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AERIAL COLOR INFRARED PHOTOGRAPHY FOR PROPERTY APPRAISAL OF CITRUS GROVES

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Abstract. **Aerial color infrared (ACIR) photographs were taken (at the scale of 2.54 cm = 61 m) of all citrus groves in Charlotte County (3181 ha) in June 1983, May 1984, and June 1985 and analyzed with a 2 camera video system to obtain total number of healthy trees in each property parcel. In previous years, tree counts were made by ground surveys. Data of the type of rootstock, variety of scion, estimated and reported yield of grove (boxes/tree), and the total number of ha in property from the ground surveys were compared with data from ACIR transparencies. Questionable tree counts by ACIR were verified by special field surveys. Comparisons were made between ground surveys and ACIR photography to determine the length of time, accuracy, estimated costs, and potential benefits of each method of data collection. Results indicated that the advantages of ACIR were: 1) reduction in time of appraisal, 2) ability to compare images from 2 different years and produce a more accurate property appraisal, 3) reduction of arithmetic errors in recording tree counts, 4) only 1 appraiser was needed for 7 to 8 weeks for photointerpretation, releasing a position for other work, 5) visits to groves were minimized, an important factor in the potential spread of citrus canker, and 6) calculated costs of conducting ACIR survey were considerably less than for ground survey.**

Property Appraisers are charged by the Florida Constitution, and the Florida Statutes to assess agricultural property (6). The Florida Department of Revenue (DOR) is the agency responsible for providing aerial photographs to the County Property Appraisers for determining property assessment. Rules of the State of Florida, Department of Revenue, Division of Ad Valorem Tax were formulated in 1983 with the guidelines approved by the Governor and the Cabinet in 1982. They were filed with the Secretary of State, and became effective on 30 Dec 1982 (6). Expected changes in state rules for appraising citrus property induced the Property Appraiser in Charlotte County to conduct a detailed and accurate ground survey in 1981 of all citrus groves in the county showing the different varieties, rootstocks, and age of trees for each property. In Charlotte County, small citrus groves are predominant, with the larger groves being no more than 500 acres. Therefore, appraisers were able to keep mapping procedures to a minimum, and did not require complicated grove maps as those prepared for groves in other counties (3, 4). A set of forms was developed that was compatible with computer forms of a Nixdorf 600 minicomputer that stores all appraiser's data base.

Citrus grove appraisal values are also of interest to grove owners (1, 2, 7, 8). It has been suggested that owners and managers maintain grove maps to keep track of tree progress (1, 3, 4, 5) so that comparisons may be made after changes occur, such as the disastrous freeze of 1983 (7). However, tree counts of groves are not easy to obtain, and owners/managers who initiate grove mapping in the first few years of ownership generally do not continue the practice because its a time consuming effort (1, 2, 3).

The purpose of this report is to compare surveys of citrus groves by ground field observations with ACIR photography and twin video camera photointerpretation, and to evaluate benefits and disadvantages from each system.

Materials and Methods

Citrus Grove Sites. Commercial citrus groves (3,181 ha) selected from Charlotte County Property Tax Rolls were outlined on U.S. Geological Survey Quadrangle (Quad) Sheets for aerial photography. Property boundaries of each grove (recorded in 2.54 cm = 61 m scale maps) were labeled by Section, Township, and Range for matching with aerial photography. Property records included: rootstock and scion, date planted, and estimated or actual production records during the past 4 yr. Total acreage in the property boundary was determined by the formula:

$$\frac{\text{Total number of trees} \times \text{spacing factor (m}^2\text{)}}{\text{m}^2 \text{ per hectare}} = \text{Total Hectares}$$

Ground Inspection Surveys. A list was prepared of all commercial citrus groves and property recorded on tax rolls as having citrus groves. Aerial photographs of grove properties were used as maps to make ground inspections (surveys) in 1981. A 4-wheel drive vehicle was used to drive through groves, which were usually irrigated and had a considerable number of ditches and gullies. These obstacles made it difficult to drive throughout the groves. Tree counts were only made for productive trees from each property. Large groves with trees of the same variety and

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age were divided into blocks for convenience in counting. Varieties were counted separately within the boundary of each property. Trees planted at different dates were also counted separately. Tree counts were entered into previously prepared forms and were turned over to a clerk for summarization, arithmetical check, and input into the county's Nixdorf 600 minicomputer.

Aerial Photography. A Zeiss RMK-A 30/23, 23 cm × 23 cm camera with a 30-cm focal length apochromatic (color corrected) lens mounted in a twin engine Aero Commander aircraft was used to photograph the county groves. The camera was connected to a Zeiss ICC/NS 1 intervalometer powered by the electrical system of the aircraft. Photography was taken with Kodak Aerochrome Infrared 2443 Film with a minus blue Zeiss "C" yellow filter (Wratten No. 12 equivalent) from an altitude of 1230 m resulting in a scale of 2.54 cm = 102 m. Photographs were taken using a forward lap of 60% (where 60% of an area would be included in the next photograph taken) and a side lap of 30% (where 30% of an area would be included on either side of the flight line). Photographs were taken in June 1983, May 1984, and June 1985. The infrared film was processed into positive transparencies with required chemicals in a standard EKC Model 1811 color processing unit. Aerial photography, processing, and copying were done by the Topographic Section of the Florida Department of Transportation (TOPO, DOT) at Tallahassee, Florida.

Computers and Data Analysis. A Nixdorf 600 Minicomputer (Charlotte County Main Computer) was used to store all property data, coordinates, plot numbers, total acreage of grove, rootstock/scion varieties, tree spacing, and all other pertinent data required in tax assessment. A Nixdorf SDT-C terminal was used at the photointerpretation station (equipped with a numberical key pad) to input all photointerpreted data.

Photointerpretation. For viewing ACIR transparencies, 2 Sony HVC-2400 Color Cameras with 58 mm close-up lenses were mounted on 2 Testrite CS-5 Photographic Close-up Stands over a flourescent light table covered with a plastic diffuser. Each video camera was connected to a Panasonic CT-1300D Data Grade color monitor mounted at eye level. The Nixdorf SDT-C terminal was located next to the color monitors for interpretation data input into the County Central Computer. A computer printout consisted of the previous year's tax rolls with all pertinent data to each property: 1) tree count, 2) production, 3) acreage, 4) rootstock/scion variety, and 5) taxes assessed. Property boundaries were delineated on transparent mylar sheets to fit the 2.54 cm = 102 m photographic scale. Rolls of ACIR film were cut into individual frames; plastic page protectors were used for each frame, which were then labeled with pertinent flight data, and property records.Photointerpretation was done by counting the number of productive trees observed on the transparency, and then comparing results with totals from the previous year. A system (4) previously used for identifying tree health, stress, and tree size was adapted to the system used in the tax rolls, where only productive trees are inventoried. ACIR transparencies of different years were mounted on the light tables and photointerpreted on the video monitors. Large differences in tree counts from 1 year to the next were verified by on-site inspection. Tree census data was used to calculate property values and the respective assessment on the Nixdorf minicomputer.

Results and Discussion

All citrus groves and property with citrus trees in Charlotte County were counted in a ground survey conducted in 1981. It took 2 field appraisers 7½ months to evaluate the county's (then) 3,182 ha of citrus. A clerk transferred all data from the appraiser's survey to computer sheets and entered the data into the County's minicomputer. Manual handling of numerical data 3 times prior to input into the main computer required considerable double checking to insure numbers were correct and minimize potential errors. Repetitive driving through groves on a daily basis had a negative impact on the performance of the appraisers, requiring additional computational time to insure accuracy of records.

Results of the ACIR photographic survey conducted in 1982 indicated that the total citrus acreage had increased to 3,864 ha. Preliminary problems in adapting to ACIR photography interpretation were overcome when a video system was installed for photointerpretation (C. H. Blazquez, unpublished data) and the data entered into the County's minicomputer. A comparison between ACIR and Ground Survey showed that the greatest advantage of ACIR was the time saved in the duration of the survey without loss of data or accuracy.

ACIR produced a transparency that was a permanent legal record, and showed the productive capability and health of trees in each grove at a point in time, while tree counts recorded in the ground survey did not. The ACIR transparency could be re-photointerpreted, while the ground survey records were the final results with no image recall capability.

An added advantage of the ACIR surveys was the ability to compare transparencies from different years and determine possible patterns of change, or to modify previous photointerpretations. The more photographs that are taken of a specific grove, the greater the potential to obtain information from those photographs, and all photographs taken in subsequent years. Comparisons between transparencies from 3 different years of the same grove increased the accuracy of photointerpretation, since it was possible to identify productive trees and follow their growth progress in subsequent transparencies. Interpretation was easier because the total number of trees was already recorded from previous year's count and was displayed on the screen of the terminal. Unless some changes were observed, the previous year's count was accepted and recorded into the computer terminal as the current year's count.

Photointerpretation of ACIR required only 1 appraiser for 7 to 8 weeks; thus, it was possible to assign the companion appraiser and the recording clerk to other duties. Compared to the ground survey data collection, direct input of tree counts into the Nixdorf SDT-C terminal considerably reduced the error potential and the need to conduct arithmetical double checks to photointerpreted data.

In 1984, citrus canker, caused by (*Xanthomonas campestris* pv. *citri*) (Hasse) Dow., appeared in nurseries, which led to restrictions on entrance into groves. ACIR allowed the appraisers to count trees in the office, reducing travel into groves only for verificaton of photointerpretation. Even though the County's citrus acreage increased to 4,546 ha the appraisal was completed without an increase in work force and with minimal travel.

Table 1. Projected expenses and time involved in ground surveys and aerial color infrared (ACIR) photography of citrus groves.

Ground survey	ACIR
I. First year's estimated costs A. Two appraisers and clerk B. Survey vehicle operation and maintenance C. Calculator, expendable materials, graph paper Total cost $21,000	I. First year's estimated costs A. One appraiser B. Video system C. Computer program D. ACIR film E. Expendable material Total cost $8,500
II. Second year's estimated costs A. Labor and expenses would be approximately the same as the first year's. B. Additional operation and maintenance of the survey vehicle required. Total cost $21,000	II. Second year's estimated costs A. Interpretation and film costs were same as the first year's. B. Minor maintenance of video equipment. Total cost $6,700
III. Third year's estimated costs A. Labor and expenses would be approximately the same as the first year's. B. Additional operation and maintenance of the survey vehicle required. Total cost $21,000	III. Third year's estimated costs A. Interpretation and film costs were same as the first year's. B. Minor maintenance of video equipment. Total cost $7,000
IV. Three-year costs for ground survey Labor, expendable materials, and cost of survey vehicle $63,000	IV. Three-year costs for ACIR Intrpretation, film, video system and expenses $22,000
V. Two Appraisers and a Clerk were assigned to Ground Survey for a total of 24 months.	V. One appraiser was assigned to the ACIR survey for 24 weeks each year.
VI. There were no cost savings.	VI. Potential savings in 3 years of $41,000.

Comparison of the man-hours and equipment requirements between the 2 survey methods suggested that there would be considerable cost benefits in counting trees with ACIR photography (Table 1). However, actual dollar cost savings were difficult to establish because savings in personnel and equipment could not be charged to a specific account. The survey vehicle already belonged to the Appraiser's office, and the citrus appraisers were already on the payroll. In a commercial environment, cost comparisons could have been more easily calculated (7). Even so, with the above limitations, potential cost savings to the county could be estimated (Table 1). The major cost savings of ACIR were: 1) only 1 appraiser instead of 2 was required, and 2) survey time was reduced from 24 months to 24 weeks. Total potential cost savings to the county over the 3-yr survey period was estimated to be $41,000.

Input of photointerpretation data into a terminal was a faster method of counting trees from aerial photographs, and worked well for the small citrus acreage found in Charlotte County. This system would probably require more development in counties with larger citrus acreage like Polk or Highlands. The results obtained for Charlotte County during the past 4 yr suggest that the development of an automatic tree counter and photointerpreter could accelerate data acquisition and input into a computer. Property appraisers, large grove operations, and other interested parties would then be able to more rapidly obtain tree counts and establish property values in a more timely manner.

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THE PROPAGATION OF CITRUS ROOTSTOCKS BY STEM CUTTINGS

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Abstract. **When seed of desired citrus rootstocks is not available in sufficient quantities, rootstocks can be propagated as stem cuttings. Rooting hormones, leaf area, maturity of the stock plants and propagation environment are among the important factors affecting the rooting of citrus cuttings. In experiments with Swingle citrumelo (*Citrus paradisi* Macf. × *Poncirus trifoliata* (L.) Raf.), 6-inch cuttings were rooted in a 1:1 peat:perlite mixture in styrofoam trays under intermittent mist in a greenhouse. Evaluations after 6 weeks revealed that juvenile 3-leaf cuttings produced more roots than mature 3-leaf cuttings. The leaf area of mature cuttings but not of juvenile cuttings affected root production. Indolebutyric acid and napthaleneacetic acid, both at 3000 ppm, stimulated the greatest root production in juvenile and mature cuttings, respectively.**

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Recent freezes in Florida have limited the supply of rootstock seed and created interest in the propagation of