HEAVY CROP LOADS INCREASE APPLE TREE SENSITIVITY to European Red Mites

One of the basic concepts of Integrated Pest Management is that plants can tolerate a certain amount of damage to their leaves before significant loss in crop quantity or quality develops. This is called a "threshold." Thresholds for action are actually set somewhat earlier in the pest development so that actions, such as spraying, can work before much more pest damage can occur.

Action thresholds for leaf feeders (mites, miners, leafhoppers) in apple trees have been developed for several pests, but experimental results and observations have shown variable responses of the trees to these leaf pests. This appears to be due to differences in tree physiological status, crop load, and environmental conditions even before the pest develops. Since the apple tree deals with many other stresses, it is not surprising that tree performance may not be controlled only by a specific pest stress.

To understand these varying responses and how they may affect pest management practices required a new approach based on understanding how the apple tree sensitivity to a pest is affected by other stresses and especially crop load.

Prior studies in our lab on the behavior of apple trees point to the carbohydrate supply/demand balance as the best overall indicator of tree sensitivity to pest stresses. We think that leaf pests like mites have their effect by destroying the leaves' abilities to supply the carbohydrates needed for final fruit sizing. The demand depends on the crop load (Fig. 1). ***This approach suggests that low crop trees have a greater ability to tolerate foliar stresses, but that high crop trees will have much greater sensitivity, thus having a much higher risk of crop loss if thresholds are exceeded.***

WRITTEN BY A.N. LAKSO, A.H.D. FRANCISCONI, J. NYROP and S.S. DENNING. *A.N. Lakso is Professor of Pomology and Viticulture, Department of Horticultural Sciences, A.H.D. Francisconi is a graduate student in pomology; J. Nyrop is Associate Professor, Department of Entomology, and S.S. Denning is Research Support Specialist, all at Cornell University's New York State Agricultural Experiment Station in Geneva, New York.*

After growing up in a fruit growing region of California, ***Alan N. Lakso*** *completed his education in 1973 at the University of California at Davis in plant physiology, emphasizing environmental effects on grape quality. Since coming to Cornell's New York State Agricultural Experiment Station in Geneva in 1973, he has researched management and physiology of both apples and grapes with an emphasis on environmental stresses and cultural influences, particularly thinning and canopy management, on the physiological limits of yield and quality of fruit.*

Experiments Used

Our studies in the last few years have emphasized an important pest, European Red Mite (ERM), that affects the tree's ability to supply carbohydrate, and crop load that affects the sensitivity of the trees to this pest. Mature, cropping 'Starkrimson'/M26 trees were hand-thinned early to give a range of crop levels. Also high, medium, and low mite damage target levels (above, near and below the current threshold) were used to see how cropping affected response to mites. Mite populations were monitored weekly on 20-leaf samples per tree as typical of IPM monitoring. Mite damage increased rapidly in late July and early August as typical in Western New York. After the mite-day accumulations reached the desired levels in early August, the mites were killed with two miticide sprays.

Fruits in each tree were tagged for weekly diameter measurements to see when and how much mite damage affected fruit sizing.To test the concept of carbohydrates as the way mites affect the tree, whole tree carbohydrate production via photosynthesis was measured by enclosing entire trees in several clear Mylar "balloon" chambers for a day at a time at intervals during the season before and after the mite infestations. High flow rates of air passing through them maintained conditions near to normal. At harvest, fruits were picked, counted and weighed. Samples were taken to evaluate fruit size, color, starch, soluble solids, firmness, ethylene evolution and storage disorders. Carry-over effects on flowering and fruit set were measured in 1993 after a study in 1992 and will be examined in 1995 following the 1994 study.

Results

Mite populations increased as expected in late July and early

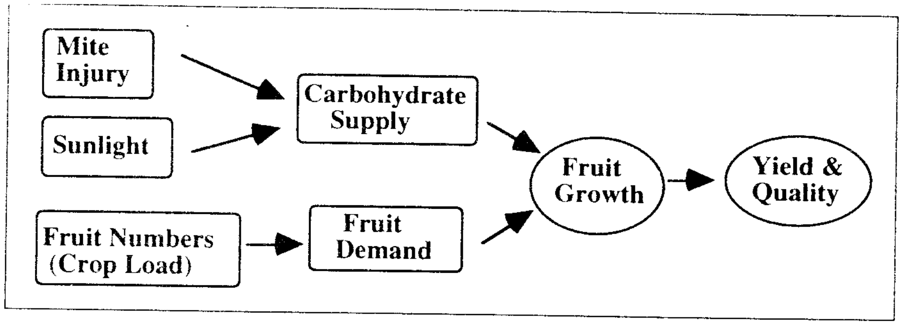

Fig. 1. Diagram of proposed effects of mite injury on tree function and performance via effects on carbohydrate supply/demand for fruit development.

August (arrow in Fig. 2), with a range of cumulative mite-days (CMD) achieved from a low of about 70 to a high of about 2400 while about 500-700 are normal thresholds. As in our previous studies, both single leaf and whole tree photosynthesis function were reduced by mite damage, but the primary effect of the mites was to decrease fruit size and yield related to fruit size. As predicted, the effect of comparable high mite damage on fruit growth occurred sooner and was more severe in heavy-cropping trees (reduction from 189 g to 180 g for low cropped trees versus 171 g to 141g for heavier cropped trees in Fig. 2). ***This represents a double penalty in fruit size since the fruit was already smaller on heavy-cropping trees even before the mites developed.***

In this study, no significant effect of mites was found on fruit color, firmness and starch, and the effect of reducing soluble solids were minimal compared to the size effect. Effects on fruit ethylene production and watercore were not great, but suggested that the mites delayed maturity somewhat. These relatively minor effects on fruit quality are similar to results from a previous study with Starkrimson Delicious in 1992, although mites have been observed to clearly affect

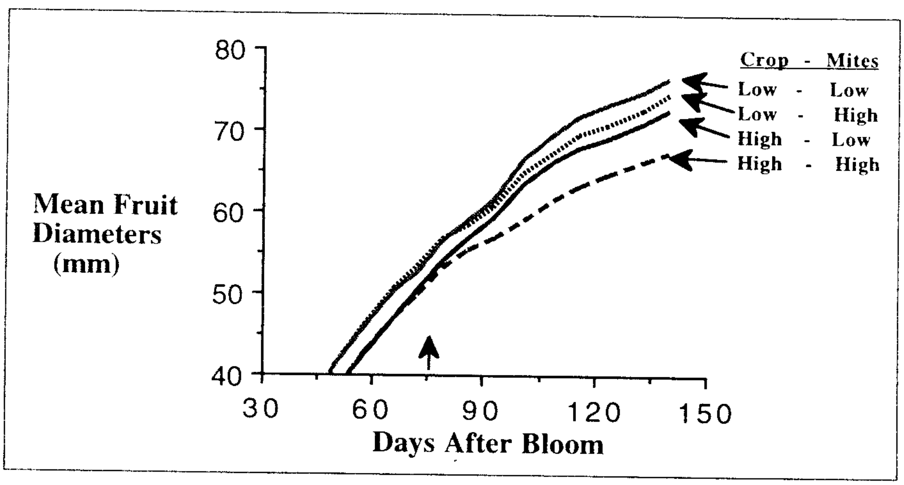

Fig 2. Growth curves of Delicious apples before and after the onset (arrow) of ERM damage. The curves represent low cropped trees (upper lines) and high cropped trees (lower lines) with low (<500) versus high (>1,700) mite day accumulations. Note much earlier and greater total reduction in fruit growth and final size due to mites in the high-cropped trees.

fruit color of Gala in nearby orchards this year.

At harvest, the smaller fruit size due to high crop level without mites are seen as expected, but the effect of mites reducing fruit size is also greater in the heavy cropped trees (Fig. 3). Using data from the same orchard in 1992 and 1994, we related the fruit size to total mite days as had been done in past studies to establish action thresholds. The results were extremely variable and thresholds were not apparent. However, our tree-based estimates of carbohydrate supply/demand showed a much clearer threshold as we had predicted. These results support the ideas described in Figure 1.

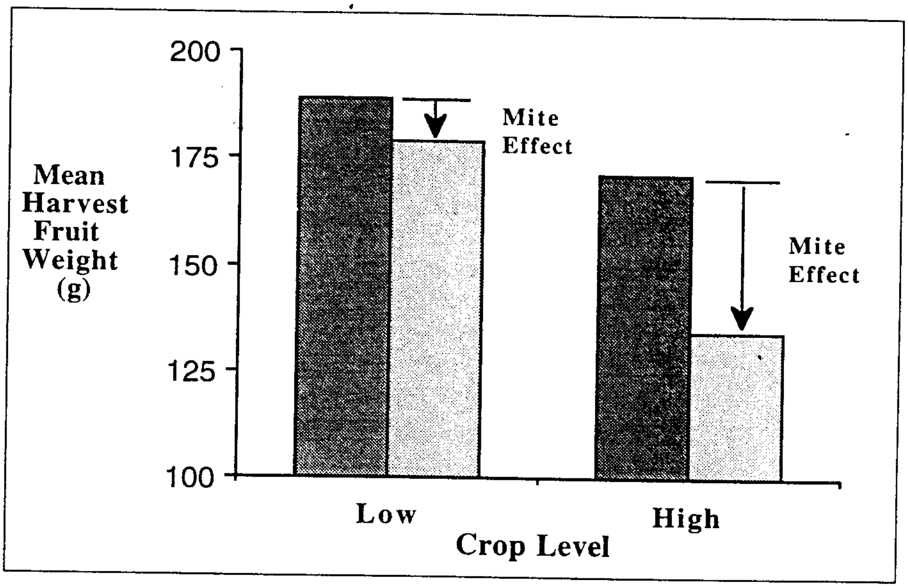

Fig. 3. Mite effects on final fruit weight of Starkrimson Delicious depending on the crop load of the tree. Note much greater effects on heavy cropping (a good commercial crop) trees that already had smaller fruit size.

Low crop trees have a greater ability to tolerate foliar stresses, but high crop trees will have much greater sensitivity, thus having a much higher risk of crop loss if thresholds are exceeded.

Implications for IPM

The importance of these findings to IPM is that we seem to have found a mechanism, carbohydrate supply/demand, by which foliar pests like ERM can cause many of the known effects.The implications for IPM are:

(1) Other stresses, such as crop load can make the apple tree more sensitive to foliar pests.
(2) For normal crops, the current mite threshold of 500-700 total mite-days appears to be valid.
(3) For low crops, the thresholds can be relaxed and may allow reduction in miticides and better development of predators.
(4) For heavy crops that struggle to size the fruit without pest injury, the risk is much higher since the trees are already more sensitive to any added stress. Due to this higher risk associated with mites in higher cropping orchards, ***we emphasize the importance of following the current sampling and threshold recommendations very strictly when the crop is heavy.***
(5) Better knowledge of how the sensitivity of our trees can change before we deal with pests will help assure that we minimize any crop value loss due to pests while using as few pesticides as possible.

The authors would like to acknowledge the assistance of J. Kovach and C. Watkins, to the CAPES foundation of Brazil for the graduate study fellowship to A.H.D. Francisconi and to the Cornell IPM program for partial support.