendant tubers. The analysis did not cover an average infection from three planted tubers, but only the fact of being infected or not. Each of the plants grown from these mini-tubers was DAS ELISA tested, using Polish polyclonal antibody.

Obtained infection results were transformed according to the following formula (Wójcik *et al.* 1976):

$$y = \log\left[100 \ln\left(1 - \frac{\text{value in \%}}{100}\right)^{-1}\right] + 1$$

value in % – values of viruses infection in percentage

and then they were subject to the variance analysis (ANOVA), at significance level $\alpha = 0.05$. Obtained average values were subject to the t-Student's test. After statistical analysis was completed, obtained values were retransformed into per cent values.

RESULTS AND DISCUSSION

The highest reduction in the PVY and PVM propagation was obtained in treatments where mineral oil was applied both onto the virus sources and the test plants (Table 2). On the contrary, it was slightly lower in the case, when only the virus source was protected with mineral oil solution.

Table 2. Potato tuber infection [%] with viruses PVY and PVM in individual treatments involving mineral oil application

No.	Virus source	Test plants	PVY	PVM
1	without protection	without protection	25.9 a	10.5 a
2	without protection	treated with oil	9.4 b	2.8 b
3	treated with oil	without protection	4.6 c	2.4 b
4	treated with oil	treated with oil	2.4 c	0.5 b

Means in the column marked with same letters do not differ significantly

Achieved results comply with data previously obtained by Powell and Hardie (1994) and Powell *et al.* (1998), who assessed *M. persicae* capability to transmit PVY to tobacco plants in laboratory tests. They found that mineral oil aplication on plants constituing virus sources was considerably impeding virus acquisition by aphids, as well as its subsequent transmission. Besides, oil layer visible on a plant was significantly delaying the start of acquisition. A similar effect was also observed during the performed experiment. Changes in aphid behaviour due to mineral oil application were indicated earlier by Simons *et al.* (1977), Powell (1992), and Powell and Hardie (1994). The opposite view was presented by Bradley (1963), Vanderveken (1968), and Qui and Pirone (1989), who noticed that mineral oil had no effect on aphid behaviour. Powell (1991, 1992), and Powell *et al.* (1992) consider that change in aphid behaviour as a result of oil application seems to be of little probability in explaining how mineral oil acts. Therefore, to a high extent, there is no direct evidence here to support the hypothesis based on virus ability to remain on stylets of *M. persicae*. Certain explanation for the reduction in aphid capability to transmit viruses on stylet may be direct disturbance of interactions between virus particles and their ability to remain on aphid stylets, in particular during the acquisition from infected plants. Qui and Pirone (1989), Wang and Pirone (1996), and Powell *et al.* (1998) agreed with that hypothesis. Wang *et al.* (1996), found that the loss of aphid capability to transmit viruses was very strongly correlated with the lack of virus particles' ability to remain on aphid stylets. This was confirmed by Wang and Pirone (1996), who had used in their research virus particles marked with radioactive Iodogen. They observed that *M. persicae* capability to transmit marked particles of *Tobacco etch virus* (TEV) was completely or drastically reduced when trying to take viruses from leaves, earlier treated with mineral oil. However, it was possible to transmit the virus to healthy plants only from 20 out of 120 check plants (not protected with mineral oil).

When assessing aphid capability to transmit PVY to successive plants, it was proved that *M. persicae* could effectively infect as many as 7 successive plants, both in check objects where no oil was applied, and in objects, in which only test plants were protected (Fig. 1). Similar results without the application of oil were obtained by Trojanowska (2004), who studied retention of two strains, PVY^{N} and PVY^{NTN}, for *M. persicae* on test plants *Physalis floridana*. She found that apterae of *M. persicae* could be an effective virus vector on 4 to 5 successive plants, depending on a strain. Moreover, an individual research proved that percentage of infected plants was definitely higher for check objects, whereas in both treatments it was generally dropping along

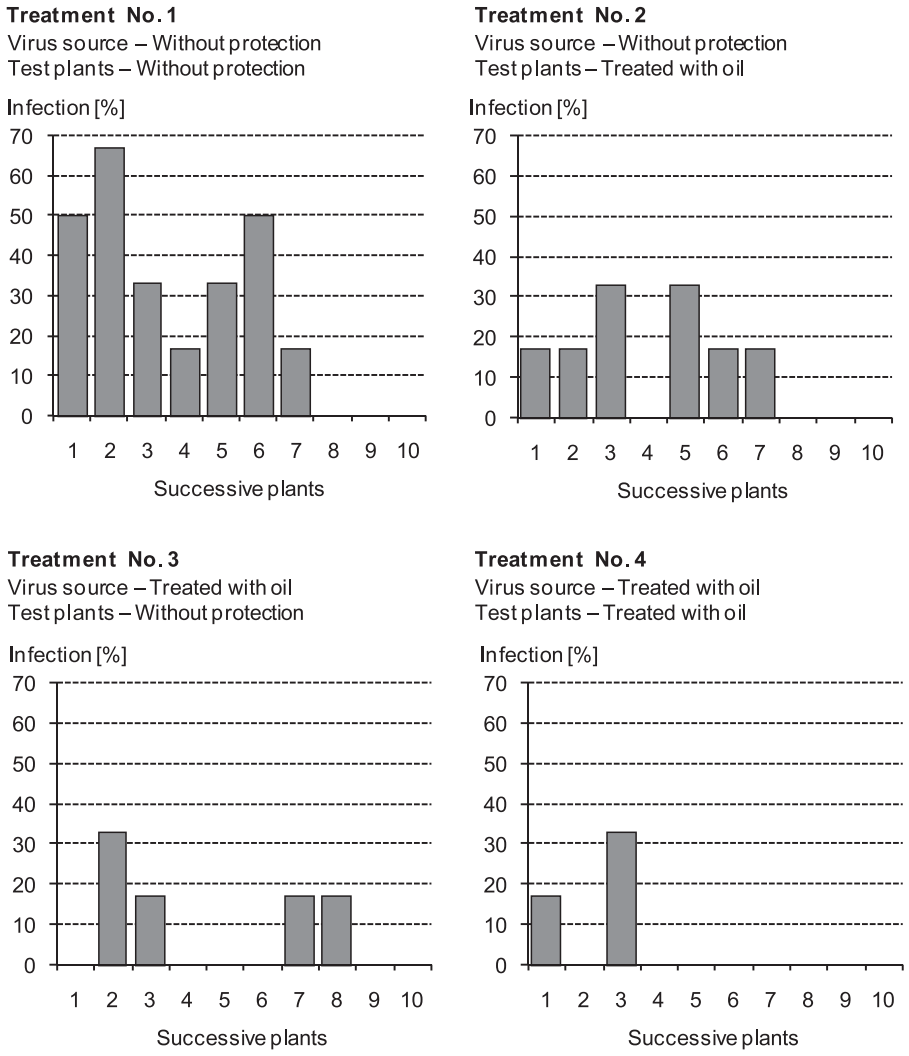

Fig. 1. Mineral oil effect on *M. persicae* capability to transmit PVY to successive test potato plants

with inoculation of another plants, while these were not always successive plants. For those treatments, where mineral oil was applied both onto the virus source, or both onto the source and on the test plants, aphid capability to transmit PVY to successive plants was limited. In the first case *M. persicae* were able to infect only 4, and in the second case only 2 out of 10 inoculated test potato plants. Plants 2, 3, 7 and 8 were infected, whereas in the second case – only plants 1 and 3. Similar relationships were observed for PVM, however the difference was that aphids were able to transmit the virus to six test plants in those check objects, where no mineral oil was applied. On the contrary, three plants were infected in other treatments (oil protection only for test plants), two when only the virus source was protected, and one in treatment, in which complete protection was applied both for plants constituting the source of

PVM, and for test plants (Fig. 2). Plant infection with PVM was much lower. This proves lower efficiency of *M. persicae* as regards transmission of this particular virus, which had been earlier stated by Kostiw (1987).

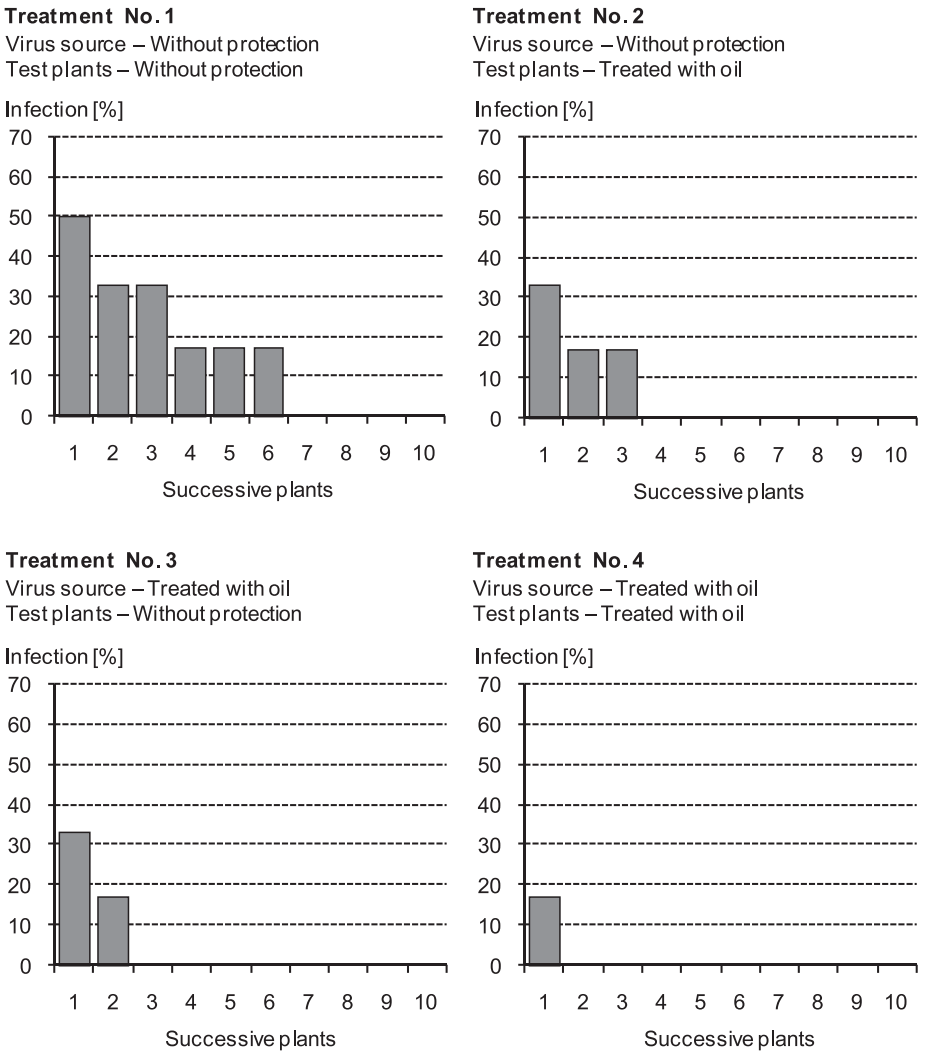

Fig. 2. Mineral oil effect on *M. persicae* capability to transmit PVM to successive test potato plants

Obtained results prove a decreased *M. persicae* efficiency as an active vector of PVY and PVM after contact with mineral oil already at first infections. Some confirmation is provided here by studies carried out by Powell and Hardie (1994), who assessed *M. persicae* capability to transmit PVY only to two successive plants. They found out that mineral oil application to protect test plants (tobacco plants) considerably reduced virus retention already during the attempts to have it transferred by the same aphids to the second plant, in spite of the fact that time of their stay on the latter was very long (15–20 hours).

CONCLUSIONS

Laboratory assessment of mineral oil effect on virus retention indicates the possibility of considerable reduction in *M. persicae* capability to transmit PVY and PVM, particularly in cases when both plants constituting virus sources and healthy plants are treated with oil. This has a considerable practical effect, since this system is used in seed plantations.

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POLISH SUMMARY

WPŁYW OLEJU MINERALNEGO NA ZDOLNOŚĆ *MYZUS PERSICAE* DO PRZENOSZENIA PVY I PVM NA KOLEJNE ROŚLINY ZIEMNIAKA

Oceniano zdolność mszyc *Myzus persicae* (Sulz.) do infekcji kolejnych roślin ziemniaka PVY i PVM, po zastosowaniu oleju mineralnego Sunspray 850 EC. Badania przeprowadzono w szklarni, wykorzystując jako materiał badawczy 4-tygodniowe, zdrowe rośliny ziemniaka o niskiej odporności na wirusy, pochodzące z *in vitro* (rośliny testowe). Dla każdej kombinacji i każdego wirusa inokulowano każdorazowo 10 kolejnych roślin w 6 powtórzeniach. Źródła wirusów stanowiły rośliny ziemniaka porażone PVY lub PVM, które przetrzymywano w izolowanych kamerach.

Zastosowanie oleju powodowało opóźnienie rozpoczęcia żerowania osobników mszyc *M. persicae* na roślinach wcześniej nim traktowanych. Największe ograniczenie przenoszenia PVY i PVM przez *M. persicae* uzyskano w kombinacji, gdy chroniono zarówno rośliny stanowiące źródło wirusa, jak i rośliny testowe, gdyż jedynie dwie z dziesięciu roślin uległy infekcji PVY i tylko jedna PVM. Zastosowanie oleju mineralnego jedynie na rośliny testowe ziemniaka (zdrowe) ograniczało w niewielkim stopniu zdolność mszyc do przenoszenia PVY do sześciu kolejnych roślin (na kontroli do siedmiu), natomiast znacznie bardziej w wypadku PVM – do trzech (na kontroli do sześciu). W sytuacji, gdy chroniono olejem jedynie rośliny stanowiące źródło wirusa, zdolność do przenoszenia PVY przez *M. persicae* ograniczona była do czterech roślin, a PVM do dwóch. Wyniki te zdają się potwierdzać bardziej hipotezę, że olej mineralny inaktywuje cząstki wirusa w mszycach w czasie próby nabycia go z roślin, które wcześniej były chronione olejem mineralnym.