burn, potassium by the third crop, and lime at or before the 18th month after burning. Yields under this management system will be high by local standards, and comparable to those at Yurimaguas. Differences in the patterns of nutrient dynamics at Manaus and Yurimaguas point to the need for obtaining similar information on other major soil types in the humid tropics.

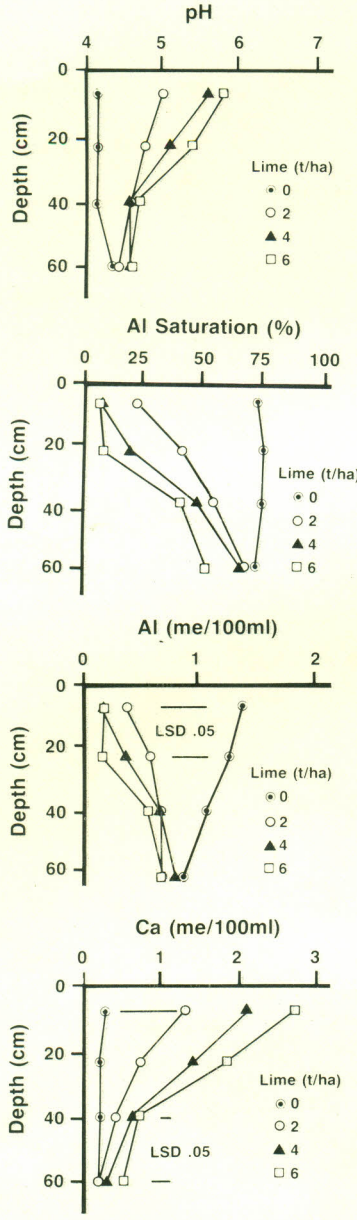

Figure 8. Soil-profile acidity acidity characteristics for the lime treatments at 21 months after liming.

Phosphorus Management In Humid Tropical Oxisols

Thomas Jot Smyth, N. C. State University
Manoel Cravo, EMBRAPA
Joaquim B. Bastos, EMBRAPA
P. Le Mare, Reading University, UK

Phosphorus deficiency is common in Oxisols of the Brazilian Amazon. For clayey Oxisols, P fertilization could become an important economic factor, as their P sorption capacities are high, in the same range as those in Oxisols of the Cerrado region. Although several studies have demonstrated marked yield responses to P fertilization with annual crops on these soils, information has been needed on soil-test calibrations and the long-term effects of different strategies for P fertilization.

The objectives of this project were: 1) to obtain detailed P response curves and soil-test calibration data for the main annual crops cultivated in the region; 2) to obtain a description of the residual P fertilizer value, and 3) to provide indications of appropriate maintenance P fertilizer rates for sustaining adequate crop yields.

Eight consecutive crops of the annual corn-cowpea rotation have been harvested in this study. The ex-

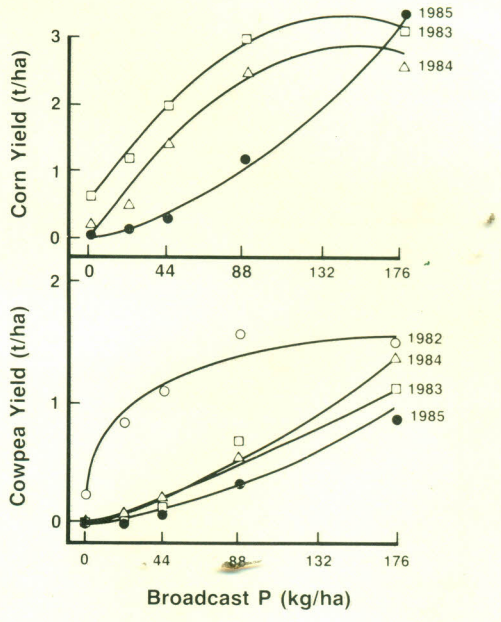

Figure 1. Corn and cowpea yield responses to initial broadcast P applications during the first four years.

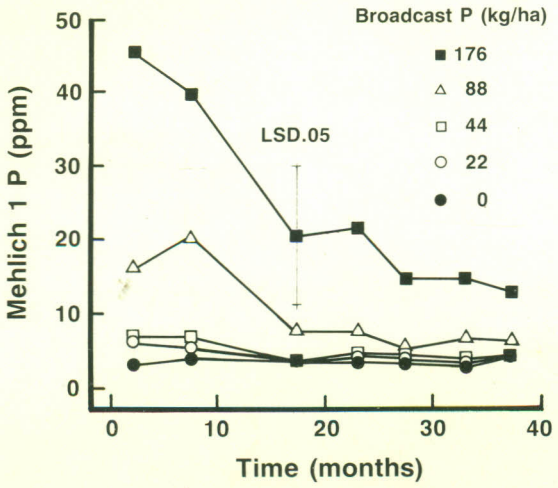

Figure 2. Available soil test P dynamics with time and rate of P application.

periment consists of a split-plot design in which the main plots were broadcast P rates (0, 22, 44, 88, and 176 kg P/ha), and the subplots were banded P rates. Broadcast P was applied once, before planting the initial corn crop. All other nutrients were maintained under nonlimiting conditions.

Yield Responses to Phosphorus

Corn was the first crop planted after felling and burning the primary forest in 1981. Yields on this initial crop were reduced by diseases (primarily mycoplasma) and showed a significant response only to 22 kg P/ha (data not reported due to the very low yields). Yield response of corn and cowpeas to the P broadcast in 1981 are shown in Figure 1. Maximum yields for cowpeas in 1982 and for corn in 1983 and 1984 were approached with 88 kg P/ha. In subsequent crops, maximum yields for both species were approached with 176 kg P/ha. These changes in yield response curves during successive years of cultivation are in agreement with changes in soil-test P with time after broadcast P fertilization (Figure 2). For 88 kg/ha of broadcast P, Mehlich 1 extractable P values declined from 20 ppm with cowpeas in 1982 to 7 ppm with cowpeas in 1983.

Data in Figure 1 also indicate that, for a fixed level of broadcast P, corn yields were sustained for a greater succession of crops than were cowpea yields. This observation is supported by the higher critical level of soil-test P for cowpeas than for corn (Figure 3). During three consecutive years, cowpea yields above 80% of maximum occurred when Mehlich 1 extractable P was greater than 10 ppm. Similar corn yield levels were obtained with soil-test P values of 5-7 ppm.

Broadcast vs. Banded P

Yield trends for successive crops of corn and cowpeas are compared in Figure 4 for various treatments of broadcast and banded P. Yields in each crop are presented as a percentage of yields for the broadcast P rate of 176 kg/ha. Data for both corn and cowpeas indicate that P supplied solely by banding 11 kg P/ha/crop does not increase soil P availability, as yield levels on the final crops were similar to the initial crops. However, banded applications of 22 kg P/ha/crop provided corn yields comparable to those obtained with a single broadcast application of 176 kg P/ha. Yields of cowpeas with this banded P rate increased from 86% on the first crop to 95% on the fourth crop, relative to yield obtained with the maximum broadcast P rate. The negligible difference in yield response between banded applications of 22 and 44 kg P/ha/crop led to discontinuing applications of the latter rate after the fourth crop in the study. Comparisons of yield trends

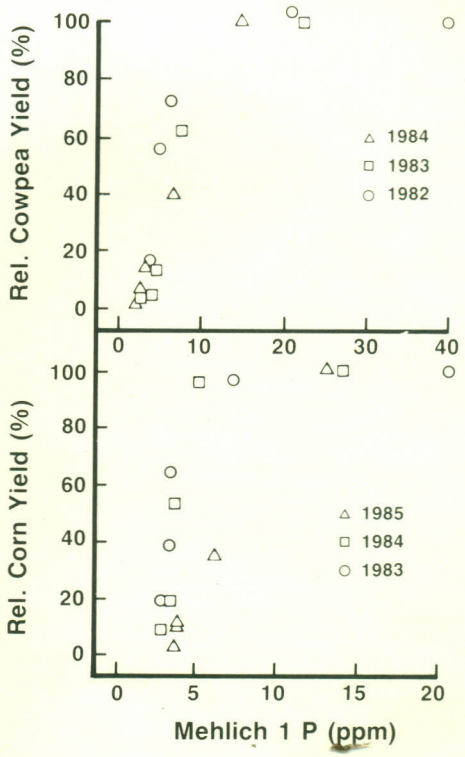

Figure 3. Cate-Nelson diagram suggesting Mehlich I P critical levels of 10 ppm for cowpeas and 5 ppm for corn in Manaus.

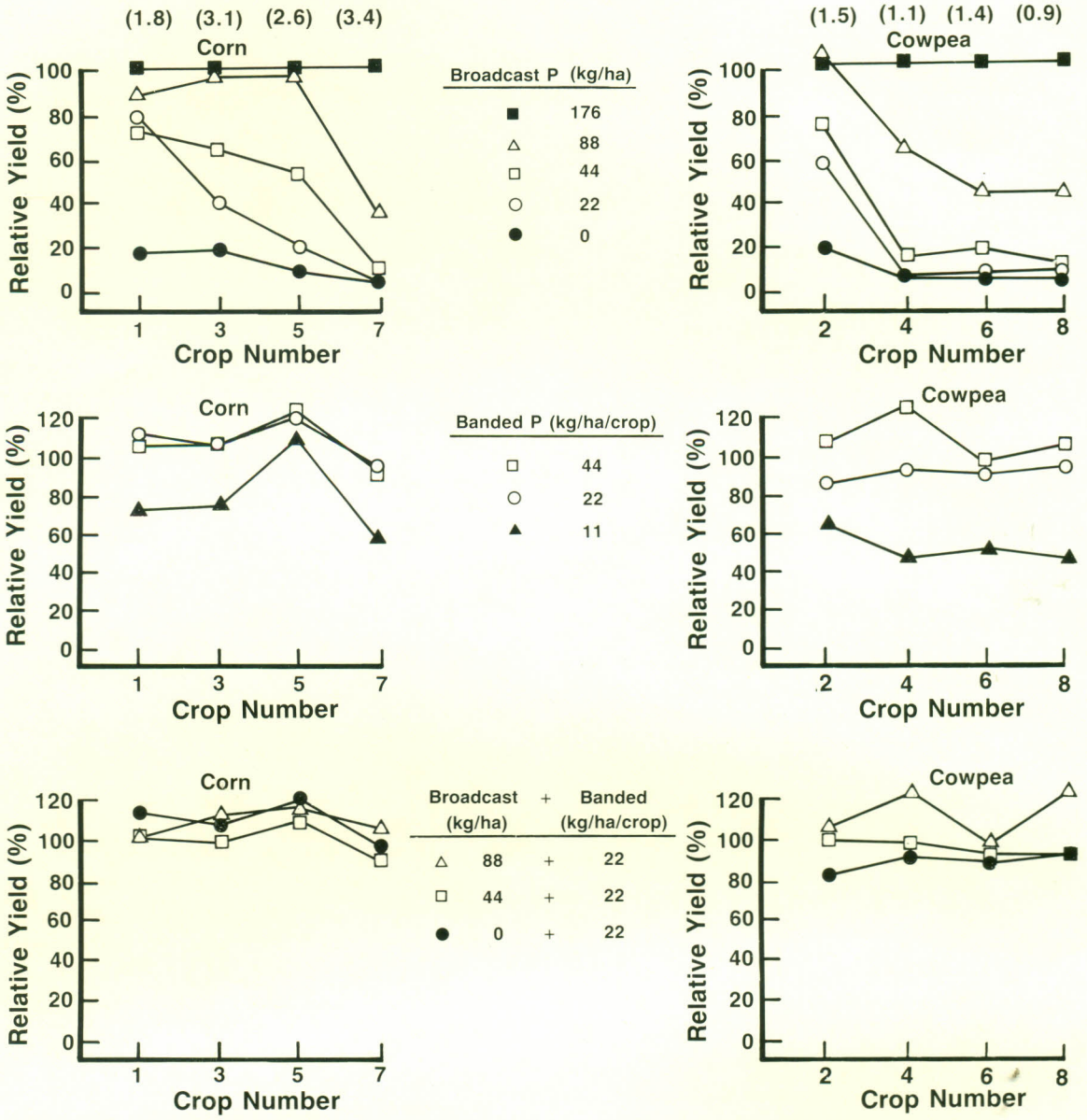

Figure 4. Residual effect of different P rates and placement methods in a corn-cowpea rotation in Manaus. Yields are expressed as percentages of yields obtained from a single application of 176 kg P/ha, broadcast prior to planting first crop. Numbers in parentheses are absolute yields (t/ha) for the broadcast 176 kg P/ha.

between combinations of broadcast P with the banded rate of 22 kg P/ha/crop do not indicate a consistent yield increase to broadcast P. Apparently P requirements for optimum corn and cowpea yields were approached with this banded P rate alone.

Conclusions

Cumulative yields for corn and cowpeas are shown in Figure 5, as a function of total P applied in all the banded and broadcast combinations. The similarities in yields among the different fertilizer-application methods at a given P level suggest that grain yields, for the crop rotation under study, were primarily a function of the amount of P applied. Results, therefore, point to different P fertilization strategies with similar outcomes. Banded P applications would be preferred by most farmers in the region, since most crops are planted by hand. With a banded P rate of 22 kg/ha/crop, total yields were 15.9 t/ha, as opposed to 1.4 t/ha in the absence of P fertilizer inputs.

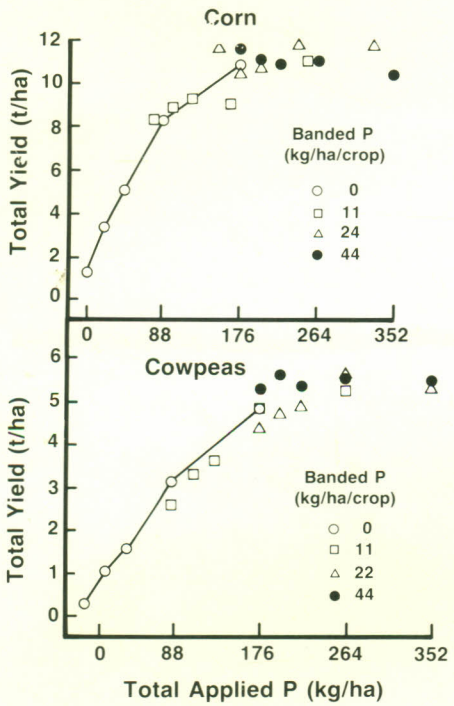

Figure 5. Cumulative corn and cowpea yields in relation to total applied P during four years in Manaus.

Implications

Results from this study have been used in the farmer-demonstration trials which UEPAE/Manuas has established as its participation in the State Rural Integration and Development Program. Soil-test critical levels for P have aided in the selection of appropriate sites for corn and cowpea trials. In P deficient areas, cowpea trials were established with and without 22 kg/ha of banded P.

Potassium Management In Humid Tropical Oxisols

Manoel S. Cravo, EMBRAPA
Thomas Jot Smyth, N.C. State University
Joaquim B. Bastos, EMBRAPA

Abundant rainfall in the Central Brazilian Amazon, and the naturally low cation exchange capacities of the regions's clayey Oxisols, promote the rapid leaching of potassium from the soils. Native soil K reserves can be expected to be small, since clay mineralogy is predominantly kaolinitic. These conditions suggest that crop production on these soils will require continual K fertilization, and that management systems should be considered to minimize K losses.

The objectives of this project were 1) to establish K response curves and soil-test calibration data for the main annual crops cultivated in the region, and 2) to determine whether split applications would improve the efficiency of K fertilization.

Yield Response to Broadcast K

The first phase of this project examined the yield response of a corn-cowpea rotation to annual broadcast rates of 0, 16.5, 33, 66, and 132 kg K/ha, applied at corn planting during two consecutive years. Although maximum corn yields were obtained in both years with 66 kg K/ha, yield differences between 33 and 66 kg K/ha were not significant. Cowpea yield responses to residual fertilizer K were not significant in either crop. Measurements at harvest of K uptake in all crops indicated that maximum fertilizer K utilization (39%) occurred with the application of 66 kg K/ha. Periodic soil K measurements to a 60 cm depth indicated significant increases in subsoil K only in the treatment with 132 kg K/ha.

Effects of Split Applications

A second K experiment was established in December, 1983 to evaluate whether split K applications might reduce fertilizer K requirements or improve the efficiency of K fertilization in a corn crop. Three methods of K application were combined with four K rates in a factorial design with four replications. Potassium rates were 0, 16.5, 33, and 49.5 kg K/ha. Methods of K application were 1) 100% broadcast at planting; 2) 50% broadcast at planting and 50% sidedressed at 55 days, and 3) divided equally among three broadcast applications—at planting, 25 days and 55 days. Times for side-dressed K applications were selected to coin-