PROTECTION OF GENETIC RESOURCES OF POMOLOGICAL PLANTS AND SELECTION OF GENITORS WITH TRAITS VALUABLE FOR SUSTAINABLE FRUIT PRODUCTION

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# RESISTANCE TO APHIDS AND SCALE INSECTS IN NINE APPLE CULTIVARS

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## A B S T R A C T

From 2001 to 2004, nine apple varieties were evaluated in terms of their resistance to infestation by three species of aphid and three species of scale insect. The cultivars evaluated were 'Bell Golden', 'Cooper Sel. 4', 'Granny Smith', 'Melrose', 'Morspur Golden Delicious', 'Mutsu', 'Primrouge', 'Starkrimson' and 'Vista Bella'. The aphid species studied were *Dysaphis plantaginea* Pass., *Dysaphis devecta* Walk. and *Aphis pomi* De Geer, all from the family Aphididae. The scale insects studied were *Diaspidiotus perniciosus* Comst. and *Lepidosaphes ulmi* L. from the family Diaspididae, and *Eulecanium mali* Schr. from the family Coccidae.

The trial was carried out in a fourteen-year-old orchard which belongs to the Agricultural University at Plovdiv, Bulgaria. The resistance of the cultivars to a particular pest were based on the the level at which their shoots were infested with that pest.

The cultivar most resistant to infestation by aphids was 'Bell Golden', followed by 'Starkrimson', 'Melrose', 'Morspur Golden Delicious', 'Mutsu', 'Cooper Sel. 4', 'Granny Smith', 'Vista Bella' and 'Primrouge'.

All of the cultivars were infested by scale insects during the winter, but to varying degrees. The cultivar most resistant to infestation by scale insects was 'Starkrimson', followed by 'Morspur Golden Delicious', 'Bell Golden', 'Melrose', 'Granny Smith', 'Vista Bella', 'Primrouge', 'Mutsu' and 'Cooper Sel. 4'. Starkrimson' was resistant to infestation by both aphids and scale insects.

**Key words:** aphids, scale-insects, infestation, susceptibility, cultivar, apple

## INTRODUCTION

To ensure a high quality crop, apple orchards need to be sprayed with pesticides from ten to fifteen times a season. This is costly and harmful to the environment. Therefore, a lot of research has recently been directed toward developing ways to reduce the amount of chemicals used in commercial orchards.

One of the most promising ways to reduce chemical use is breeding cultivars which are resistant or tolerant to pests and diseases. This approach has already had significant success. There are now several new apple cultivars which are resistant to economically important diseases such as apple scab and powdery mildew (Pedersen et al. 1994; Nakov et al., 1999). There has been less progress in developing cultivars resistant to insect and arthropod pests, though intensive research has been carried out, especially on cultivars resistant to sucking pests such as aphids and mites (Habekuss et al., 2000).

In one study, the cultivars 'Florina' and 'Fiesta' were found to be resistant to *Dysaphis plantaginea* Pass. (Rat-Morris, 1993; Rat-Morris and Lespinasse, 1995) In another study, young apple trees grafted on three different rootstocks were evaluated in terms of their resistance to *Dysaphis plantaginea* and *Aphis pomi* De Geer (Sacco and Dalla-Monta, 1994). In yet another study, apple cultivars were were evaluated in terms of their resistance to the woolly aphid, *Eriosoma lanigerum* Hausm. (Asante, 1994). In Quebec, Canada, thirty-two apple rootstocks resistant to the wooly aphid were selected in (Khanizadeh et al., 2000). There has been considerable progress in developing apple cultivars resistant to the codling moth, *Cydia pomonella* L. (Dandekar et al., 1994; Clark et al., 2004). In several countries, programs have been established for breeding cultivars resistant to pests and diseases (Labuschagne and Schmidt, 1999; Bus et al., 2000; Ballard, 2002). Molecular and genetic studies on pest and disease resistance are also underway (Roche et al., 1997; Cevik and King, 2000).

The aim of this study was to evaluate nine apple cultivars in terms of their resistance to aphids and scale insects in order to select the cultivars that should be used in future breeding programs.

## MATERIAL AND METHODS

From 2001 to 2004, nine apple varieties were evaluated in terms of their resistance to infestation by three species of aphid and three species of scale insect. The cultivars evaluated were 'Bell Golden', 'Cooper Sel. 4', 'Granny Smith', 'Melrose', 'Morspur Golden Delicious', 'Mutsu', 'Primrouge', 'Starkrimson' and 'Vista Bella'.

The aphid species studied were the rosy apple aphid (*Dysaphis plantaginea* Pass.), the rosy leaf-curling aphid (*Dysaphis devecta* Walk.), and the green apple aphid (*Aphis pomi* De Geer), all from the family Aphididae.

The scale insect species studied were San Jose scale (*Diaspidiotus perniciosus* Comst.) and oystershell scale (*Lepidosaphes ulmi* L.) from the family Diaspididae, and *Eulecanium mali* Schr. from the family Coccidae.

Twenty to thirty trees of each cultivar were planted in a fourteen-year-old orchard which belongs to the Agricultural University at Plovdiv, Bulgaria. No pesticides were applied. The resistance of the cultivars to a particular pest were based on the the level at which their shoots were infested with that pest.

Infestation by aphids was recorded in the second half of May, when aphid colonies are most abundant. In 2001 and 2002, all aphid species were recorded together. In 2003 and 2004, individual species were recorded separately. Infestation was graded according to the following scheme:

| Level of infestation | Percentage of infested shoots | Score |
|---|---|---|
| No infestation | No aphids seen | 0 |
| Slight | 0 to 5% | * |
| Moderate | 5 to 15% | ** |
| High | 15 to 50% | *** |
| Severe | over 50% | **** |

Infestation by the scale insects was recorded in the winter of 2003/2004. Two shoots were collected from each tree of each cultivar and cut into 10 cm sections. Sixty to eighty 10 cm sections were examined for each cultivar. The mean total number of scale insects per section and the mean number of living scale insects per section were recorded for each cultivar.

## RESULTS AND DISCUSSION

Aphids were most abundant in May and early June (Tab. 1). The most abundant aphid species was *Dysaphis plantaginea*. The only cultivar not infested by *D. plantaginea* was ‘Bell Golden’. The cultivars least resistant to *D. plantaginea* were ‘Granny Smith’ and ‘Primrouge’.

The next most abundant aphid species was *Dysaphis devecta*, which infested relatively more trees in 2004 than in 2003. This may be because 2004 was a rainy year. The cultivars which were not infested at all by *D. devecta*

were ‘Bell Golden’, ‘Granny Smith’, ‘Matsu’ and ‘Starkrimson’. The cultivar least resistant to *D. devecta* was ‘Primrouge’.

T a b l e 1. Infestation by three species of aphid in nine apple cultivars. Plovdiv region, 2001 to 2003

| Cultivar | All species | | *Dysaphis plantaginea* | | *Dysaphis devecta* | | *Aphis pomi* | | Total stars for all years |
|---|---|---|---|---|---|---|---|---|---|
| | 2001 | 2002 | 2003 | 2004 | 2003 | 2004 | 2003 | 2004 | 2001-2004 |
| ‘Bell Golden’ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ** | 2 |
| ‘Cooper Sel. 4’ | ** | * | * | ** | 0 | ** | 0 | 0 | 8 |
| ‘Granny Smith’ | *** | ** | *** | *** | 0 | 0 | 0 | 0 | 11 |
| ‘Melrose’ | * | * | ** | ** | 0 | * | 0 | 0 | 7 |
| ‘Morspur Gol. Del’ | * | * | * | ** | 0 | ** | 0 | 0 | 7 |
| ‘Mutsu’ | * | 0 | * | *** | 0 | 0 | ** | 0 | 7 |
| ‘Primrouge’ | ** | ** | ** | *** | * | ** | ** | * | 15 |
| ‘Starkrimson’ | 0 | 0 | * | ** | 0 | 0 | 0 | 0 | 3 |
| ‘Vista Bella’ | ** | * | * | ** | * | * | * | ** | 11 |

0 – no aphids * – slight infestation ** – moderate infestation
*** – high infestation **** – severe infestation

The least abundant of the three aphid species was *Aphis pomi*, which was found only on trees not infested by *D. plantaginea*. This suggests that there is an antagonistic relationship between *D. plantaginea* and *A. pomi*, in which *D. plantaginea* is the stronger competitor. Because only a few of the cultivars were infested by *A. pomi*, it is harder to rank them in terms of their resistance. The cultivars which were not infested at all by *A. pomi* were ‘Cooper Sel. 4’, ‘Granny Smith’, ‘Melrose’, ‘Morspur Golden Delicious’ and ‘Starkrimson’. The cultivars which were least resistant to *A. pomi* were ‘Primrouge’ and ‘Vista Bella’.

The cultivar most resistant to combined infestation by all three aphid species over all four years of the study was ‘Bell Golden’, followed by ‘Starkrimson’, ‘Melrose’, ‘Morspur Golden Delicious’, ‘Mutsu’, ‘Cooper Sel. 4’, ‘Granny Smith’, ‘Vista Bella’ and ‘Primrouge’.

In the winter of 2003/2004, all of the cultivars were infested by scale insects, but to different degrees (Tab. 2).

By far the most abundant scale insect species was *Diaspidiotus perniciosus*, probably because it produces three generations a year in the Plovdiv region. The cultivars most resistant to *D. perniciosus* were ‘Starkrimson’ and ‘Bell Golden’. The cultivars least resistant to *D. perniciosus* were ‘Cooper Sel. 4’ and ‘Mutsu’.

Table 2. Infestation by three species of scale insect in nine apple cultivars. Average number per 10 cm section of shoot. Plovdiv region, winter 2003/2004

| Cultivar | *Diaspidiotus perniciosus* | | *Lepidosaphes ulmi* | | *Eulecanium mali* | | Total for all species | |
|---|---|---|---|---|---|---|---|---|
| | total | live | total | live | total | live | total | live |
| 'Bell Golden' | 9.6 | 1.2 | 4.8 | 3.2 | 1.4 | 0.8 | 15.8 | 5.2 |
| 'Cooper Sel. 4' | 68.2 | 13.0 | 2.4 | 1.6 | 1.4 | 1.0 | 72.0 | 15.6 |
| 'Granny Smith' | 19.4 | 2.2 | 4.6 | 2.8 | 2.2 | 1.2 | 26.2 | 6.2 |
| 'Melrose' | 12.0 | 0.8 | 8.3 | 4.5 | 3.2 | 1.8 | 23.5 | 7.1 |
| 'Morspur Gol. D' | 13.0 | 2.1 | 1.4 | 1.0 | 0.2 | 0.1 | 14.6 | 3.2 |
| 'Mutsu' | 40.6 | 13.4 | 0.6 | 0.4 | 5.6 | 2.0 | 46.8 | 15.8 |
| 'Primrouge' | 30.8 | 5.5 | 0.0 | 0.0 | 8.8 | 5.7 | 39.6 | 11.2 |
| 'Starkrimson' | 8.8 | 0.5 | 1.3 | 0.8 | 1.7 | 1.3 | 11.8 | 2.6 |
| 'Vista Bella' | 26.3 | 9.7 | 0.0 | 0.0 | 9.3 | 5.4 | 35.6 | 15.1 |

The next most abundant scale insect species was *Lepidosaphes ulmi*, which produces one generation a year in the Plovdiv region. The cultivars most resistant to *L. ulmi* were 'Vista Bella' and 'Primrouge', which were not infested at all. The cultivar least resistant to *L. ulmi* was 'Melrose'.

The least abundant of the three scale insect species was *Eulecanium mali*, which produces one generation a year in the Plovdiv region. *E. mali* has become more abundant in the Plovdiv region in the past few years. The cultivar most resistant to *E. mali* was 'Morspur Golden Delicious'. The cultivars least resistant to *E. mali* were 'Vista Bella' and 'Primrouge'. It is worth noting that the cultivars most resistant to *L. ulmi* happened to be the cultivars least resistant to *E. mali*. This may be because 'Vista Bella' and 'Primrouge' are early varieties.

The cultivar most resistant to combined infestation by all three scale insect species was 'Starkrimson', followed by 'Morspur Golden Delicious', 'Bell Golden', 'Melrose', 'Granny Smith', 'Vista Bella', 'Primrouge', 'Mutsu' and 'Cooper Sel. 4'.

## CONCLUSIONS

The cultivar most resistant to combined infestation by all three aphid species over all four years of the study was 'Bell Golden', followed by 'Starkrimson', 'Melrose', 'Morspur Golden Delicious', 'Mutsu', 'Cooper Sel. 4', 'Granny Smith', 'Vista Bella' and 'Primrouge'.

The cultivar most resistant to combined infestation by all three scale insect species was 'Starkrimson', followed by 'Morspur Golden Delicious', 'Bell

Golden', 'Melrose', 'Granny Smith', 'Vista Bella', 'Primrouge', 'Mutsu' and 'Cooper Sel. 4'.

'Starkrimson' was resistant to infestation by both aphids and scale insects.

Our results will not only to help fruit growers select which cultivars to plant, but also to help breeders select cultivars for future breeding programs.

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# STOPIEŃ ODPORNOŚCI NA MSZYCE, SKORUPIKI I MISECZNIKI DZIEWIĘCIU ODMIAN JABŁONI

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## STRESZCZENIE

W latach 2001-2004 oceniano dziewięć odmian jabłoni pod względem stopnia zasiedlenia ich przez mszyce oraz skorupiki i miseczniki. Badaniami objęto odmiany jabłoni: 'Bell Golden', 'Cooper Sel. 4', 'Granny Smith', 'Melrose', 'Morspur Golden Delicious', 'Mutsu', 'Primrouge', 'Starkrimson' i 'Vista Bella', na których określano stopień zasiedlenia drzew przez gatunki *Dysaphis plantaginea* Pass., *Dysaphis devecta* Walk. i *Aphis pomi* De Geer z rodziny Aphididae oraz *Diaspidiotus perniciosus* Comst. i *Lepidosaphes ulmi* L. z rodziny Diaspididae, i *Eulecanium mali* Schr. z rodziny Coccidae. Doświadczenie przeprowadzono w czternastoletnim sadzie należącym do Akademii Rolniczej w Plovdiv w Bułgarii.

Drzewa odmiany 'Bell Golden' były w najmniejszym stopniu zasiedlone przez mszyce, a następnie odpowiednio odmiany 'Starkrimson', 'Melrose', 'Morspur Golden Delicious', 'Mutsu', 'Cooper Sel. 4', 'Granny Smith', 'Vista Bella' i 'Primrouge'.

Drzewa wszystkich badanych odmian jabłoni były zasiedlone przez skorupiki i miseczniki, ale w różnym stopniu. Odmianą najbardziej odporną okazała się 'Starkrimson', a następnie 'Morspur Golden Delicious', 'Bell Golden', 'Melrose', 'Granny Smith', 'Vista Bella', 'Primrouge', 'Mutsu' i 'Cooper Sel. 4'. Starkrimson' był w najmniejszym stopniu zasiedlony zarówno przez mszyce, jak i skorupiki i miseczniki.

**Słowa kluczowe:** mszyce, skorupiki i miseczniki, wrażliwość, odmiana, jabłoń