Section 1: Flooding in Agricultural Fields in South Florida

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HYDROLOGICAL ASPECTS

There is a great deal of concern among members of the agricultural community in south Florida about the potential impact of regional water management decisions on crop production. The primary concern is the potential for crops to be flooded as a result of elevated canal levels. Currently, regional water management decisions in south Florida are generally based on large-scale hydrological (2 x 2 mile or larger) grids. These regional scales are generally too large to make predictions at the field (farm)-scale level.

In Miami-Dade County, the hydrological and soil conditions are unique and currently not well understood. This can result in the inability to predict accurately the effects on individual fields of different canal management scenarios adopted at the regional level. Work has been initiated by Rafael Muñoz-Carpena, Bruce Schaffer, others at the Tropical Research and Education Center (UF TREC) of the University of Florida Institute of Food and Agricultural Sciences (IFAS), and colleagues at the U.S. Department of Agriculture other institutions, to gather more detailed information about the interaction between the canal and field hydrological conditions. This work requires quantification of the small-scale variability of the hydrological properties of the soil and aquifer and their effects on soil and ground water flow and water table depth changes. The effort will lead to development and testing of new (and existing) smaller scale hydrological models that will allow the prediction of flooding events in individual fields (or specific areas within a field) in response to a given canal management scenario.

A critical issue that needs to be resolved for south Miami-Dade County is the lack of detailed information on surface elevations for the agricultural area. This is extremely important for successful development and application of field-scale models for predicting flooding in agricultural fields as a response to canal levels under specific water management schemes.

PLANT RESPONSES TO FLOODING

Hydrological conditions need to be linked to plant responses to minimize the potential effects of high water levels on crop production. Work has been underway by researchers at IFAS and other institutions to determine the effects of flooding on crops and to identify**,** develop, and recommend flood-tolerant crops for areas that may be affected by elevated water tables in the future.

Vegetable Crops

Flooding is the major risk to fresh vegetable production in south Florida especially in the south Dade area. Although most soils are normally well drained, low-lying areas are often prone to flooding during periods of high rainfall. In Miami-Dade County, agriculture loss estimates from flooding as a result of rainfall (13.9") in December 2000 were 13 million dollars. In October 1999, vegetable crop losses due to Hurricane Irene were estimated to be

about 77 million dollars with nearly 19,000 acres of agricultural production damaged by floods. A project is currently being conducted to develop effective management techniques to prevent or reduce flooding damage to vegetable crops. Yuncong Li at UF TREC and Stewart Reed at the USDA in Miami are currently studying flood tolerance of vegetable crops and developing effective management techniques to prevent or reduce flooding damage to these crops.

Ornamental Crops

Jorge Peña of UF TREC has been working on testing woody ornamental crops for flood tolerance in the "Frog Pond" area adjacent to Everglades National Park. He has found that some native ornamental species [*Conocarpus* spp., *Quercus virginiana*, Sabal palmetto] can survive flooding very well and even require fewer pesticides under flooded conditions compared to non-flooded conditions. Plants have been grown under "organic" and "chemical" systems. Those plants grown with minimum to no insecticides and herbicides have similar market quality to those grown with the use of agrichemicals (agrichemicals). An economic analysis for both systems will be done to provide growers with alternative systems for growing native plants under conditions in the Florida Everglades.

Tropical Fruit Crops

For the past 15 years, Bruce Schaffer and others at the UF TREC have been studying flood tolerance mechanisms of tropical fruit crops and trying to develop flood-tolerant rootstocks. Much of this work is published, but some of the highlights are listed below.

Scions of commercial *Annona* trees such as 'Gefner' atemoya have been successfully grafted (with the help of Gary Zill of Zill's High Performance Plants Nursery) on rootstocks of the non-commercial species *Annona glabra* (pond apple), which is native to the Florida Everglades. The commercial crops grafted on their traditional *Annona squamosa* rootstocks can only survive about 3 days of continuous flooding, whereas plants grafted on *Annona glabra* rootstocks have survived and grew for up to 17 months in continuously flooded conditions. These *Annona* cultivars are currently being evaluating for horticultural and fruit quality characteristics and in the future they will be field tested in conjunction with Jorge Peña on his flood-prone experimental site in the "Frog Pond" near the Everglades National Park.

For avocado, it has been determined that a strong synergistic effect exists between Phytophthora root rot (PRR) (caused by *Phytophthora cinnamomi*) and flooding. The disease generally does not cause mortality under non-flooded conditions. By preventing *Phytophthora* infection, one can greatly improve flood-tolerance of avocado trees. Flood tolerance of avocado was improved by preventing *Phytophthora* infection with the use fungicides applied to the soil or injected directly into the tree. However, this approach is impractical since fungicides are expensive and growers do not want to apply them if they are not sure that their fields will be flooded. The best solution for improved avocado flood tolerance is *Phytophthora*-resistant rootstocks; however, there are no truly resistant rootstocks (some cultivars are said to have resistance, but this is only because the roots outgrow the pathogen). Although the avocado tree has little or no resistance to PRR, other *Persea* species in the subgenus *Eriodaphne* are highly resistant to the disease. Unfortunately,

these related species are sexually and graft-incompatible with avocado. A promising but long-term solution is the work being done in Richard Litz's laboratory at UF TREC. Through somatic hybridization and other genetic manipulation approaches, artificial hybrids between avocado and the PRR resistant species are being synthesized. One of the PRR resistant species is *Persea borbonia*, which is native to the Florida Everglades. Plants that develop in-vitro from fused protoplasts of resistant species and avocado are still in the test tube stage and first need to be acclimated to pots, than the field tested for horticultural performance. Developing flood-tolerant avocado through molecular techniques is very promising, but a long-range goal**.**

Work with carambola trees has indicated that short-term flooding (a couple of days) actually can stimulate flowering of carambola, whereas longer-term flooding can harm the plants. Trees will recover from flooding stress after the water recedes, unless the flooding goes too long (several weeks) or there are repeated flooding cycles for a few days each.

Anatomical and morphological features that confer flood-tolerance to some mango trees have been identified by Bruce Schaffer and colleagues at UF TREC. These features have been utilized as markers for screening and selection of flood-tolerant rootstocks. The mangoes that are grown in south Florida are of the monoembryonic type and do not come "true to type" from seed, unlike polyembryonic mangoes. Thus, in order to assess the genetic diversity within mango germplasm for flooding tolerance, it is essential to develop clonal material of monoembryonic mango accessions to successfully screen and select for flood tolerance. This work has been tried in Richard Litz's lab using tissue culture techniques. The study was successful in the laboratory, but long-term survival following transplantation from test tubes to the field is a problem.

THE BOTTOM LINE

Several conclusions can be made concerning flooding in agricultural fields in South Florida:

- A better understanding of the hydrological system by experimental fieldwork is critical for developing much needed field-scale models. These small-scale tools could then be linked to more general regional models currently in use to assess the effects of different canal management scenarios on the field in the south Florida agricultural area. Initial work by researchers at UF TREC and the USDA is under way in this direction, but is currently limited by lack of sufficient research funding.
- Detailed surface elevation data is critically needed for accurate predictions of flooding at the field (farm)-scale. Public and private institutions in the area should join efforts to obtain this information for the agricultural land in South Florida.
- Research has been conducted to understand crop responses to flooding and identify or develop flood-tolerant crops and rootstocks. There are some promising results with native woody ornamentals. For tropical fruit crops, we may soon be successful in developing flood-tolerant rootstocks for *Annona*, but whether it is economical is uncertain. There also may be other horticultural problems associated with this new material so it is being tested. Flood-tolerant rootstocks for some tropical fruit species (i.e., avocado) can be developed using molecular and tissue culture techniques, as a

long range, environmentally sensitive solution to the problem and to overcome the current reliance upon agrichemicals for disease control.