

Report on Travel to Costa Rica
August 3-7, 1998

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SM-CRSP Project *Decision Aids for Integrated Nutrient Management*

Traveler:

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Objectives:

- Become familiar with the Central American Regional Maize Trials by CIMMYT;
- Select soils to be used in a short-term P sorption study; and
- Plan experiments to improve the application of PDSS to soils other than Ultisols and Oxisols.

Itinerary and Activities:

August 3 and 4, Guatemala City - Met primarily with Elio Duron at the CIMMYT office in Guatemala City, but also had discussions with Jorge Bolanos, a regional agronomist, and Jerome Fournier, from the Swiss Development Corporation. CIMMYT operates in 9 countries and has about 378 experiments per year, each with a specific objective. A majority of their trials are on breeding, but about 1/3 are agronomic. In the agronomic, Jerome has trials in Honduras (replicated) and Guatemala (unreplicated) with 2 varieties and three treatments: farmer practices, CIMMYT recommended package, and greater than CIMMYT recommended package. The experiments are stick-planted, then stick-fertilized. We discussed analysis of soil, plant, and yield data, especially of the non-replicated trials. Depth to rock on hillsides and depth to watertable on flatlands were factors.

Elio knew of several soils that might produce information on field-derived P critical level and/or P sorption. These are:

- (1) Cuyuta in Guatemala - this site was in a P study in 1989-90;
- (2) La Esperanza in Honduras;
- (3) Porto Viejo in Costa Rica;
- (4) Cabalacito in Panama;
- (5) San Andreas in Panama; and
- (6) Fraijanes in Costa Rica.

Sites (2), (3) and (4) had field trials established as part of Elio's thesis. Sites (5) and (6) are field sites included in Dr. Donald Kass's report (1991). In later discussions it was indicated that Alfredo Alvarado will pick up the non-Costa Rican samples from Elio while in Guatemala on August 20 and also arrange for collection of the Costa Rican samples.

August 5, 6, and 7, San Jose - met Adrian Ares from the University of Hawaii and conferred with him the rest of the week. Also met with Alfredo Alvarado, Lidieth Uribe, and Gilberto Cabelceta. Alfredo indicated that sand content might be used to separate the Vitrandepts from the Hapludands and Hydrandepts, and that the Hydrandepts are likely to be higher in Fe and be thixotropic.

Cabalceta has 100 soil samples from Costa Rica from four soil orders which he has reported on with greenhouse estimates of critical soil P levels for sorghum and P sorption by the Hunter method (Cabalceta and Cordero, 1994). These soil samples will be available and we will use

them. Dr. Jose ('Pepe') Espinosa from Ecuador and Russ Yost from Hawaii are also to provide samples from P experiments.

The first afternoon Adrian and I each gave a seminar on our plans for improving PDSS. There was good attendance and discussion. Among the attendees was Donald Kass with whom we conferred, and he is to send information and reprints.

The second day was a field trip to a nursery and field plantations for heart-of-palm ('palmito') production with peach palm. Gabriella Soto also took the first week's samples of bagged leaves for the rate-of-breakdown on peach palm prunnings studies during our visit. On an aside, I observed the application of sugarcane residue about 10-cm deep being tried in one location. It will be interesting to see the effects of that much carbon on the nitrogen status of the plants. Rafael Salas explained routine practices in the DEMASA plantation during our visit.

On the last day, I met with Rafael Salas. The experiences of the week have altered my view of research needs slightly. A P sorption study is still needed, and Rafael would like samples from a P experiment at DEMASA to be included. This is fine, but the study should be restricted to short-term (1 and 7 day) reaction times. A short, preliminary study should be conducted to determine the effect of temperature on thixotropic soils. Long-term data, although nice for reference, is not at all practical.

There is need for a greenhouse study to relate the level of P in a variety of soils to growth of peach palm. Plans were made to collect about 10 low P soils on a transect from near Turrialba (Andisols) to between Pital and Los Chiles (Ultisols). Treatments will be six levels of soil P, replicated four times. Peach palm seedlings, grown about 2 months or about 5 cm tall, will be transplanted into pots and grown several months, perhaps as much as six months. At harvest, yield, soil, and plant samples will be taken. Details will be given in a following section.

I also discussed P sorption by soils in Costa Rica with Elemer Bornemisza. He stressed the importance of knowing the quantities of allophane and halloysite.

References:

- Cabalceta, G., and A. Cordero. 1994. Niveles criticos de fosforo en Ultisoles, Inceptisoles, Vertisoles y Andisoles de Costa Rica. *Agronomia Costarricense* 18:147-161.
- Kass, D. 1991. Development of appropriate technology for overcoming different mechanisms of P retention in Central American soils. Final report, project AID-SCI 936-5442. 80p.

List of Contacts:

CIMMYT, Guatemala

Ing. Elio Duron, Coordinator for the Central American Maize Agronomic Trials Network

Ing. Jerome Fournier, Central American Maize Agronomic Trials Network

Dr. Jorge Bolanos, Regional Agronomist for Central America and the Caribbean

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Dr. Alfredo Alvarado, Director

Dr. Rafael Salas, Soil Scientist

Dr. Elemer Bornemisza, Soil Scientist

Ing. Lidieth Uribe, Soil Scientist

Ing. Gabriella Soto, Soil Ecologist

Ing. Gilberto Cabalceta, Soil Scientist

Design and Research Protocol for Experiments

I. Relationship between P Sorption and Soil Properties

Background:

The relationship between P sorption and soil properties has been evaluated for Ultisols and Oxisols in some detail, with specific surface area and clay content each showing a high correlation with P sorption. As clay content can be determined or estimated more readily, it was selected for use in PDSS. In Andisols, clays are amorphous and clay content would not be a good measure, so other properties must be evaluated. Various forms of extractable Al and Fe are expected to be related to P sorption in these soils.

Principal Investigators:

UCR - Rafael Salas and Lidieth Uribe
NCSU - Fred Cox

Location:

UCR - CIA laboratories
NCSU laboratories

Soils:

As indicated earlier, about 70 soils will be collected from P field experiment sites in Guatemala, Honduras, Panama, Ecuador, Hawaii, and Costa Rica, and from the greenhouse study with Ultisols and Andisols in Costa Rica by Cabalceta. The soils will be analyzed at UCR for the following: (a) routine Modified Olsen and KCl-extractable Al, (b) routine Mehlich 3, but to include Al, (c) KOH active Al, (d) ammonium oxalate Al and Fe, (e) organic matter, (f) P sorption with Modified Olsen, (g) P sorption with Mehlich 3, (h) particle size, and (I) preparation for clay mineralogy.

Treatments:

Phosphorus will be added at 0 and 60 $\mu\text{g mL}^{-1}$ in a 1:1 suspension and dried by two methods: (a) open in laboratory for 7 d and (b) open in oven overnight at 40 C. Two methods are to be used to extract P; Modified Olsen and Mehlich 3. If the P sorption is greater than 95%, then the process should be repeated at 0 and 120 $\mu\text{g mL}^{-1}$.

Evaluation:

For each extractant, the P buffer coefficient will be determined, i.e., the change in soil test P per unit of P applied. These buffer coefficients will be related to soil properties for each of the two times of reaction. On those soils with field observations, comparison will also be made with field data.

Timetable:

Routine and other soil analysis will be completed by mid-December, 1998. The P sorption analysis will be completed by early January, 1999, and all data will be sent to NCSU by mid-January, 1999.

II. Effect of soil P in Andisols and Ultisols on the Growth of Peach Palm

Background:

The critical level of Modified Olsen P generally accepted in Costa Rica is 10 ug mL^{-1} . There are indications, however, that it may be lower on Ultisols and higher on Andisols. Crop differences are apparent, too, in that it is lower for rice and higher for potatoes. There have been no detailed evaluations with peach palm and further information with this crop is needed.

Principal Investigators:

UCR - Rafael Salas, Lidieth Uribe, and student greenhouse caretaker

NCSU - Fred Cox

Location:

UCR greenhouse

Soils:

About 10 low P soils (0 to 20 cm) will be collected on a transect from near Turrialba northwest to between Pital and Los Chiles. This gradation will be from Andisols to Ultisols. Low P should mean $< 5 \text{ ug mL}^{-1}$ in Andisols and $< 2 \text{ ug mL}^{-1}$ in Ultisols, assuming the Ultisols are very high in clay content. Taxonomy shall be ascertained and analysis for texture and amorphous and crystalline Al and Fe, as well as determination of Mehlich 3- extractable Al, will be conducted. Allophane and halloysite will also be estimated. KOH may be used in place of oxalate extraction. Samples will be sent to Raleigh for x-ray and surface area measurement.

A sorption curve will be used to determine the rate of P required to raise Modified Olsen to 10 ug mL^{-1} . This should be by the 7 d procedure, as requirements for other fertilization and lime should also be determined with that procedure.

Treatments:

Six soil P levels will be established with rates of P applied: 0, 0.25X, 0.5X, X, 2X, and 4X, where X is the quantity to raise the soil test P either to the critical level as determined by PDSS or to 10 ug mL^{-1} for soils not presently covered by PDSS.

Greenhouse procedure:

Treated soil will be placed in a 20-cm pot and 2 peach palm seedlings will be transplanted into the soil. The seedlings should be about 2 months old, or 5 cm tall, and the cotyledons removed. Some seedlings should be analyzed at this time. There should be four replications of these treatments. There should also be an extra treatment (X') to have plants to sacrifice occasionally to evaluate root growth and/or plant nutrient concentrations.

Evaluation:

Crop growth will be observed and recorded during the next 4 to 6 months. At harvest, top and root fresh and dry weight will be determined and the tissue analyzed for P and other nutrients. Soil test P will be determined by both Modified Olsen and Mehlich-3.

Timetable:

Site selection and preliminary analysis of the samples should begin in 1998, but the study is to be conducted in 1999.