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PROEXAG II

EXPORT INDUSTRY TECHNOLOGY SUPPORT PROJECT (AGRICULTURAL COMPONENT)

REPRODUCTIVE MANAGEMENT OF MANGO IN CENTRAL AMERICA

Assignment Number: ST-013

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A DEVELOPMENT PROJECT SPONSORED BY USAID/ROCAP AND IMPLEMENTED BY CHEMONICS INTERNATIONAL

REPRODUCTIVE MANAGEMENT OF MANGO IN CENTRAL AMERICA

A Report to Chemonics-ROCAP Following Initial Visit to Guatemala, Costa Rica, Nicaragua, Belize, and Honduras.

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January 28, 1992

The following report describes the locations visited during a recent consulting tour of Guatemala, Costa Rica, Nicaragua, Belize, an Honduras. All trips were hosted and accompanied by Dr. Jose Mondoñedo representing the PROEXAG II project of Chemonics International. Names of all individuals encountered on these trips are included in Appendix A which was provided to me by Dr. Mondoñedo. Others are included herein where appropriate.

January 5, 1992

Dr. Mondoñedo received me at the Guatemala City International Airport on the evening of Sunday, January 5, 1992 and assisted checking me in at the hotel, Camino Real. The following morning, we traveled several hours to two mango orchards. The first was interplanted with a failed crop of corn on an arid hillside near Saspan in the province of Chiquimula. The 3-yr-old 'Tommy Atkins' trees looked healthy having had periodic irrigation to establish the orchard. Experimental trees which had been treated with 2, 4, 6, 8, & 10 gm ai of Cultar distributed in four gallons of water last July and various nitrate sprays during the previous month were in full bloom. Trees sprayed with KNO_3 (no Cultar) showed variable results with formation of mixed and vegetative shoots among a few non-responsive sections of trees. Non-treated trees throughout the orchard were in rest. The results of the trials clearly demonstrated the potentially efficacious use of a triazole plant growth retardant (Cultar) and KNO_3 to stimulate early flowering in Tommy Atkins, a cultivar which has generally been resistant to flower promotion by KNO_3. We then traveled to another orchard which had undergone similar treatments of Cultar and nitrate sprays. It was located in Rio Hondo in Zacapa. The notable difference between this orchard and the previous one was that these trees were irrigated weekly throughout the year. Similar flowering responses to all treatments were noted. In addition, other non-treated trees in the orchard were flowering. Our observations confirmed a suspicion noted in my earlier travels that mango flowering occurs independent of soil water conditions. The trees under irrigation were reported to flower more reliably than those grown in the dry area. Similar flowering responses to treatments, again, confirmed this notion. These

observations prompted us to focus our attention on the passage of cold fronts from the north and the lows in night temperatures which occur in the region. It was generally felt that lows of 15° to 18°C were common during such periods. We returned to Guatemala City.

January 7, 1992

We traveled to Tiquisate where we visited a mango orchard interplanted in cashew on la Ceiba Farm. The area is located on a coastal plain dominated by fields of cotton and sesame. Rates and timing of Cultar and nitrate compounds applied these trees were similar to the previously described locations except that Cultar was applied in a volume of only one liter per tree. Little flowering response was noted in all treatments, perhaps due to the lack of adequate distribution of the minimally soluble (30 ppm) paclobutrazol to roots. Moreover, those trees which did flower seemed to do so independent of treatment concentration, and panicles lacked the characteristic internode compression typical of paclobutrazol treatment. Water applied after Cultar applications were apparently insufficient for adequate distribution to roots. A valuable lesson in method of application of Cultar was recognized; with soil application, distribute the desired amount of material suspended in plenty of liquid within the root zone. The total amount applied (i.e. gm/tree) and distribution to the root zone is more important than the solution concentration. We returned to the hotel in Guatemala city.

January 8, 1992

We flew to San Jose, Costa Rica and took a taxi to the office of CINDE (see acronyms listed on page 2 of Appendix A). There I met with Henry Fonseca regarding problems with macadamia flowering. The primary problems appear to be lack of complete inflorescence development and a lack of presentation of the style within flowers as a result of high night temperatures in the areas where the Costa Rican trees are grown. I suggested they try Abbott Laboratories' Promalin (ABG-3001) which is a mixture of GA_{4+7} (1.8%) and 6-Benzyladenine (1.8%). (Chemical and Agricultural Products Div., Abbott Laboratories, North Chicago, IL 60064). I also promised to refer the problem to Dr. Mike Nagao, macadamia specialist at the University of Hawaii (Kona) for possible answers. We then spent the early afternoon discussing the conceptual mango flowering model from which our recommendations to growers would be derived. We then departed in two vehicles for Liberia, located in the arid region of north-western Costa Rica. We travelled with Edgar Valverde, Carlos Gonzalez, and Fernando Fernandez. We checked into the hotel, El Sitio.

January 9, 1992

We first visited mango orchards at la Hacienda la Flor near Liberia. This orchard, as were all observed on this

trip, were composed primarily of 'Tommy Atkins', 'Keitt', and 'Haden' mangos. A distinction was made about so-called "red" and "yellow" Haden cultivars. (We were later informed by Carlos Vargas of Mangosa Farm in Nicaragua that the "yellow" cultivar is a zinc-deficient 'Haden'.) The trees were generally large, standing about 8 meters high. Most were flowering. They showed us examples of experiments they had conducted on flower promotion using KNO_3, girdling, light pruning, and water stress. Here again, it was noted that irrigated areas flowered as well, if not better than non-irrigated areas. Girdling was inconclusive. Tip pruning of some trees in November-December with KNO_3 sprays initiated growth which resulted in much flowering. Unfortunately these treatments lacked proper controls, but it was clear that, within trees, flowering was stimulated primarily on the tip-pruned branches. The field manager also indicated that using minor elements, especially zinc, in their spray treatments tended to increase the flowering response. This observation and the mistaken identity of the unique "yellow Haden" suggests that zinc and other minor element deficiencies may be widespread and should be corrected with regular minor element sprays.

We travelled on to Mango Tico, a farm also near Liberia. We were shown trees of the above named cultivars and the efforts of the farm manager to manipulate off-season flowering by withholding irrigation water. Few trees were flowering. Virtually all were in rest. As at all the farms, we spent time describing the mango flowering model with the growers. All seemed enthusiastic about the concepts.

We then travelled to Manuel Giron's farm near Liberia. It is a new planting with 'Tommy Atkins' trees 2 years of age or less. After discussing the proposed methods to induce flowering he was advised that many of his trees were large enough to begin synchronizing growth followed by inductive treatments this summer and fall. We returned to San Jose that evening and checked into the Gran Hotel Costa Rica.

January 10, 1992

We flew to Managua, Nicaragua where we were greeted by Carlos Vargas of Mangosa Farm and James Johnson of APENN. After checking into the Intercontinental Hotel, we travelled to Mangosa Farm on the eastern shore of Lake Managua. It has several hundred acres of the above-named cultivars growing in a very dry climate. Trees varied in size from about 5 to 8 meters. Microjet sprinkler irrigation was installed on much of the farm. Their flowering strategy utilizes trunk girdling of trees. Girdling of main trunks was done in August. They indicated that it always results in immediate vegetative flush. Then, KNO_3 was applied in December to stimulate flowering. It appears that the girdling treatment tended to synchronize the growth of the trees. We returned to Managua.

January 11, 1990

We flew to Guatemala City during the morning. No farm visits were planned for the afternoon so we toured local markets.

January 12, 1992

We flew to Belize City, Belize during the morning. We were greeted by Fred Hunter (USAID) who took us to the Radisson, Fort George Hotel. No Farm visits were planned, so we toured the local area.

January 13, 1992

Jose Novelo (BABCO) drove us to the BABCO headquarters at Orange Walk where we had a lengthy discussion among various representatives of the agricultural community about the conceptual model of mango flowering. It appeared to agree with their observations. As at all the locations, I made suggestions, based on the model, of a working strategy to achieve reliable out-of-season flowering of mango. Following the discussions, we travelled to the BABCO Farm near, Corozal, where several trees had been treated with 2 to 8 gm ai of Cultar two years previously. Trees were growing in a humid area which receives ample annual rainfall. The treated trees had a slightly greater propensity to flower than the non-treated trees. They had not been sprayed with KNO_3 to initiate growth. The farm manager felt that the treatments were not effective in stimulating flowering. I suggested they spray the trees immediately with 4% KNO_3 and observe the response. Moreover, I suggested that they severely prune portions of the Cultar-treated trees to see if the resulting growth might be excessively inhibited as has occurred on trees in Homestead. A detrimental response would indicate exercising extreme care in the use of this product in future years. As at la Ceiba Farm in Tiquisate, Guatemala. They applied the material in only one liter of water. The trees demonstrated little uptake of the material as evidenced by lack of inflorescence compression.

Following the visit to this farm, we drove to another area to observe papayas. The farm managers were most interested in a problem they were having with compression of internodes which occurs in older plants (about one year old?). Symptoms were not visible in the young trees we observed. Not being familiar with the problem, I had no solutions. I suggested use of GA_3 (ProGibb) or GA_{4+7} (ABG-3035) to promote elongation. Both are available from Abbott Labs (address above). We returned to Belize City.

January 14, 1992

We travelled to San Pedro Sula, Honduras where we were met at the airport by Moises Molina of FPX and Teofilo Ramirez of FHIA. After lunch, we proceeded to La Ceiba where we checked into La Quinta Hotel. We later discussed

the flowering model with grower, Rene Lafitte, and Patrick Blake (Standard Fruit Co.). over super.

January 15, 1992
The next morning, we drove to Lafitte's mango farm composed of 2 to 3 year old 'Tommy Atkins', 'Keitts', and 'Haden' trees. There we also met Dr. Jorge Gonzalez who has part interest in the farm. The trees were growing in a dry area getting about 20 inches of rainfall per year. They required supplemental irrigation. Most of the trees were large enough to begin synchronization and induction treatments. Following the visit to the farm, we proceeded to Comayagua. We checked into the Hotel Emperador and later visited with Mrs. Alma Rodas de Fiallos in her home to discuss the potential for floral induction in her family's mango orchard. We returned to the hotel.

January 16, 1992
We visited the Fiallos Farm where we met Manuel Fiallos. The mango trees were growing in a dry area. Some trees were planted along an irrigation canal which provided ample water to those trees during the dry months. All trees, including the irrigated ones, were flowering as a result of recent KNO_3 sprays. All trees were very large (up to 10 meters) and crowding together. They asked about pruning back to open up the orchard. I agreed that it would be beneficial to reduce the size of the trees to permit more light into the canopy. I recommended pruning back to about 2.5 to 3 meters diameter with annual pruning to control tree size and synchronization of tree growth. Following our visit, we returned to San Pedro Sula to catch our flight returning to Miami.

OBSERVATIONS AND RECOMMENDATIONS

All the orchards I observed seemed to be well-managed by the growers and farm advisors. Each was attempting to manipulate flowering by utilizing the most appropriate treatments known to them for the specific climatic conditions. Discussions of the conceptual flowering model was fruitful for both the growers and me. I was pleased that the model seemed to answer questions which they had regarding their attempts to control flowering. Observations I made on several farms and discussions with growers and advisors either confirmed or reinforced my notions about the control of mango flowering. One of these was the confirmation that water stress does not play a direct role in floral induction as is true for citrus. More exciting, however, was the realization that Celsius night temperatures get into the teens during winter and appear to play an important role in induction even as far south as Costa Rica. This surprising conclusion must be confirmed with accurate temperature data gathered from the field. The best method would be to utilize thermocouples to directly measure leaf temperatures throughout the night during the year. Recording thermographs or even max-min thermometers will be sufficient. Local conditions, including elevation prevailing breezes, convective cooling and relative humidity can all play a vital role in the leaf temperature which is suspected of controlling the level of florigenic promoter in mango leaves.

The concepts summarized in the mango flowering model (Appendix B) were discussed in detail at each location we visited. There is, thus, no need for detail here. To understand the model, it is important to know that two physiological switches must be activated within branches before flowering can occur:

1. New growth must be initiated in resting buds. Initiation is controlled by internal cycles within the plants about every 4 to 6 months. It can also be manually activated by pruning, girdling, or application of nitrate salt sprays such as KNO_3 or NH_4NO_3. Water stress delays the onset of initiation. Fruit and recent vegetative flushes inhibit initiation.

2. When initiation of new growth begins, each bud must decide whether to develop into a flowering panicle, a vegetative shoot or a confused mixture of the two. We believe control of this decision rests with the interactive balance (not absolute concentration) of a florigenic promoter, which is controlled by temperature, and an inhibitor which is derived from fruit and recent vegetative flushes. The unidentified promoter appears to be present in elevated levels during periods of lowered temperature (18°C or less). It cannot, at present, be manually controlled in

the field. The inhibitor, however, appears to be linked in some way to gibberellins and can, therefore, be controlled with the triazole class of plant growth retardants, such as paclobutrazol. These compounds inhibit synthesis of gibberellins.

We are especially interested in reproductive management of recalcitrant cultivars such as Tommy Atkins. If we can successfully manage this popular cultivar, then management of other cultivars is assured. Differences in tree size or growing environment should little affect the general strategy which I am recommending in this initial phase of study to induce off-season flowering. It would be desirable to achieve several goals in our cooperative planning. This report will:

1. provide to growers and advisors recommendations which they can utilize immediately to maximize the opportunity for increased productivity. It is too late to shift the flowering period forward, and although we have the technology to delay flowering for up to two months beyond the normal flowering period, experimentation in each growing area will be necessary.

2. describe a generalized strategy, based on the mango flowering model, by which growers can prepare their trees for flowering up to four months ahead of this year's flowering period. Whereas the strategy has not been demonstrated on recalcitrant cultivars such as Tommy Atkins, results of experiments in Guatemala and Puerto Rico strongly suggest that the strategy will provide a strong flowering response.

3. describe experiments to be conducted on the farms which will provide more precise information on the flowering response of trees at each location. In this way, we can discern environmental influences on the flowering response to better refine the management strategy to make it more economical and dependable.

4. provide warning of potential risks involved in use of growth regulators and pesticides in the reproductive management of the trees.

IMMEDIATE RECOMMENDATIONS

Several farms such as:
Hacienda La Flor - Liberia, Costa Rica
Mangosa Farm - San Francisco, Nicaragua
Fiallos Farm - Comayagua, Honduras
have already stimulated flowering of their trees using KNO_3 or Flowerkem. If only portions of the trees produced panicles, then another application is recommended. In general, lack of synchronous growth habit is the primary reason for partial results. Sprays should be repeated each three to four weeks until the entire tree has responded. Repeated sprays give non-responsive sections of trees a chance to mature before responding to treatment. Generally, 4% KNO_3 or 2% NH_4NO_3 should be effective for all the orchards which I observed. Use of surfactant is not necessary.

Farms which have not applied flower-stimulating sprays should do so, at the above concentrations, as soon as possible if flowering is desired. Orchards include:

Saspan Farm - Chiquimula, Guatemala
Rio Hondo Farm - Zacapa, Guatemala
La Ceiba Farm - Tiquisate, Guatemala
Mango Tico - Liberia, Costa Rica
M. Giron's Farm (larger trees) - Liberia, Costa Rica
BARCO Farm - Corozal, Belize
Lafitte Farm (larger trees) - La Ceiba, Honduras.

Orchards planted on arid land should be irrigated, if possible, at the same time as spray application to further stimulate growth. The best time to apply the material should be when the night temperatures are 18° C or less. If the night temperatures are not likely to be in this range, then it is recommended that four representative trees be sprayed. observe those trees for growth within 10 to 14 days. Note if the response is reproductive or vegetative. If panicles are forming, then spray the entire orchard. If vegetative shoots form, then wait for more favorable, low (<18° C)night temperature conditions. If paclobutrazol (trade names, Cultar or Bonzai) can be obtained, then it may be helpful to apply 50 ppm ai of paclobutrazol spray with a surfactant such as 0.1% Silwet L-77 surfactant (Union Carbide, Tarrytown, NY) to aid leaf penetration.

GENERAL FLOWERING STRATEGY

The purpose of the strategy, based on the flowering model, is threefold: 1) to synchronize growth of the trees, thus making treatments and disease control more efficient; 2) to reduce endogenous flowering inhibitors; and 3) to stimulate reproductive growth in specific trees within the grove. Fruit harvest can occur up to 4 months ahead of normal to take advantage of market conditions.

Step 1. Synchronize vegetative flush to occur throughout individual trees by lightly (tip) pruning trees. The timing of the pruning will depend upon the date of desired flowering. One may plan on pruning approximately 4 months prior to the desired flowering period. Therefore, if one desires to move the flowering period forward by four months, then pruning must take place as soon as the fruit from this current season is harvested. Pruning should be planned in blocks of orchard in the same order in which harvest times are desired.

As many terminals as possible on the trees should be cut 20 to 25 mm from the tips. This can be accomplished with machetes by hand or with a variety of hand-held or power saws and clippers, including larger topping and hedging machines pulled behind tractors. In the case of orchards having larger-than-desired trees, this first pruning should be heavier to reduce and shape the tree to slightly less than the desired dimensions. Such shaping will facilitate easier grove management in the future. If the pruning time coincides with an extended dry period, the orchard should be irrigated at the same time to facilitate vigorous growth.

Step 2. It is probable that anthracnose-infected leaves facilitate infection of panicles. Moreover, there is evidence that trees may be suffering minor element deficiencies. As indicated earlier, the occurrence of the "yellow 'Haden'" may be a morphological symptom of zinc deficiency. To help control anthracnose infection of leaves and to correct minor element deficiencies, it is recommended that the growers use combined sprays of fungicide and minor elements at least twice during the vegetative flush following pruning. The first spray should be timed when new leaves are about 2 cm long during the early spike stage. The second treatment (or third if rains are persistent during this period) may be combined with the triazole treatment during the limp red leaf stage described in the next step. Good coverage will be insured with a good surfactant such as Silwet L-77.

Step 3. Triazole plant growth retardants such as paclobutrazol (Cultar or Bonzai from ICI) inhibit synthesis of endogenous gibberellins. We believe that application of this material during the vegetative flush will reduce the levels of inhibitor sufficiently to allow later flowering

even under marginally inductive conditions (apparently governed by night temperatures). In this first year, a rate of 25 ppm ai paclobutrazol plus 0.1% surfactant such as Silwet L-77 is recommended (See PRECAUTIONS, p. 13). It should be sprayed on the developing leaves of the synchronized flush (Step 1). The flush should be in the limp, red-leaf stage, i. e. the new leaves should be about 2/3 full size, have a reddish tint (stronger in some cultivars than others), very limp, very thin (thickness), and very soft to the touch. This should occur approximately 3 to 4 weeks after pruning. Sprays should be applied to the new foliage without delay after mixing. Good coverage of the underside of the new leaves is desirable. Do not worry about spray coverage on old leaves.

Step 4. Allow the new flush to mature. The leaves should turn from light to dark green. This will generally take about three months from pruning (October if pruning occurred in July).

Step 5. The trees should now be prepared for initiation of reproductive growth using nitrate sprays such as 4% KNO_3 or 2% NH_4NO_3. These compounds and concentrations have proven effective in other areas. The latter is less expensive and requires less, but it may be difficult to obtain due to its use in making explosives. Surfactant is not necessary. Complete coverage of the entire tree, including the undersides of leaves, is necessary. Although the reduction of inhibitor resulting from the previous application of triazole increases the likelihood of success, the flowering response may still require reduced night temperatures which may not be available as early as October. Therefore, it is recommended that a small number of trees (2 to 4) be sprayed 5 weeks prior to the desired flowering time. If one observes development of panicles approximately 10 days after treatment, then begin spraying blocks of orchard trees on a schedule consistent with the harvesting plan. If the test trees grow vegetatively or do not respond, repeat the test on other sets weekly until the desired response is observed. Then begin spraying the orchard as previously described. Results from this first year will be a guide for future years.

Step 6. Moving the harvest time forward is the most desirable feature of the reproductive management strategy. One can only move the flowering time of a set of trees up by four months since eight months are required from the synchronizing pruning to harvest. Thus, if a further shift in flowering is desired, then it may be accomplished in the second year on previously shifted trees by doing a synchronizing pruning again after harvest of the first out of season crop. Once individual trees are synchronized to flower on a particular date, they should be kept at that flowering date on an annual basis by pruning at the same

time annually rather than trying to produce a crop from individual trees every 8 months. This allows two opportunities for vegetative growth which are necessary to maintain viable production, during the synchronizing flush and during a naturally-occurring post-harvest flush. Fungicide and minor element sprays are also recommended during this natural flush.

EXPERIMENTS

Use of nitrate salts to stimulate flowering in the tropics is well established, thus there is little need to experiment with effective concentrations. In the lower latitudes where these sprays are most effective, optimal concentrations have generally been 4% KNO_3 or 2% NH_4NO_3. Conversely, the use of the triazole plant-growth retardants are still in an experimental stage of development. We know from recent experiments in the Zacapa and Chiquimula area of Guatemala that summer application of as little as 2g ai soil-drenched Cultar applied in large volumes (4 gal) of water coupled with later KNO_3 sprays have produced excellent flowering responses. However, due to other considerations (see PRECAUTIONS below) care must be taken in use of these materials. Moreover, we feel it important to spray apply the materials specifically to the site of intended action, i. e. the developing leaves at the appropriate time to avoid accumulation in soil and trees. Thus, experiments are needed to establish the optimal concentrations and most economic use of these materiels for each growing area. It is hoped that all farms involved in the PROEXAG II project will cooperate in these experiments. Such cooperation will not only help to develop a scientific data base from a diverse range of climatic conditions but also provide better information for future management of out-of-season flowering at each location. The goals af the following experiments are to:

1. establish a quantitative relationship between Cultar (Bonzai) and the flowering response.

2. establish a quantitative relationship between night temperatures and flowering response.

Protocol: Select five representative trees for each of three spray treatments of triazole and control (a total of 20 trees). Trees should be organized into five blocks each with four trees randomly arranged within each block (randomized complete block design). Tag trees according to treatments, and draw a map of their locations to insure that their identity is not lost. Tip prune trees as described in *Step 1* above for synchronization with the rest of the orchard as soon as this year's crop is harvested. Protect new growth as described in *Step 2*. Spray experimental trees at the limp-red leaf stage as described in *Step 3*. Use

surfactant on all treatments including control. If possible, use the same spray equipment as used in the orchard. Begin with a clean spray tank, apply the surfactant control (0.1% Silwet L-77, Union Carbide, or other effective leaf wetting agent) to the tender leaves, especially the undersides of the leaves. Apply 10, 25, and 50 ppm paclobutrazol (Cultar) with surfactant, sequentially in increasing concentrations, to each designated tree within the five blocks. The amounts of material actually applied to trees depend upon how much is required to get good coverage on new growth.

Table 1. Examples of absolute amounts of paclobutrazol (ai) contained in spray volumes applied to trees.

Conc.	4 liters (1 gal)/tree	20 liters (5 gal)/tree
10 ppm	0.04 grams	0.2 grams
25 ppm	0.10 grams	0.5 grams
50 ppm	0.20 grams	1.0 gram

As soon as a growth response to nitrate spray is noted in the orchard test trees (See step 5 above) spray only the eastern half of the experimental trees with the same material as used in the orchard. The western sides will serve as non-sprayed controls. Observe responses on the eastern and western sides of trees one month later. The following data should be gathered:

1. Observe two randomly distributed sets of 100 branch terminals on each side of the trees (200 on eastern & 200 on western sides). Note the number of terminals which produced panicles, the number of terminals which produced vegetative growth, and the number which did not grow for each set of 100 terminals. You should end up with 4 X 100 observations for each tree. Tree replicates and the two sample replicates for each treatment should be clearly identified in the data. If desired, a uniform set of data sheets can be prepared from this office.

2. Record the orchard temperature continuously from the date of synchronized tip pruning to observation of flowering. Calibrated, spring-wound, one-week, strip-chart recorders, such as those furnished by Cox or Ryan used to monitor fruit temperature during shipment are recommended. Calibrated max-min thermometers may also be used as backup.

3. Dates when irrigation (if not continuous) is applied to experimental trees and rainfall dates and amounts should be noted. Also include annual rainfall.

4. Any other information which the grower feels may be helpful should be included.

5. All data will be processed in my lab for analysis. Results will be distributed to all cooperators.

PRECAUTIONS

Recommended use of any product in this report does not preclude use of other products which will accomplish the same goals outlined above.

The growers must be aware that paclobutrazol is not registered for use in mangos destined for the US market. Other products, such as fungicides, which may be used by growers may also lack registration for use on mango. Growers must assume responsibility for selecting products which have been cleared for use on mango. If the proposed experiments prove effective in producing out-of-season flowering, a serious effort should be made to convince ICI and Sumitomo Chem. Co. of Japan (another manufacturer of triazole, uniconizol) to seek registration. If such registrations are not forthcoming, the US market should be avoided until alternate strategies can be developed. Regardless, the grower must assume responsibility in the unlikely event that a shipment is rejected due to detection of residue of any material applied to mango trees.

Excess paclobutrazol in the tree has the undesirable effect of compressing internodes and inflorescences of panicles. Such compression results in increased risk of anthracnose infection. Optimization of product application with the above described experiments will likely eliminate this problem.

There is also evidence that accumulation of the material in the tree trunks following soil applications may irreversibly and severely stunt the growth of the trees if heavily pruned. This is one reason why sprays directly to the new flush of leaves are recommended. Large branches of Cultar-treated trees (8 gm/tree) planted at Chiquimula and Zacapa, Guatemala and at Corozal, Belize should be severely pruned to see if this prospect is a potential problem.

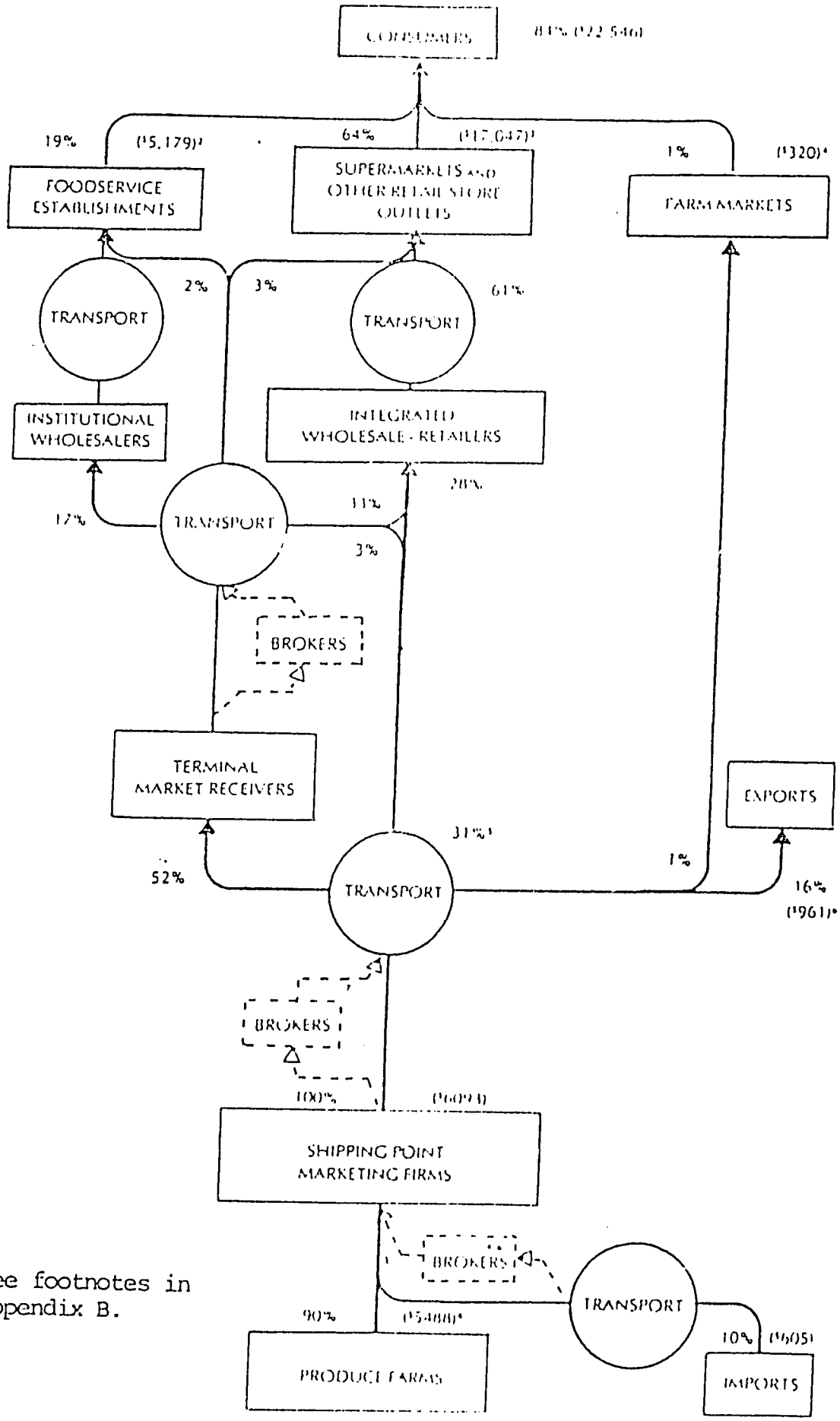
Manipulation of the flowering date must take into account the added risk of encountering rain during the critical flowering period. The choice of flowering date must be made carefully. While synchronization and fungicide application during the vegetative flushes should make anthracnos control more effective, attention to details such as anthracnose control with fungicide sprays when flowering is moved to more humid and wet conditions is imperative. If flowering is ruined by excessive rain, it is possible to reinitiate growth of axillary panicles with KNO_3 once the danger of rain is past.

Fruit bound for the US market should be aimed at advancing the production season through management of off-season flowering. Florida growers have established a production season of 'Tommy Atkins' and 'Keitt' from June to early August. They do not, at present, have the flexibility

of advancing their season due to sometimes severe winter conditions. Competition with these growers is ill advised as it would defeat your purpose due to the high cost of hot water treatment, shipping, and lowered returns during this period. Although Mexico and Haiti have successfully exported early-season fruit to the US in February, March and April, the volume is low compared to that of summer fruit (See Appendix C). It is, thus, highly advised that growers strive to achieve early flowering in late October to mid January to capture this early season market. Moreover, it is possible that some cultivars may be induced to flower during the summer canicula. This could provide mangos for export during the winter months. I the early-season Mexican fruit are likely yellow cultivars from Chiapas followed a month later from the state of Colima.

Do not, by all means, attempt to ship immature fruit to the US market. You would only destroy potential market growth of your product by creating distrust in a fruit with which few North Americans are familiar. There are simple ways to determine fruit maturity. Use them to everyone's advantage.

FIGURE 1. U.S. FRESH FRUIT AND VEGETABLE MARKETING SYSTEM, 1980[1]



Note: See footnotes in Appendix B.

Appendix A

PERSONS CONTACTED DURING THE TRIPS OF
TOM DAVENPORT AND JOSE MONDONEDO

A. In Zacapa, Guatemala - January 6:

Jorge Escobar and Rene Villagran of IICA/MAG.
Rolando Lemus of ICTA/MAG.
Oscar Paz, Jorge Chacon & Hugo Rios of MAG.

B. In Tiquisate, Guatemala - January 7:

Edwin Zaparolli, Eddy Martinez, Carlos Lira of IICA/MAG.
Francisco Solorzano of GEXFRONT.
Jorge Fuentes Serrano, a mango farmer.
Three other agronomists from MAG.

C. At CINDE, San Jose, Costa Rica - January 8:

Edgar Valverde, Carlos Gonzalez, Fernando Fernandez and Henry Fonseca of CINDE.

D. At Hacienda La Flor, Liberia, Costa Rica - January 9:

Luis Ulloa, Agronomist and field Manager.
Victor Julio, Vallverde, Gonzalez and Fernandez of CINDE.

E. At Mango Tico, Liberia, Costa Rica - January 9:

Pedro Iglesias and 3 other agronomists of the farm.
Alberto Saenz and 2 other agronomists of MAG.
Valverde, Gonzalez and Fernandez of CINDE.

F. At Manuel Giron's Farm in Liberia, Costa Rica - Jan 9:

Manuel Giron, farm owner.
Valverde, Gonzalez and Fernandez of CINDE.

G. At Mangosa Farm, San Francisco, Nicaragua - Jan 10:

Carlos Vargas, Agronomist of the farm.
James Johnson, Agronomist of APENN.

H. In Belize - January 13

Fred Hunter and George Like of USAID/Belize.
Jose Novelo and Wilbert Vega of BABCO.
Francine Magliore of Cental Farms, MAG.
Hugh Obrien of Belize Agricultural College.
Enrique Caraballo, Gilberto Vivas and Florencio Esquivel are agronomists of BABCO.
Sergio Garcia of MAG at Stann Creek.

Eduardo Zetina, BABCO Chairman of the Board.
Three farmers of Orange Walk.

In La Ceiba, Honduras - January 15:

Moises Molina of FPX,
Teofilo Ramirez of FHIA.
Rene Lafitte and Jorge Gonzalez, farm owners at Olancho.
Patrick Blake of Dole.

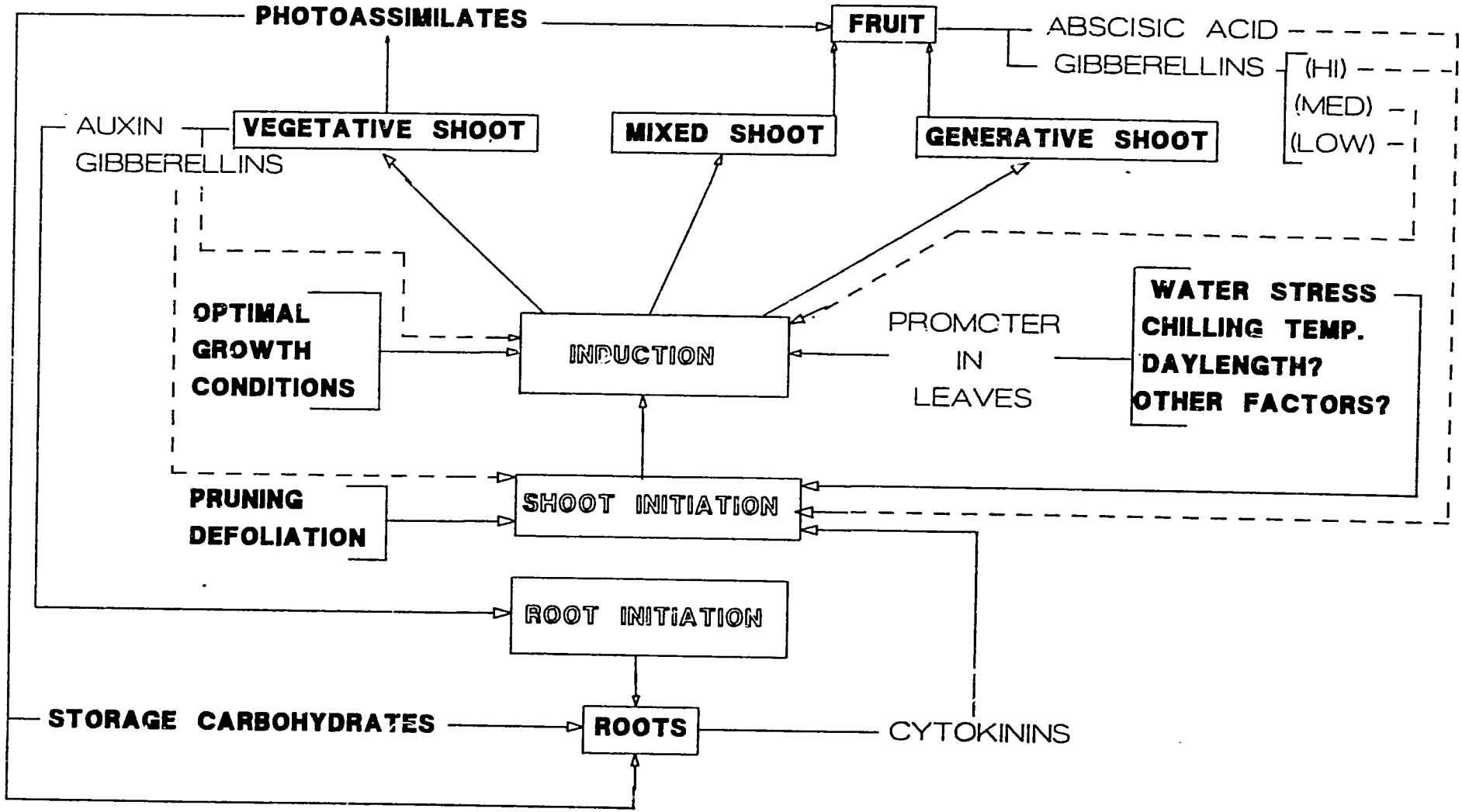
In Comayagua, Honduras - January 16:

Panfilo Tabora and Teofilo Ramirez of FHIA.
Mauricio Blessing, Agronomist of the Mango COOP.
Alma Rodas de Fiallos and Manuel Fiallos, farm owners.

Abbreviations used:

IICA	Instituto Interamericano de Ciencias Agrícolas
MAG	Ministerio de Agricultura y Ganadería
GEXPRONT	Gremial de Exportadores y Productores No Tradicionales
CINDE	Costa Rican Investment and Development
APEXNIC	Asociación de Productores y Exportadores Nicaragüenses
USAID	United States Agency for International Development
BABCO	Belize Agricultural Business Company
FPX	Federación de Productores y Exportadores
FHIA	Fundación Hondureña de Investigación Agrícola

Appendix B


PHOTOASSIMILATES
FRUIT
ABSCISIC ACID
GIBBERELLINS
(HI)
(MED)
(LOW)
AUXIN
GIBBERELLINS
VEGETATIVE SHOOT
MIXED SHOOT
GENERATIVE SHOOT
OPTIMAL GROWTH CONDITIONS
INDUCTION
PROMOTER IN LEAVES
WATER STRESS
CHILLING TEMP.
DAYLENGTH?
OTHER FACTORS?
PRUNING
DEFOLIATION
SHOOT INITIATION
ROOT INITIATION
STORAGE CARBOHYDRATES
ROOTS
CYTOKININS

Appendix C

TABLE 3--SHIPMENTS BY COMMODITIES, ORIGINS, AND MONTHS--CONTINUED
(AMOUNTS ARE SHOWN IN UNITS OF 1,000 CWT)

NON-CITRUS FRUITS

ORIGIN	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC	TOTAL
KIWIFRUIT - AVAILABLE TRUCK													
CALIF CENT	51	53	50	54	31	4	-	-	-	16	27	25	311
CALIF CENT EXPT	16	8	23	9	1	-	-	-	-	10	11	5	83
CALIF NORTH	19	33	39	27	21	6	-	-	-	7	8	9	169
CALIF NORTH EXPT	19	26	33	20	7	1	-	-	-	3	7	4	120
U. S. TOTAL	105	120	145	110	60	11	-	-	-	36	53	43	683
IMPORT													
CHILE	-	-	-	7	6	-	-	-	-	-	-	-	13
ITALY	-	-	-	-	-	-	-	-	-	-	-	2	2
NEW ZEALAND	-	-	-	-	91	161	128	116	152	1	-	68	717
IMPORT TOTAL	-	-	-	7	97	161	128	116	152	1	-	70	732
MANGOES - AVAILABLE TRUCK													
FLORIDA	-	-	-	-	7	22	5	1	-	-	-	-	35
AVAILABLE BOAT													
PUERTO RICO	-	-	-	-	-	-	-	-	-	1	-	-	1
U. S. TOTAL	-	-	-	-	7	22	5	1	-	1	-	-	36
IMPORT													
BRAZIL	-	-	-	-	-	-	-	-	-	-	-	4	4
HAITI	6	11	22	39	43	21	18	2	-	1	6	4	173
MEXICO	-	14	26	135	227	240	309	173	32	-	-	-	1156
IMPORT TOTAL	6	25	48	174	270	261	327	175	32	1	6	8	1333
MIXED DECIDUOUS - PIGGYBACK													
CALIF CENT	3	6	1	-	4	22	39	17	14	11	4	5	125
NECTARINES - PIGGYBACK													
CALIF CENT	-	-	-	-	2	63	31	40	27	-	-	-	163
AVAILABLE TRUCK													
CALIF CENT	-	-	-	-	256	1301	1192	1017	564	30	-	-	4360
IDAHO	-	-	-	-	-	-	-	3	-	-	-	-	3
TOTAL	-	-	-	-	256	1301	1192	1020	564	30	-	-	4363
U. S. TOTAL	-	-	-	-	258	1364	1223	1060	591	30	-	-	4526
PAPAYA - AVAILABLE TRUCK													
HAWAII	12	10	10	12	11	6	5	10	10	11	11	12	120
AVAILABLE AIR													
HAWAII	12	13	12	14	18	13	9	22	12	14	11	10	160
HAWAII EXPT	13	12	18	17	14	15	12	14	12	14	14	14	169
TOTAL	25	25	30	31	32	28	21	36	24	28	25	24	329
AVAILABLE BOAT													
HAWAII	8	6	4	4	7	6	2	12	11	9	15	8	92
U. S. TOTAL	45	41	44	47	50	40	28	58	45	48	51	44	541
IMPORT													
BAHAMAS	1	1	1	1	1	1	1	6	8	6	5	4	36
MEXICO	11	10	14	17	16	15	15	13	11	10	12	10	154
IMPORT TOTAL	12	11	15	18	17	16	16	19	19	16	17	14	190
PEACHES - PIGGYBACK													
CALIF CENT	-	-	-	-	7	19	22	15	3	-	-	-	64

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Supplemental Labeling For Special Local Need For Distribution and Use Only Within Florida

Read "Limit of Warranty and Liability" before using. If terms are not acceptable, return at once unopened.

The liability of UCB Chemicals Corporation ("UCB") for any injury, loss or damage to property associated with use of this product under any theory of warranty, negligence, or strict liability shall be limited to a refund of the purchase price of the product.

Carbamate WDG
Fungicide

EPA Reg. No. 45728-7 EPA Est No. 32557-BL-1
EPA SLN NO. FL 910012

Active Ingredient:
Ferbam (Ferric Dimethyldithiocarbamate.....76.0%
Inert Ingredients:.....24.0%

Total 100.0%

For control of anthracnose (Colletotrichum gloeosporioides) on Mangoes.

Keep Out of Reach of Children

CAUTION

PRECAUCION AL USUARIO
Si usted no lee ingles, no producto hasta que la etiqueta haya sido explicado ampliamente.

All applicable directions, restrictions and precautions on the EPA-registered Carbamate WDG label are to be followed.

This labeling must be in the possession of the user at the time of pesticide application.

Chemigation: Do not apply this product through any type of irrigation system.

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Limit of Warranty and Liability

Neither UCB Chemicals Corporation or the seller makes any warranty of merchantability, fitness of purpose, or otherwise, expressed or implied, concerning use of this product in accordance with these provisions. The user and/or grower acknowledges the preceding disclaimer and accepts liability for any possible damage resulting from this use, whether under theories of warranty, negligence, or strict liability which exceed the purchase price of the product.

UCB and the seller make this product available to the user because the benefit and utility, in the opinion of the grower and/or user, out weigh the extent of potential crop injury, loss, or damage associated with use of the product.