EFFECT OF NITROGEN-FERTILIZERS AND APPLE CULTIVARS ON APHIDS UNDER IPM TREATMENT CONDITIONS

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Abstract

Our investigation, a part of a four year project, was aimed at testing both the aphid-susceptibility of some apple cultivars grafted on different rootstocks, and the effect of different levels of nitrogen fertilisers on the insect communities. The experiments took place in the experimental apple orchard of the University of Horticulture, Budapest. At the beginning of the project the conventional management system (based on broad-spectrum insecticides) was changed to IPM.

The samples were taken at 14 days intervals, from the beginning of April 1995, through to the end of September. The identification of aphid species, the number of colonies per tree and the age-classes were determined. The number of predators and parasitoids were recorded. Our observations were conducted on the cultivars Kovelit, Idared, Jonathan, Jonagold, Jonathan M41, Gloster and Mutsu with four repetitions. The rootstocks were M.26, MM.106 and M.9.

The most abundant aphid species was the Green Apple Aphid (*Aphis pomi*), followed by the Rosy Apple Aphid (*Dysaphis plantaginea*). The Rosy Leaf-curling Aphid (*Dysaphis devecta*) was observed to have an isolated occurrence. On the basis of more than 220.000 aphids, we can conclude that the aphid-sensitivity of apple cultivars in descending order is: Gloster, Mutsu, Jonagold, Jonathan M41, Idared, Kovelit and Jonathan.

Fertiliser experiments were carried out on the cultivars Idared and Jonagold using solid ammonium nitrate (doses of 0, 50, 100, and 200 kg/ha), and on Jonathan using ammonium nitrate (0,50 kg/ha and liquid urea 1%). The rootstock used was MM.106. The aim of the experiment was to find the N level that would give maximum growth, without increasing the aphid numbers.

In the case of the cv. Jonathan, we found that the lowest aphid infestation was in the urea plot and the highest in the ammonium nitrate plots, with doses of 50 kg/ha. In the case of Idared and Jonagold the results were variable: the lowest aphid level was found on the 50 kg/ha plots in 1995, but this tendency was reversed in 1996.

There were significant differences between the two apple cultivars: Idared and Jonagold. The density of the Green Apple Aphid was always higher than the density of Rosy Apple-Aphids.

1. Introduction

The most important factor which affects the dynamics of aphid populations is the amount and the quality of nutriment produced by the plant. It is well known that, amongst components of the plant sap, amino acids have the most significant effect on aphids. The rate of basic nutriment supply in the sap is more important than the absolute amount (Klingauf, 1987).

It seems that the nitrogen component of the plant tissue is the principal component that is damaged by phytophagus insects. Many aphid species suck nutriments up directly from the phloem, which has the highest nitrogen content amongst plant tissues. Interaction between the growth of aphids and the nitrogen content of the host plant can be proved and the first examples of this relationship were found on woody plants. It can be shown that

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considerable seasonal changes in the number of aphid populations and the migration of aphids to and from the secondary host plants in summer are connected to the low nitrogen content of the tree in summer and the high nitrogen content during spring and autumn (Dixon, 1970).

Harrewij (1970) also showed a positive connection between aphid reproduction and the soluble nitrogen content of the plant. On the basis of experiments on fertilisation conducted on annual crop plants, it was demonstrated that a certain content of nitrogen is essential for aphid growth.

Although the effect of the soluble nitrogen on the aphid growth is obvious, we are far from knowing whether the complex correlation, between the physiological condition of the host plant and the aphid growth and reproduction, is valid.

Nitrogen fertilising not only increases the amount of soluble nitrogen content in the plant but it also changes the pH level, the condition of tissues, etc. and we need to pay attention to all of these factors in experiments (Klingauf, 1987).

It has been shown more recently that the amount of soluble nitrogen, that affects aphid growth most significantly, differs according to the aphid species. The preferred amount of amino acids is 3% in the case of Green Peach Aphid (*Myzus persicae*) whilst the Pea Aphid (*Acyrtosiphon pisum*) demands a level no higher or lower than 4.3%. It is presumed that poliphagus species are not as susceptible to different concentrations of soluble nitrogen content as monophagus or oligophagus ones but are able to tolerate more variable soluble nitrogen contents.

The existence of species-specific nitrogen level requirements by aphids was proved by an experiment in which Golden Delicious seedlings were fertilised with concentrations of 0.2, 0.5, 1.0 and 3.0 N nitrogen, under constant environmental conditions in a phytotron, and then infested with *Aphis pomi* (1N is equal to a concentration of 15 mM nitrogen which contains NO_3- and NH_{4+} at the ratio of 14 to 1). The shortest time necessary for the development of one *Aphis pomi* generation was observed in the case of the 0.5 N nitrogen fertilisation. It was concluded, therefore, that this was the most favourable nitrogen concentration, out of all the ones tested, for the growth of this species (Rutz *et al.*, 1990).

Another experiment, in which nutriment deprival was used, may prove the existence of connections between the nitrogen content of the apple leaves and apple aphids. Apple orchards were observed in West Germany from 1969 to 1975 in order to estimate by what means the ground cover affects the nutriment contents of the leaves. In the case of Cox's Orange Pippin and Golden Delicious cultivars, the amount of the nitrogen and potassium content in the leaves was found to be significantly lower in the orchard with ground cover than in the orchard without ground cover. The reverse situation was observed for P, Ca and Mg contents. The Rosy Apple Aphid (*Dysaphis plantaginea*), like many other phytophagus insects, and its eggs were found in significantly higher numbers in the orchard without ground cover crops (Schmidle *et al.*, 1975).

2. Material and Methods

The experiments took place in the experimental apple orchard of the University of Horticulture, Budapest. At the beginning of the project the conventional management system (based on broad-spectrum insecticides) was changed to IPM.

The samples were taken at 14 days intervals, from the beginning of April 1995, through to the end of September. The identification of aphid species, the number of colonies per tree and the age-classes were determined. The number of predators and parasitoids were recorded. Our observations were conducted on the apple cultivars Kovelit, Idared, Jonathan, Jonagold, Jonathan M41, Gloster and Mutsu with four replications. The rootstocks were M.26, MM.106 and M.9.

Fertilizer experiments were carried out on the cultivars Idared and Jonagold using solid ammonium nitrate (dose of 0, 50, 100, and 200 kg/ha), whilst on Jonathan solid

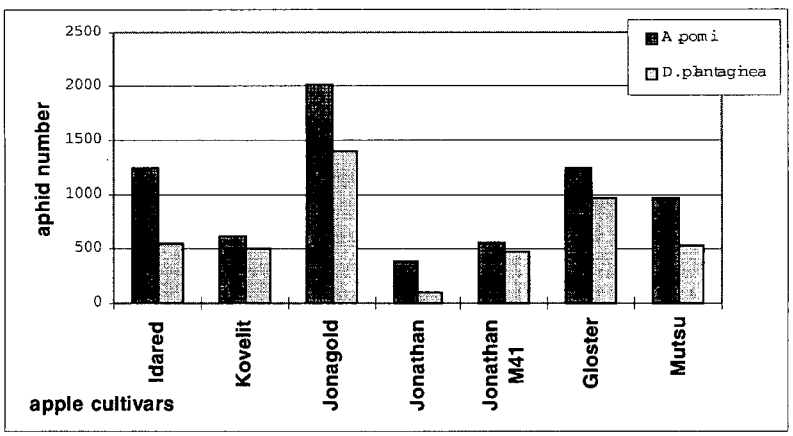
ammonium nitrate 0,50 kg/ha and liquid urea 1%o were used. The rootstock used was MM.106.

A special software programme called MiniStat was used for statistical analyses. This software deals with statistical tests as follows: Fisher F-test, Bartlett-test, Levene-test, O'Brien-test, t-tests, Welch d-test, Variance analysis, Covariance analysis, Welch and Brown-Forsythe robust variance analysis, James-robust variance analysis, Turkey-Kramer comparison test, Mann-Whitney test, Kruskal-Wallis test, Wilcoxon test, Friedman test, McNemar test.

3. Results

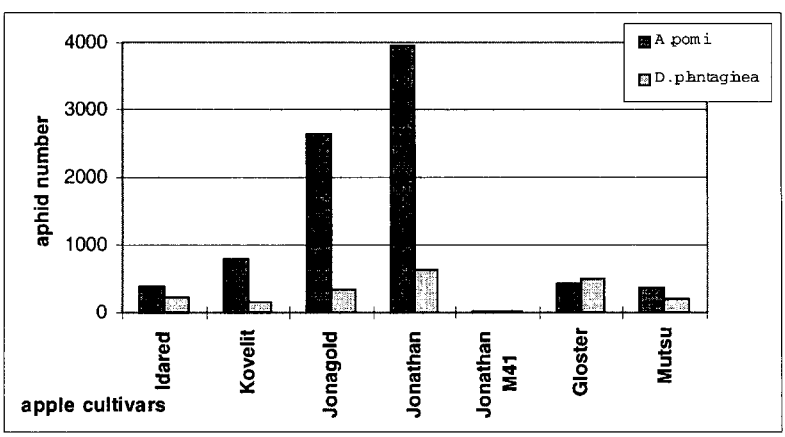
In 1995, we found the highest aphid infestation in the case of the cv. Jonagold (Fig.1.).

Fig.1: The aphid sensitivity of the apple cultivars (Szigetcsép, 1995)



In 1996 we found the highest aphid infestation in the case of cv. Jonathan (Fig.2.).

Fig.2: The aphid sensitivity of the apple cultivars (Szigetcsép, 1996)



In case of the cv. Jonathan we found that the lowest aphid infestation was in the urea plot and the highest in the ammonium nitrate plots, with doses of 50 kg/ha (Fig.3. and Fig.4.).

In the case of the cv Idared (Fig.5. and Fig.6.) and the cv. Jonagold (Fig.7. and Fig.8.) the results were variable: the lowest aphid level was found on the 50 kg/ha plots in 1995, but this effect was reversed in 1996.

The density of the Green Apple Aphid was always higher than the density of Rosy Apple-Aphid.

Fig.3: The influence of different levels of nitrogen-fertilizers on the population densities of the A. pomi and D. plantaginea (Jonathan, Szigetcsép, 1995)

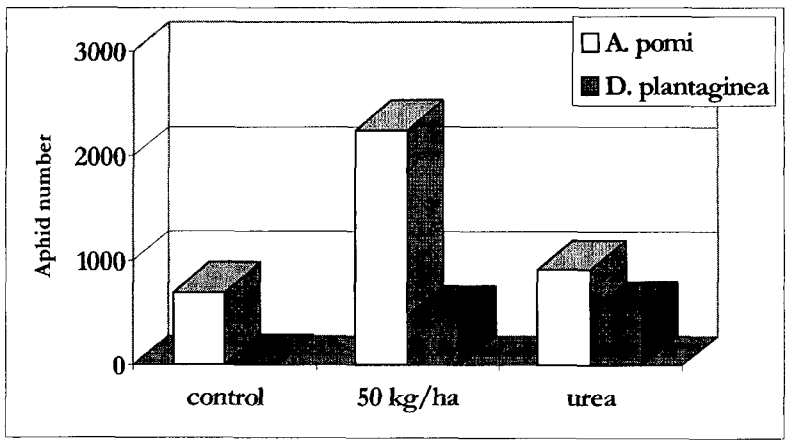


Fig.4: The influence of different levels of nitrogen-fertilizers on population densities of the A. pomi and D. plantaginea (Jonathan, Szigetcsép, 1996)

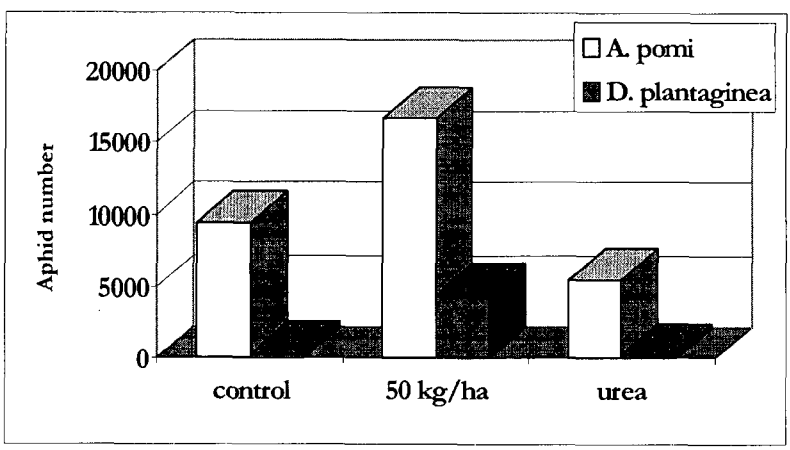


Fig.5. The influence of different levels of nitrogen-fertilizers on population densities of the A. pomi and D. plantaginea (Idared, Szigetcsép, 1995)

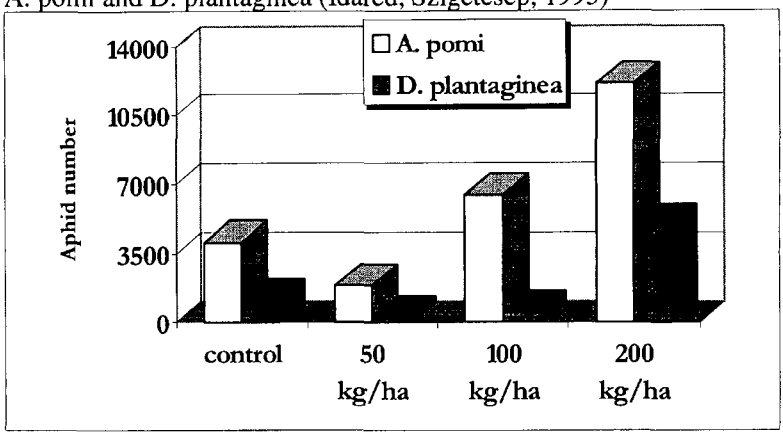


Fig.6: The influence of different levels of nitrogen-fertilizers on population densities of the A. pomi and D. plantaginea (Idared, Szigetcsép, 1996)

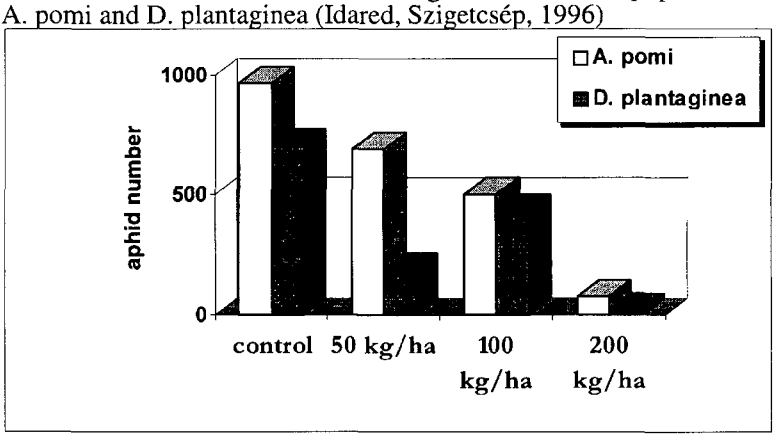


Fig.7. The influence of different levels of nitrogen-fertilizers on population densities of the A. pomi and D. plantaginea (Jonagold, Szigetcsép, 1995)

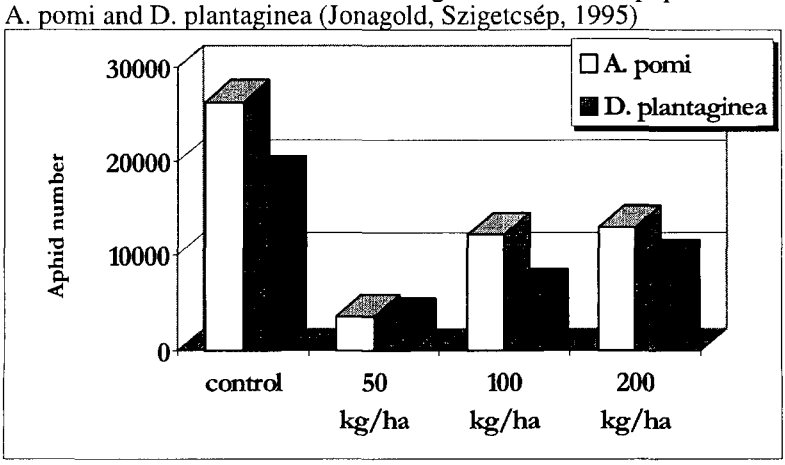
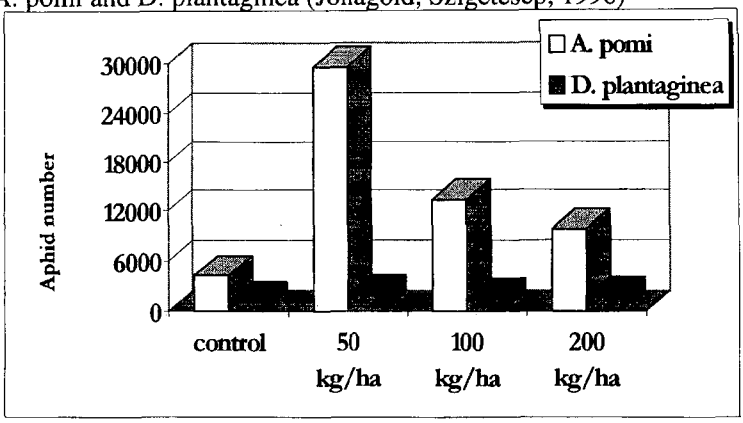


Fig.8: The influence of different levels of nitrogen-fertilizers on population densities of the A. pomi and D. plantaginea (Jonagold, Szigetcsép, 1996)



In 1995, we found the highest aphid infestations on apple cultivars which were grown on the rootstock M.9 (Fig.9. and Fig.10.).

Fig.9. The A. pomi sensitivity of the apple cultivars grafted on the MM.106, M.9 and M.26 rootstock, Szigetcsép, 1995

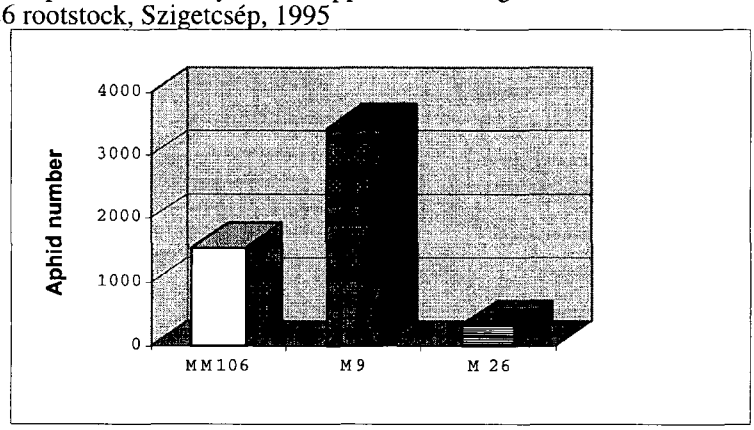
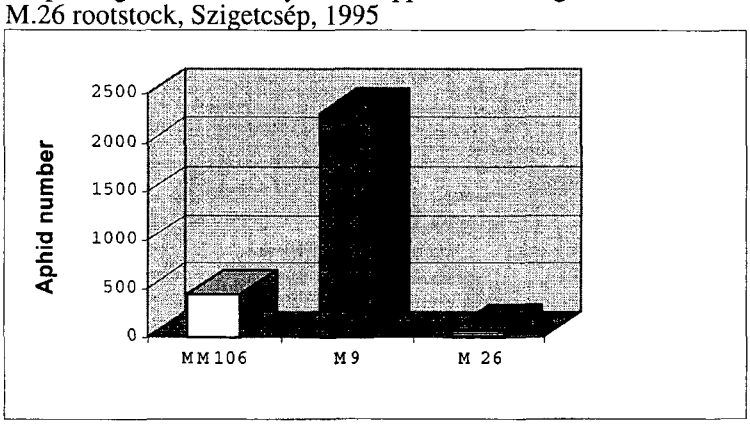


Fig.10. The D. plantaginea sensitivity of the apple cultivars grafted on the MM.106, M.9 and M.26 rootstock, Szigetcsép, 1995



In 1996, we found the highest aphid infestations on apple cultivars which were grown on the rootstock MM.106 (Fig.11. and Fig.12.).

Fig.11: The A. pomi sensitivity of the apple cultivars grafted on the MM.106, M.9 and M.26 rootstock, Szigetcsép, 1996

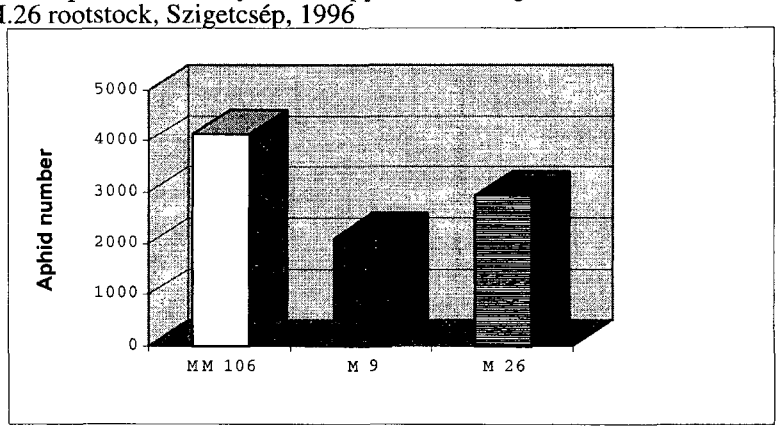
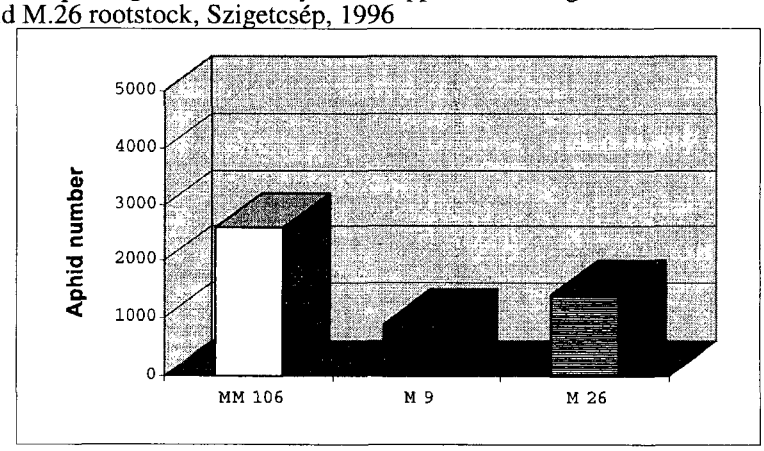


Fig.12: The D. plantaginea sensitivity of the apple cultivars grafted on the MM.106, M.9 and M.26 rootstock, Szigetcsép, 1996



4. Discussion

The numbers of aphids counted were divided by the number of observed trees. In this way, the results were comparable, even when the numbers of observed trees were not equal.

In 1995, we noted very large differences amongst the aphid infestations of different cultivars but none of them could be proved using statistical analyses. The standard deviation was always high enough to allow us to ignore the marked differences amongst the cultivars.

In 1996, we found significant differences amongst three cultivars as follows: Jonathan, Jonagold and Kovelit. In the case of the cv. Jonathan M41, the numbers of aphids counted are not shown on figure 2, on account of the very low numbers observed.

We were able to prove, significantly, that in both years the infestation of Green Apple Aphid was higher than the infestation of Rosy Apple-Aphid, except in the case of the cv. Gloster in 1996.

According to the observations made on the cv. Jonathan in both years, it seems that urea has the less significant influence on the aphid populations. But the standard deviation was so high that this effect could not be proved by statistical analysis.

We found fundamental differences in the observed numbers of aphids on the cvs. Idared and Jonagold under different nitrogen fertilisation treatments and between 1995 and 1996. None of the results were significant and further research is needed.

In the case of the aphid susceptibility of cultivars grown on different rootstocks we found a surprising result in 1995. The cultivars grown on M.9 rootstock seem to be more susceptible than the ones grown on M.26 or MM.106. It could not be proved by statistical analysis because of the high standard deviation. But the difference in susceptibility between the MM.106 and the M.26 rootstocks is significant in the case of Green Apple Aphid.

In 1996, we found that the cultivars grown on MM.106 rootstock more susceptible to Green Apple Aphid than the ones grown on M.26 or M.9 and this effect was statistically significant. But the difference in the susceptibility to Green Apple Aphid between the rootstocks M.26 and M.9 was not significant.

In the case of Rosy Apple-Aphid we found the cultivars grown on MM.106 rootstock to be significantly more susceptible than the ones grown on M.9. But there was no significant difference in susceptibility to Rosy Apple-Aphid between the cultivars grown on M.26 and MM.106 rootstocks and between the cultivars grown on M.26 and M.9 rootstocks.

Acknowledgement

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