8.10 Influence of Huanglongbing (HLB) on the Composition of Citrus Juices and Mature Leaves

Cancalon, P.F., Bryan, C., Haun, C., Zhang, J. Florida Department of Citrus, Lake Alfred, FL, USA

In this study, the composition of fruit and mature citrus leaves from Hamlin and Valencia orange and Marsh grapefruit, collected in an infected Florida grove, was followed over time during the 2009-2010 citrus season in control, symptomatic (exhibiting symptoms), and asymptomatic trees (HLB infected but not showing symptoms). In most cases, the composition of components from control and asymptomatic samples were similar.

As a continuation to a previous study (Cancalon et al., 2008), orange juice composition was further examined. Synephrine, a biological amine characteristic of immature fruit, was found to be consistently higher in HLB-infected fruit. The synephrine values during the season were 69.38 ± 20.31 mg/l and 38.93 ± 9.57 mg/l for symptomatic and control Hamlin; whereas, the values were 50.23 ± 20.66 mg/l and 22.99 ± 5.63 mg/l for symptomatic and control Valencia, respectively. Limonin was also found to be higher in HLB-infected fruit. In symptomatic Valencia, the limonin concentration was 11.1 ± 9.4 mg/l as compared with 1.7 ± 3.5 mg/l for control; in Hamlin oranges, the values were 9.8 ± 4.6 mg/l and 1.3 ± 2.3 mg/l, respectively.

Most of the study was devoted to the examination of mature leaves. Glucose, fructose, sucrose, and maltose concentrations were analyzed once a month during the 2009-2010 season by HPLC/PAD as reported previously (Cancalon, 1993). In order to determine the origin of the maltose, α- (EC 3.2.1.1) and β- (EC 3.2.1.2) amylase activities were also measured (Megazyme assay kits, Wicklow, Ireland).

Because of large sample variations, glucose, fructose, and sucrose levels did not vary significantly in Hamlin, Valencia, or grapefruit, although a trend toward higher glucose and fructose was noted in symptomatic grapefruit leaves. Small amounts of maltose, at about two orders of magnitude less than the other sugars were detected. Maltose concentrations were about three times higher in symptomatic than in control and asymptomatic leaves. Kaplan and Guy (2004) postulated that a maltose accumulation may function as a solute stabilizing factor in response to abiotic stress.

Both α- and β-amylase activities were detected in leaf samples. Only maltose and α-amylase activity were affected by the disease and were significantly higher in HLB symptomatic leaves. β-amylase was not found to vary with time or with any type of leaves and remained fairly low. No significant amounts of maltooltriose, an α-amylase byproduct, could be found. During the season, in both Hamlin and Valencia, levels of maltose and α-amylase activity varied in a similar manner, indicating a possible link between the enzyme and the product. They peaked in April then decreased significantly until the end of the study in July. Similar changes occurred in grapefruit leaves but were less striking. This late decrease in maltose and amylase levels in the leaves may be a reaction to the removal of fruit from the trees. It should also be
pointed out that an increase in maltose appears to coincide with the January 2010 freezes, which raises the possibility that a local climate effect may not be ruled out as influencing part of the observed changes.

In conclusion, high levels of maltose and α-amylase activity seem to be characteristic of mature HLB leaves; in this study, the potential relationship with variations in starch levels was not examined. The study has also revealed the difficulty of conducting research in the field, where many factors such as temperature, humidity, and other physiological stresses on the trees cannot be controlled. It is also important to note that both symptomatic and non-symptomatic groups are not homogeneous and that both fruit and leaves in these groups can have very different biochemical compositions.

References