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Apple-rosy apple aphid interaction: cultivar impact

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Abstract

Rosy apple aphid (RAA) Dysaphis plantaginea Passerini (Hemiptera: Aphididae) is a destructive pest of apple in Belgium and Europe. Feeding by RAA on the phloem induces important damage symptoms, in particular growth stunting, leaf curling and deformed fruits. A field study was conducted in 2021 to assess whether the severity of fruit damage caused by D. plantaginea is determined by the aphid population dynamic and associated leaf damage. In an insecticide-free apple orchard, D. plantaginea infestation, abundance, leaf and fruit damage were measured in ten apple cultivars. The presence of study cultivars in homogeneous environmental conditions allowed us to present reliable data on the correlation strength between the parameters investigated in this research. Significant differences between apple cultivars in the RAA infestation, abundance, leaf-fruit damage levels and the associated relationships were found. Seasonal abundances and infestations of D. plantaginea were significantly affected by the cultivar. Some cultivars especially Fuji and Jonagold hosted remarkably high numbers of aphids, while others like especially Red Delicious harboured very low numbers of aphids. Significantly, aphid feeding impacted the leaf quality of Golden Delicious, while low fruit damage was observed on the infested trees of this cultivar. However, significantly high impact of aphid feeding was found on fruit quality but not on leaves in the cultivar Red Delicious, on which low leaf damage coincided with high fruit damage level on the infested trees. Other cultivars like Gala showed significantly positive correlation, on which the increasing in leaf damage matched with increasing in the fruit damage level. These results suggest that, in some apple cultivars, the evolution of D. plantaginea caused damage on leaves and fruits are clearly further apart. Our results show that studying how damage level changes across apple cultivars provides insights into the dynamics of host plant responses to aphid feeding that would be more evident if the associated relationships were analysed at homogenous environmental conditions. By demonstrating the impact of apple cultivar on the performance of rosy apple aphid, we provide a promising insight into the importance of considering the variation in host responses to the feeding of a given pest within an eco-friendly strategy to potentially manage pest population.

Keywords Apple cultivar, Relationship, *Dysaphis plantaginea*, Aphid, Host response.

Introduction

The rosy apple aphid (RAA) is a serious pest of apple in Belgium and Europe and responsible for severe yield losses particularly in organic farming systems (Blommers 1994; Bribosia et al 2004; Bangels et al 2008). Feeding by RAA on the phloem generates several damage symptoms, in particular growth stunting, leaf curling and deformed fruits. Almost all apple cultivars are susceptible for RAA infestation, but leaf-fruit responses to the aphid feeding vary according to several elements including the cultivar ID (Arnaoudov and Kutinkova 2006; Angeli and Simoni 2006; Miñarro and Dapena 2007; Alhmedi et al 2021). Studies of plant–insect interactions are essential for understanding the dynamics of aphids on host plants (Sarmento et al 2011).

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In this study, the effects of apple cultivar on apple–RAA interaction were investigated in field conditions, by addressing the following main questions, (i) do apple cultivars respond differently to RAA infestation? and (ii) do fruits and leaves respond similarly to RAA feeding?

Materials and Methods

The study was conducted during 2021 growing season in an insecticide-free apple orchard located in an area of fruit tree production, Fruit Research Center (pcfruit), Sint-Truiden, Limburg, Belgium. Ten apple cultivars were included in the present study, Braeburn, Golden Delicious, Granny Smith, Jonagold, Red Delicious, Gala, Boskoop, Bramley's Seedling, Kanzi and Cripps Pink. On ten trees per cultivar, three terminal shoots per tree were scanned for evaluating the aphid abundance and infestation, while all shoots growing on three selected tree branches were considered for assessing leaf and fruit damage. Data analyses were performed using Minitab 18 and XLSTAT 2016 softwares.

Results and discussion

The statistical analysis applied on the data collected from this study revealed significant differences between apple cultivars in the aphid infestation and abundance ($F_{9,90}$ = 25.19, p<0.001; $F_{9,90}$ = 35.44, p<0.00, respectively). Rosy apple aphid-infested trees showed different responses, represented here by clusters of curled leaves and malformed fruits, to aphid feeding on the cultivars investigated in the present work. Significant differences between apple cultivars in their leaf and fruit responses to aphid feeding were found ($F_{9,90}$ = 14.72, p<0.001; $F_{9,90}$ = 7.29, p<0.00, respectively, Figures 1). In this context, aphid feeding highly impacted leaf quality in some cultivars such as Golden Delicious and Cripps Pink, while less damage was observed on associated fruits. Contrariwise, other cultivars such as Red Delicious and Boskoop exhibited different responses to aphid feeding, on which their leaves were less impacted than fruits by the aphid attack. Insect attackers such as pest aphids pose serious challenges to plants, and plants in turn look constantly for developing counter-adaptations through various morphological and biochemical traits (Howe & Jander, 2008; War *et al.*, 2012). Mechanisms of tree responses to insect attack are complex and can be influenced by several biotic and abiotic factors. An alternative to insecticides is looking for cultivars resistant or tolerant to *D. plantaginea* infestation (Dapena & Minarro, 2001; Arnaoudov & Kutinkova, 2006; Alhmedi *et al.*, 2021). The results obtained from this work first suggest that the evolution of aphid-caused damage on leaves and fruits in some apple cultivars are apparently further apart (Figure 2), and second demonstrate the important role of host plants in the interaction dynamics with aphids.

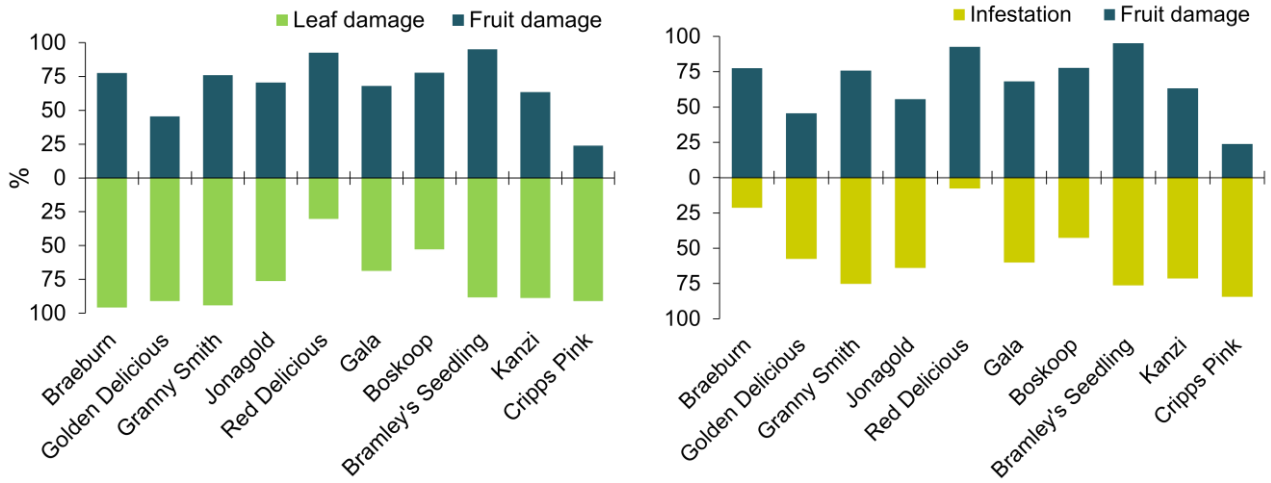

Figure 1. Rosy apple aphid infestation within tree, leaf and fruit damage (mean percentages) recorded on ten apple cultivars in 2021.

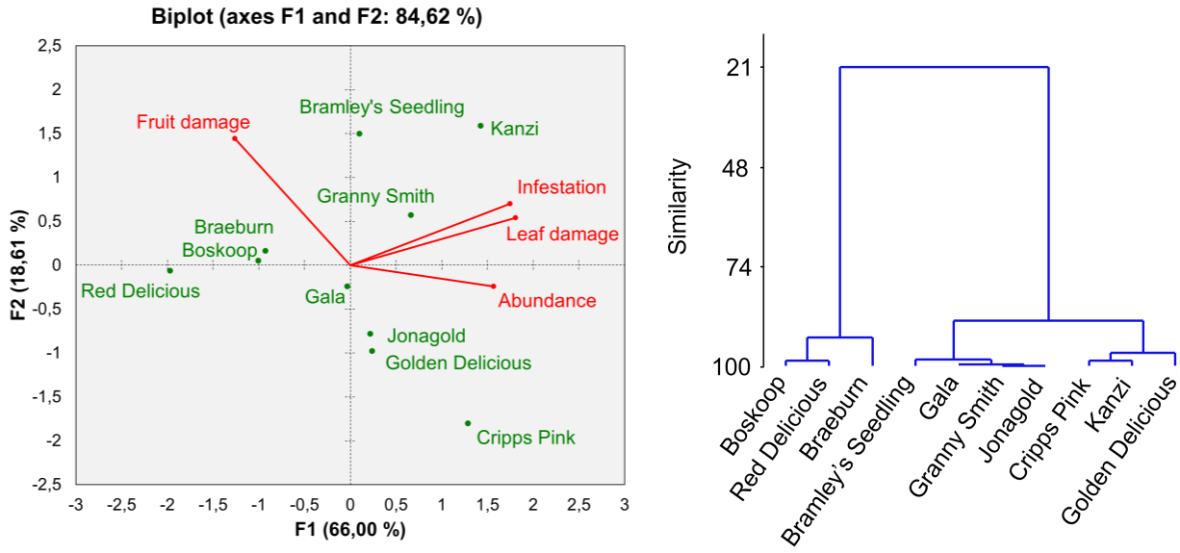

Figure 2. Principal component analysis (PCA, left) based on the interaction of rosy apple aphid with ten apple cultivars; and dendrogram (right) depicting the relationships (the similarity) among study cultivars based on their interactions with the rosy apple aphid in the apple orchard. The PCA axes PC1 and PC2 are equivalent to F1 and F2, respectively

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