PLANT-GWSS INTERACTIONS: PHYSIOLOGICAL AND BIOCHEMICAL MECHANISMS INVOLVED IN HOST PLANT SELECTION WITH PARTICULAR REFERENCE TO LEMON AND ORANGE TREES

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INTRODUCTION

The glassy-winged sharpshooter (GWSS) *Homalodisca coagulata* is an exotic insect in California and is an important vector of *Xylella fastidiosa* that causes Pierce's disease (PD) in grapes. Citrus is a favored host of GWSS throughout the year, and it has been well documented from studies of the Temecula PD epidemic that the proximity of citrus groves to vineyards has influenced the incidence and severity of PD in grapes. It is imperative that effective control strategies be implemented to curb the spread of the vector-vital to this would be establishing the host plant range of the GWSS and determining the physiological and biochemical mechanisms for host selection. One of the key factors contributing to the successful establishment of the GWSS in California has been its ability to utilize more breeding habitats and plant hosts than native PD vectors. Although a comprehensive list of suitable hosts has been identified, comprising 75 plant species in 35 families, little is known about the physiological and biochemical mechanisms involved in host selection of GWSS in California. Elucidation of the physiological and biochemical mechanisms may be usable for developing host plant resistance as a sustainable component of integrated pest management program.

Dietary nitrogen and carbohydrates are important nutritional indices impacting survival, growth and reproduction of phytophagous insects. These nutrients are particularly limited for xylophagous insects, such as GWSS, because xylem fluid consists of over 95% water and is the most dilute food source for herbivores. There are two ways in which the GWSS could compensate for the poor nutrient quality of the xylem fluid. Firstly, they could feed for extended periods of time. This is, in fact, known to be the case, as those of us who have witnessed the sharpshooter rain at first hand will attest. Indeed, it has been estimated that GWSS can process up to 10 ml of xylem fluid per day. Secondly, efficient assimilation of available nutrients during prolonged feeding periods would enhance the nutritional value of xylem. Different host plants may contain different levels of dietary nitrogen and carbohydrate during the year and the differences could play a role in GWSS host selection.

OBJECTIVES

1. Investigate the seasonal population dynamics of GWSS on orange and lemon trees.
2. Study the relationship between densities of GWSS on orange and lemon trees and the nutritional quality of the xylem fluid upon which the insects feed.

RESULTS AND CONCLUSIONS

A lemon and orange mix-planted orchard was used for the experiment. Three blocks of 30 orange and 30 lemon trees were used. Five trees of lemon or orange were randomly selected from each block to monitor the GWSS population dynamics and to extract xylem fluid. A bucket-sampling device was used to sample both immature and adult GWSS. Population dynamics of both adult and immature GWSS was monitored on a weekly basis throughout the season. Xylem fluid in one-year old stems from each of the trees was collected bi-weekly to determine levels of free amino acids, soluble proteins and carbohydrates.

Adult GWSS numbers on oranges were highest from late June to late November 2001 and a smaller peak was observed from early March to early April 2002 (Figure 1). The adult numbers on lemons peaked from mid-July 2001 to late January 2002. The adult numbers were 0.4- to 4.9-fold higher from late June to late July on oranges in comparison with those on lemons, whereas the adult numbers were up to 10.7-fold higher from early August 2001 to late February 2002 on lemons than on oranges. The numbers were 8.7- to 16.4-fold higher from early March to early April 2002 on oranges than on lemons.

Peak immature counts on oranges occurred between late April and early July 2001 and the numbers gradually reached to zero the rest of the year (Figure 1). Peak immature densities on lemons were observed from mid-May to late June 2001. The immature counts were 0.9- to 3.9- fold higher on oranges than on lemons from late April to mid-May 2001. Despite the higher adult counts on lemons between November 2001 and January 2002, nymph counts in the following months were still higher on oranges. The mini-peak of adult numbers that appeared on oranges after January 2002 suggests that the adults had migrated from the lemons to the oranges to reproduce.

Throughout the experimental season, glucose and fructose levels were generally higher in xylem fluid from lemons (Figure 2). Sucrose levels were generally higher in lemon xylem fluid except during the period of early December 2001 to mid-February 2002 when orange xylem fluid had higher levels. During August 2001, levels of xylem asparagine, glutamine, tyrosine, phenelalanine, isoleucine, valine, threonine, histidine, methionine and lysine were generally higher in lemons whereas from February to April 2002, levels of these xylem amino acids were higher in oranges, in correspondence with the higher adult GWSS numbers on these trees (Figure 3).

In summary, from early spring to mid summer adult GWSS numbers were generally higher on oranges and from belatedly summer to late winter the numbers were higher on lemons. Levels of some xylem amino acids were in positive correspondence with the higher GWSS numbers.

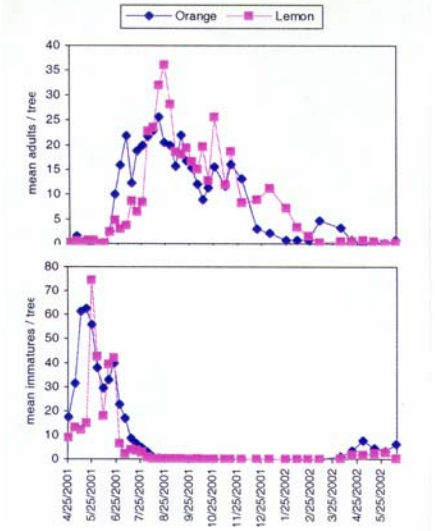

Figure 1: Seasonal population dynamics of GWSS on orange and lemon trees

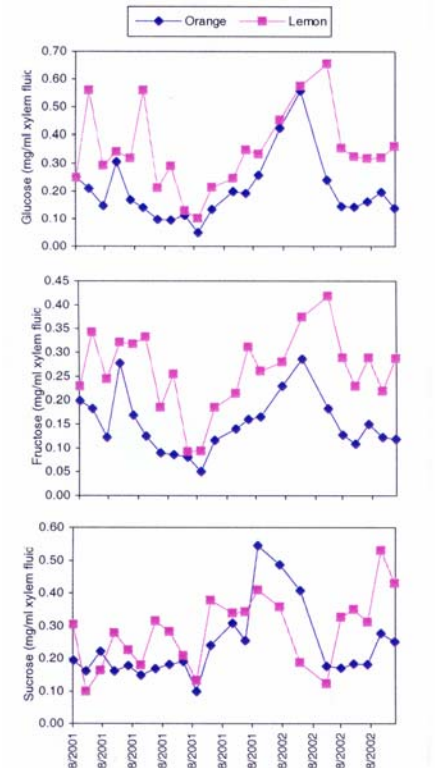

Figure 2: Seasonal variation of soluble sugar levels in the xylem fluid of orange and lemon trees

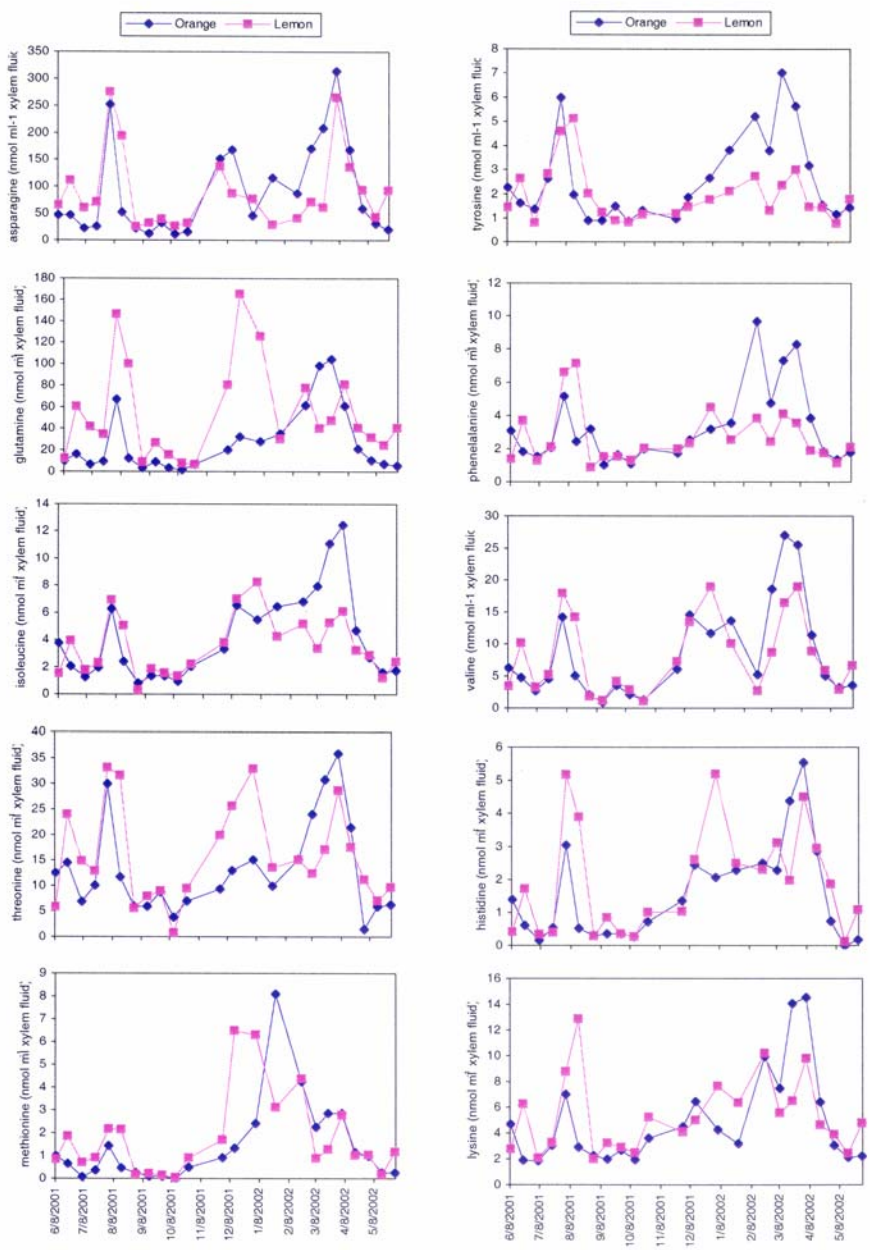

Figure 3: Seasonal variation of some amino acid levels in the xylem fluid of orange and lemon.

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