Avocado Phenology – Using Digital Monitoring to Improve Grove Management Decisions

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California's research information regarding cultural practices for avocados is growing. However, the majority of published research provides input for grove management decisions based on a calendar year and on growing conditions typical of the semi-arid subtropical conditions of Southern California. Anecdotally, the cooler, moister growing conditions of northern growing areas including San Luis Obispo County result in different phenological timing for major events like bloom, fruit set and shoot flush. This project will

- develop comparative phenological calendars for San Luis Obispo, Santa Barbara and Ventura counties through the use of pheno-camera technologies that allow remote recording of major phenological events,
- demonstrate the use of phenological information in adapting existing research information using inflorescence tissue as a tool to assess tree nutrition status,
- develop an interactive web-based mapping program to allow storage and retrieval of digital images that record growth stages, and
- expand digital methodology results to all areas of avocado production in the State through the interactive web-based mapping program using existing GIS information of avocado production areas.

During the initial assessment phase of the project we are testing the use of digital cameras to remotely monitor avocado phenological events in San Luis Obispo, Santa Barbara and Ventura Counties. These cameras (here-after called pheno-cams) are equipped with cellular modems that allow daily tracking of tree development as well as camera performance. We have recruited local cooperators and deployed pheno-cams at Cal Poly San Luis Obispo and at two locations in Santa Barbara County. A fourth camera will be installed in San Luis Obispo County in November. We will continue to monitor pheno-cam methodology through the remainder of the fall to determine if the methodology has the required sensitivity to remotely monitor tree phenology. The pheno-cams currently deployed are successfully recording and transmitting images from field locations to a password-protected website through the camera vendor.

Progress to date: The first objective for this project tests the use of digital cameras for remotely monitoring phenologic changes in avocado trees. For all objectives of this project to be met, digital cameras must meet the following criteria:

1) Weather resistant
2) Easy to establish and maintain
3) Sufficient resolution to discern changes in tree phenology
4) Ability to store reasonably high resolution images
5) Ability to remotely monitor camera performance via cellular access
6) Ability to change time of image capture as daylength changes

We have purchased four 6-megapixel cameras from a company who regularly provides services to game hunters, along with modems that attach to each camera that provide cellular service. We

remotely monitor the camera images, battery life for the camera and the modem, digital storage available on the camera's memory card, and the available data transfer for the period of the prepaid cellular plan.

The first camera site was established in a Hass avocado grove on the Cal Poly San Luis Obispo campus in late August. Cameras are mounted on metal fencing posts at six to seven feet and direct across rows, generally in a southwesterly direction. Images captured on September 2, 2012 are shown in Figure 1 below. Although initial review of literature indicated solar noon as the best time to capture images, we have found excessive glare in the grove at this time. Late morning and early evening provide good detail and reduced glare.

Figure 1. Digital images from 6-megapixel camera installed in Hass avocado grove at Cal Poly San Luis Obispo. Camera is oriented to southwest in row adjacent to trees being imaged. Examples show images captured by camera at 8:00am, 1:00pm (solar noon) and 7:00pm PDT. Yellow circles designate cluster of fruit.

DISCLAIMER: Discussion of research findings necessitates using trade names. This does not constitute product endorsement, nor does it suggest products not listed would not be suitable for use.

Two grower sites were established in October, one each in Carpinteria (Santa Barbara County) and Fillmore (Ventura County). An initial site selected by the Carpinteria grower did not have sufficient cellular tower access to provide a signal to the modem, a potential limitation for some grove locations. However, a second site at the same operation has sufficient signal access and generated the image in Figure 2(b). This camera was preferentially oriented to capture images of bloom present at the Carpinteria location, rather than for best aspect and exposure as is apparent in the image.

Figure 2. Digital images of avocado bloom from a) a 9 megapixel phone camera taken 10/19/12 11:16 am, and b) pheno-cam image taken 10/19/12 10:15 am. Yellow circle designates the same inflorescence in both images. Although pheno-cam images are available with better light exposure these images are included because they were taken within the hour and allow demonstration of image quality.

a. Image of inflorescence from 9 megapixel phone cameras 10/19/12 11:16am

b. Image of inflorescence from 6 megapixel pheno-cam 10/19/12 10:19am

Cameras may be established in the field without cellular access. The camera we are using allows 16 GB of memory card storage, sufficient to store three images per day for more than one year. Memory cards within the camera are easily accessed either by USB cable downloading to a laptop computer, or by use of a memory card reader. Growers without cellular access could import their images to a project website through file transfer programs.

At this point in the project we feel that the cameras are meeting our basic criteria as previously noted. We will continue to work on appropriate placement, orientation, and time of image capture with cameras currently installed, with a final decision by the project team in December regarding the appropriateness of this technology.

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