Development of a Binomial Sampling Plan for Persea Mite

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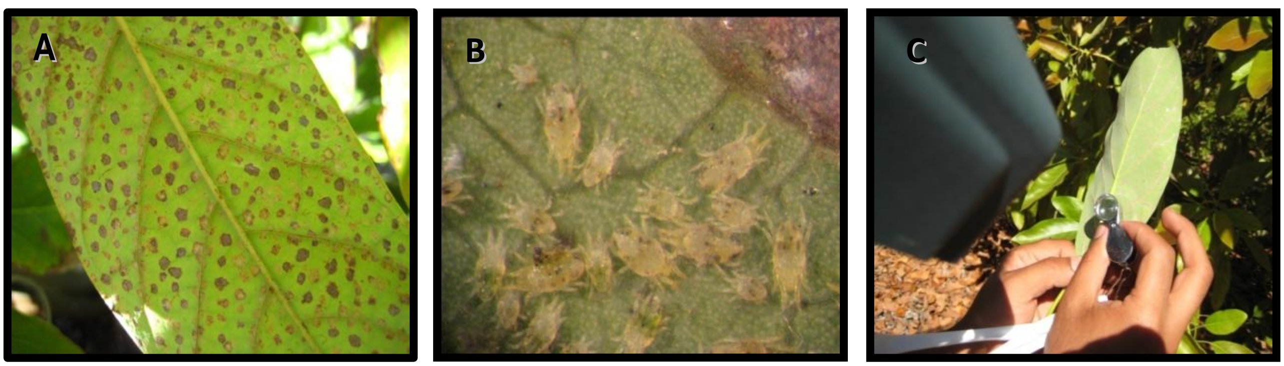
Feeding persea mites can cause extensive foliar damage to avocados and this pest is typically controlled with pesticides. Sustainable pesticide-based control programs must rely on accurate monitoring of persea mite numbers in orchards to determine if pest populations are approaching densities which require control thereby preventing economic damage to trees. Limited applications of pesticides at critical times will significantly delay resistance development by persea mite, save growers money, and promote IPM as a marketing tool for California-grown avocados. Counting persea mites with a hand lens in the field to determine average numbers per leaf is tedious, time consuming, and an inaccurate way to measure population densities for making control decisions.



Photograph A above shows necrotic spots caused by persea mite. Photograph B shows the mites living in the nests on the underside of the avocado leaf, and often there can be hundreds and sometimes thousands of mites living on a single leaf. Trying to count all of these mites with a hand lens and optivisor (Photograph C) is impossible and inaccurate (photographs provided by Ricky Lara, UC Riverside).

An alternative approach to counting absolute numbers is presence-absence or binomial sampling to determine persea mite densities. Binomial sampling simply requires information on the numbers of avocado leaves infested with persea mite and the numbers of clean leaves with no persea mites. This ratio of infested leaves to clean leaves can be used to estimate the average number of persea mites per avocado leaf. Binomial sampling is fast, simple, and allows large areas of orchards to be surveyed quickly.

This CAC co-sponsored project (the majority of funding for this project has come from a USDA-AFRI grant awarded through Western Regional IPM) is developing a binomial or presence-absence sampling plan for persea mite. Statistical analyses of very large pre-existing persea mite data sets (i.e., 36,714 leaves have been examined and 1,001,213 mites have been counted) to determine the relationship between the mean number of mites on a leaf and the proportion of infested leaves in an orchard have been completed (Fig. 1).

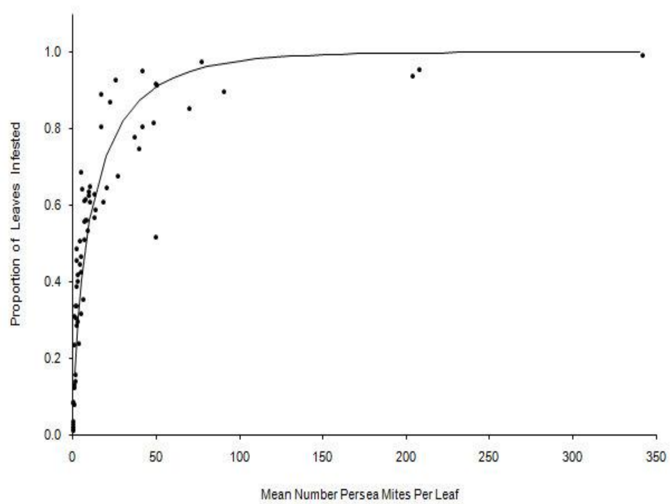


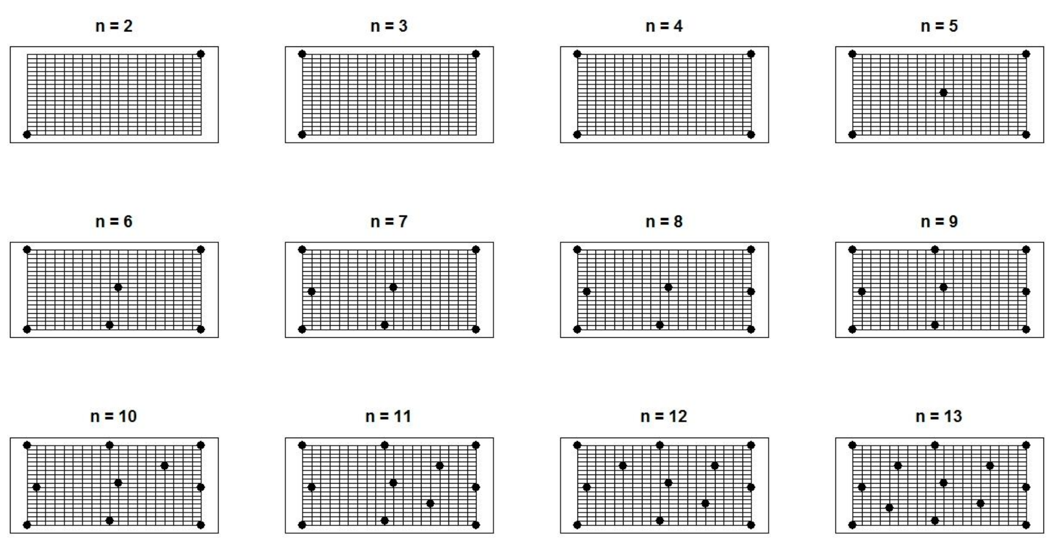
Fig. 1. Plotted values of data sets for *Oligonychus perseae*, each measuring the proportion of infested leaves and the mean mite density per leaf, and a graph of the fitted empirical equation,

$$\ln(-\ln(1-P)) = a + b \cdot \ln\left(M\right)$$

Parameters a and b were fitted using linear regression.

A second part of these analyses has examined the spatial relationship between persea mite infested trees in orchards and how this influences count data. If selected trees are too close together (i.e., sampled trees are separated by less than 3-4 trees) then mite counts are not independent as mite populations on neighboring trees affects counts and this biases estimates of mean mite densities per leaf. This effect is known as spatial correlation. Computer simulations using persea mite counts from mapped avocado trees indicates that maxi-min sampling is the most effective way to eliminate sampling bias due to spatial correlation. Selected trees for sampling can be ‘maximally spaced’ based on a maxi-min distance criterion, in which each tree is selected so as to maximize the minimum distance it has to all other previously selected trees. A design constructed by this rule has been referred to as a ‘coffee-house’ design for the similar way in which customers select their tables in a coffee-house. This approach proved to be very powerful in eliminating spatial correlation between avocado trees sampled for persea mite. The results of simulations can be seen in Fig. 2.

Fig. 2. Visual illustration of the sequential, maximin tree-selection rule applied to a 20×20 grid of trees, demonstrating how the first 13 trees are selected. Here we arbitrarily chose the first tree selected to be the lower, left-hand corner tree.



A scientific paper explaining these analyses and tree selection rules in orchards has been written and submitted for publication (DePalma, E., D.R. Jeske, J.R. Lara, and M.S. Hoddle. Sequential Hypothesis Testing With Spatially Correlated Presence-Absence Data. Submitted to the Journal of Economic Entomology (in review). All of the milestones for this project were realized in year one and have been reported on in 'Activity' Reports' submitted to the CAC.

Phase II of this project that will be conducted in 2012 and work will encompass the following: refining current models, and field testing sampling plans prior to release to growers and PCA's. Training and demonstration field days will be held to provide instruction in the use of the binomial sampling plan for persea mite monitoring in California avocado orchards. Ultimately, our overriding objective is to develop a statistically sophisticated and accurate sampling plan that will be very simple for PCA's, growers, and other pest managers to use thereby allowing them to quickly assess persea mite densities in their orchards and to reach control decisions based on their own personal tolerances for mites. We think it will be possible to develop this sampling program as an "App" that can be interfaced with a smart phone or tablet, and will utilize Google Earth and GPS technology in these gadgets, to step PCA's or growers through the sampling process and interpretation of data.