Papaya Nutrient Management by Plant Tissue and Soil Analysis for Several Soils in Hawaii

Raymond S. Uchida, Agricultural Diagnostic Service Center (ADSC) UH-Manoa
Melvin Nishina, Cooperative Extension Service, Hilo Office, Hawaii County

Project Proposal

Project Justification

Papaya production in the State of Hawaii has been centered in the Puna District on the Island of Hawaii since the early 1970's. This area produced approximately 95% of the annual 50 million pounds of papaya for the fresh fruit market. With the spread of papaya ringspot virus in the Puna area, production has been declining and the survival of the industry is being threatened. The shut-down of sugar production on the Hamakua coast has provided new acreage for papaya. Presently, Pepeekeo has 450 acres planted with an additional 800 acres planned for the near future, Papaaloa has 150 acres, and Paauilo has 100 acres. There is also the potential for several thousand more acres to be planted in the near future. With the closing of sugar plantations on Kauai and Oahu, growers on Kauai, and Oahu have also started to expand large acreage of papaya. Growers on Molokai have also been expanding and have also developed a treatment plant. With the high rainfall along the Hamakua coast, and the use of drip irrigation on the other islands, fertilizer application must be carefully monitored to minimize runoff and/or leaching of nutrients to protect the environment.

Nutritional levels in papaya plant tissue for Hawaii are well established and fertilizer practices have been developed to attain these levels under Puna soil conditions. The "rocky" nature of the Puna soils combined with occasional heavy rainfall required high application rates with frequent application. Growers moving to the Hamakua coast are utilizing their past experiences in fertilizer application which may be excessive for the Hamakua coast soils. First time growers on Kauai, and Oahu are following fertilizer practices that were used for sugarcane, and growers on Molokai are applying fertilizer by "best guess" method. By monitoring the crop progress through tissue analysis, guidelines for nutrient requirements can be developed. These guidelines can then be used to assist growers by improving the efficiency of their fertilizer application, which would reduce their production costs and minimize pollution of the environment.

Previous Work
In 1990, a similar project was conducted in the Puna area to monitor papaya nutrition and fertilizer practice. The results of the study showed that the papaya grower cooperator was probably applying an inadequate amount of fertilizer since the tissue nutrient levels recorded during the length of the project was less than the established critical levels. This indicated that the papaya growers' fertilizer practices were probably not contributing to the contamination of ground water in the Puna area.

In the Paauilo area, which is characterized by low rainfall, initial papaya planting resulted in trees growing much too high before the initial fruit set. Therefore, the recommendation has been to reduce the nitrogen levels and move from a 1:1:1 (N:P:K) ratio to a 1:2:2 ratio fertilizer. Preliminary data has been collected from a commercial grower in this area but the results are inconclusive at this time.

In the first six months of 1996, an observation variety trial in Hakalau has resulted with "Kapoho" producing fruits averaging 0.75 pounds rather than the optimum 1.0 pounds produced in Puna. This possibly indicates the need for more information to determine the proper fertilizer ratio and rates for the Hamakua area.

From December 1996 through April 1997, Water Quality Project 09-096 was initiated to establish base level plant tissue analysis data with several grower participants along the Hamakua coast. From May 1997 through January 1998 this project was expanded to involve growers from Kauai, Molokai and Oahu. Results to date have shown a wide range of soil pH and nutrients in the soil and plant tissue levels. Also a wide range of fertilizer practices were found. Visiting the growers of all the islands also showed that growers need to be educated on insect and disease problems on papaya.

Project Objectives:

The primary objective is to demonstrate to the present and future papaya growers throughout the state, that an efficient fertilizer practice, based on critical plant tissue levels established for papaya production in Hawaii, can be developed by gathering and utilizing tissue analysis, soil analysis, and yield data.

Based on the critical plant tissue nutrient levels established for papaya grown in the Puna area, the crop will be monitored to prevent over application of fertilizer, thereby, minimizing potential runoff and leaching of nutrients. Field observations will be made to evaluate fruit size and column in relation to established critical plant tissue levels of papaya to produce fruit size and column comparable to those in the Puna district. Also, by incorporating an amounts of fertilizer experiment, further calibration for critical levels on papaya under different conditions can be compared with present critical levels.

This project will also provide county extension agents with training in the use of diagnostic tools to gain more information in nutrient management and crop production. By developing teamwork and collaboration among pier, s, ideas can be exchanged to help develop and provide better outreach programs to the papaya growers throughout the state.

Plan of Action and Expected Results
By combining efforts with a grower, a statistically designed amounts of fertilizer experiment will be monitored. The experiment has 5 treatments, this includes four (4) treatments of different amounts of N-P-K applied comparing it with the amount of N-P-K applied by using critical levels established by M. Awada for papayas grown in the Puna area as a guide. This trial will be used to confirm present critical levels that were established on Histosols or will assist in developing new critical levels for papayas grown in Oxisols to assist in calibrating fertilizer application.

Soil analysis will be conducted at all sites to correlate the soil data collected with fertilizer application and tissue analysis. In collaboration with the faculty in the Department of Agronomy and Soil Science, a fertilizer recommendation will be made. Follow-up soil analyses at 6 month intervals will be made.

Plant tissue analysis will be done at two months interval with the current grower participants on Hawaii, Kauai, Molokai and Oahu for a period of 2 years and fertilizer recommendation on rates and formulation will be made according to growth response and plant tissue levels. Plant tissue analysis for the fertility calibration experiment will be done monthly for the next 2 years.

Agents will assist in collecting cultural practice data from participating growers to develop base line information. All data collected will be summarized and distributed to the participating growers and to the growers in the area biannually. To keep the confidentiality of the individual participating grower, the data will be coded.

At the end of the project, a presentation will be made at the papaya industry conference to share the information with all papaya growers.

Maintaining concern on environmental quality and pollution control, combined results from the fertilizer calibration experiment and from the state-wide participating growers will help develop a foundation of an efficient fertilizer program for papaya production in Hawaii. The success of this project will demonstrate to the growers that plant tissue and soil analyses can be used as diagnostic tools to farm more profitably. It will also enable the $14 million papaya industry of Hawaii to expand and thrive throughout the state and assist papaya growers to farm responsibly and help protect the environment.
agent and the client, which in turn helps to improve the relationship between the client and the College.

A cooperative project on fertilizer treatments with Dole was also started. This cooperative work with Dole will provide the papaya project the opportunity to work on the calibration on the critical plant tissue levels for papaya.

Most growers throughout the state are not aware of the use of plant tissue and soil analysis as diagnostic tools to assist them with crop production. The growers are also unaware that over-application of fertilizer can be harmful to the environment. Periodic visitation with these growers have helped to educate some growers that these diagnostic tools can help them become more productive as well as make them more aware of the impact of over-fertilizing on the environment.

## Accomplishments

1. The primary objective is to demonstrate to papaya growers that plant tissue and sod analysis can be used to monitor the crop progress and assist in developing an efficient fertilizer program for papayas.
   - Showing and explaining to each grower how their sod and plant tissue analysis data compare with other growers throughout the state has demonstrated to growers that there is a difference in crop response with different practices. This has demonstrated to the growers that crop progress can be monitored through soil and plant tissue analyses.
   - The data collected to date also shows that some growers may be over-applying both nitrogen and potassium. Also, phosphorus in the soil is also high for most growers.

2. The second objective was to provide training for the extension agents in the use of both plant tissue and soil analysis as diagnostic tools in nutrient management.
   - Meeting and reviewing the soil and plant tissue data with the agents during the site visits has given the agents the opportunity to evaluate the field appearance with the data. Also, by observing the cultural practice of the grower, the agent can also relate the effects of the environment on plant tissue data.

3. A total of 13 farmers participated in project activities on a total of 650 acres

## Future Plans

By concentrating on a few "better" growers, comparison and correlation of their data with data collected from the calibration experiment with Dole will help to formulate the critical nutrient levels on papaya under different soil conditions. Also, with the introduction of the new transgenic papaya, plant nutrient levels from this new strain can be compared with the present industry standard.