Management of Green-Manure Nitrogen on Oxisols at Manaus, Brazil

Thomas Jot Smyth, N. C. State University
Luiz A. Oliveira, EMBRAPA
Manoel S. Cravo, EMBRAPA

Studies on Oxisols in the Cerrado of Brazil have shown that mucuna, a common green manure, can provide much of the nitrogen required by a succeeding food crop. Such green manures, if effectively managed, appear to hold promise as a supplement or an alternative for fertilizer nitrogen in the Cerrado.

This experiment, established as a companion study to the work in the Cerrado, sought to test similar green-manure management techniques for their suitability to soil and climate conditions in the Manaus region. The objectives were 1) to quantify the N supplied by green manures to corn and rice, and 2) to evaluate the importance and availability of green-manure N to crops.

This study contained two experiments with treatments described in Table 1. Both experiments were planted to corn in October, 1984, followed by rice in February, 1985. Treatments were established only at corn planting. For the N-supply study, the five rates of fertilizer N were split into three equal applications broadcast at planting and sidedressed at 25 and 55 days after planting (concurrently with two weedings and two corn-hillings). Corn- and rice-yield responses to the incorporation of *Indigofera, Stizolobium* and cowpea crop residues (after harvesting 1 t/ha of grain) were compared to yields obtained with fertilizer N.

Table 1. Treatment specifications for the green manure studies.

Treatment	N Applied
N Supply*	**kg/ha**
N0	0
N10	20
N40	40
N60	60
N120	120
Indigofera tinctorium	152
Stizolobium aterrimum	168
Cowpea crop residues	32
Green Manure Management**	
Bare soil check	0
Bare soil + urea-N	80
Whole plant incorporation	298
Plant top incorporation	254
Mulch with plant tops	257
Plant roots	-

* N source for the fertilizer N treatments was urea.
** Green manure utilized was *stizolobium aterrimum.*

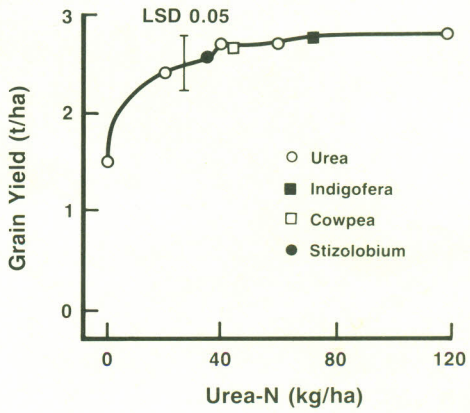

Figure 1. Corn grain yields as a function of fertilizer N rates and green manure sources.

The green-manure management study was performed solely with *Stizolobium*, a mucuna. Treatments using the legume were: 1) whole plant incorporation, 2) whole plant mulch, 3) removal of above-ground biomass (roots), and 4) incorporation to bare soil of tops harvested from (3). Two additional treatments, with and without fertilizer N, were included on bare plots where *Stizolobium* was not grown. All other fertilizers were maintained constant in both studies and consisted of P, K, B Cu, Zn, and lime.

Yield Response to N Sources

The maximum corn yield with fertilizer N was obtained with 120 kg N/ha, although yield response to successive increments of N was not significant above 20 kg N/ha (Figure 1). Corn yields for the three sources of green manure were not significantly different from yields with the highest N rate. Yields for the green-manure treatments were equivalent to yields obtainable with 72, 36, and 42 kg/ha of urea N, respectively, for *Indigofera, Stizolobium* and cowpea residues. Nitrogen levels for corn leaves and aboveground dry

Management of Green-Manure Nitrogen on Oxisols at Manaus, Brazil

Thomas Jot Smyth, N. C. State University
Luiz A. Oliveira, EMBRAPA
Manoel S. Cravo, EMBRAPA

Studies on Oxisols in the Cerrado of Brazil have shown that mucuna, a common green manure, can provide much of the nitrogen required by a succeeding food crop. Such green manures, if effectively managed, appear to hold promise as a supplement or an alternative for fertilizer nitrogen in the Cerrado.

This experiment, established as a companion study to the work in the Cerrado, sought to test similar green-manure management techniques for their suitability to soil and climate conditions in the Manaus region. The objectives were 1) to quantify the N supplied by green manures to corn and rice, and 2) to evaluate the importance and availability of green-manure N to crops.

This study contained two experiments with treatments described in Table 1. Both experiments were planted to corn in October, 1984, followed by rice in February, 1985. Treatments were established only at corn planting. For the N-supply study, the five rates of fertilizer N were split into three equal applications broadcast at planting and sidedressed at 25 and 55 days after planting (concurrently with two weedings and two corn-hillings). Corn- and rice-yield responses to the incorporation of *Indigofera*, *Stizolobium* and cowpea crop residues (after harvesting 1 t/ha of grain) were compared to yields obtained with fertilizer N.

Table 1. Treatment specifications for the green manure studies.

Treatment	N Applied
N Supply*	**kg/ha**
N0	0
N10	20
N40	40
N60	60
N120	120
Indigofera tinctorium	152
Stizolobium aterrimum	168
Cowpea crop residues	32
Green Manure Management**	
Bare soil check	0
Bare soil + urea-N	80
Whole plant incorporation	298
Plant top incorporation	254
Mulch with plant tops	257
Plant roots	-

* N source for the fertilizer N treatments was urea.
** Green manure utilized was *stizolobium aterrimum*.

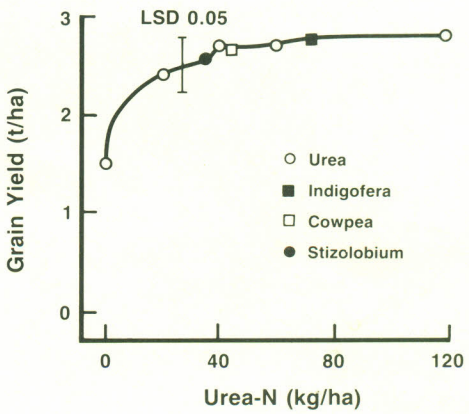

Figure 1. Corn grain yields as a function of fertilizer N rates and green manure sources.

The green-manure management study was performed solely with *Stizolobium*, a mucuna. Treatments using the legume were: 1) whole plant incorporation, 2) whole plant mulch, 3) removal of above-ground biomass (roots), and 4) incorporation to bare soil of tops harvested from (3). Two additional treatments, with and without fertilizer N, were included on bare plots where *Stizolobium* was not grown. All other fertilizers were maintained constant in both studies and consisted of P, K, B Cu, Zn, and lime.

Yield Response to N Sources

The maximum corn yield with fertilizer N was obtained with 120 kg N/ha, although yield response to successive increments of N was not significant above 20 kg N/ha (Figure 1). Corn yields for the three sources of green manure were not significantly different from yields with the highest N-rate. Yields for the green-manure treatments were equivalent to yields obtainable with 72, 36, and 42 kg/ha of urea N, respectively, for *Indigofera*, *Stizolobium* and cowpea residues. Nitrogen levels for corn leaves and aboveground dry

Stizolobium or *Indigofera* biomass were superior to the other treatments.

Preliminary Findings

1) All three green-manure treatments produced corn yields equivalent to those produced by the highest rate of fertilizer N.

2) Yield data suggest that the majority of green-manure N supplied to corn came from the legume tops.

3) Mulching with green-manure tops produced yields comparable to whole-plant incorporation, and, during a ten-day dry period, mulched corn plants grew faster than corn in the other treatments.

4) There were no significant differences among treatments on the response of rice to residual N, apparently because N was not a major limitation in this crop.

Implications

The relatively high corn yields obtained with the *Stizolobium* mulch treatment indicate that mulching with this green manure may be a favorable alternative for farmers with insufficient machinery or labor to incorporate the legume biomass. In addition to supplying N, the legumes contained significant levels of other nutrients, and may be particularly important in reducing K leaching by retaining K in the biomass. Further experiments will validate these first-year results and produce more data useful in establishing guidelines for green-manure management in these soils.

Conditions Other Than Extractable Nutrient Concentrations in the Soil Test Interpretations for P and Zn

Ibere D. G. Lins, N.C. State University
Fred R. Cox, N.C. State University

The major soil fertility constraints for crops grown in the Cerrado of Brazil are acidity, phosphorus and zinc. For maximum economic returns, the exact requirement of lime and fertilizer, as indicated by soil tests, must be applied. Soil tests are very straightforward for soils on which prior field experiments have been conducted. However, tests for only a few tropical soils have been covered by field calibration, and there is evidence that certain soil test interpretations are too broad; that is, they are not really applicable for all conditions.

The objectives of these continuing studies are 1) to determine the effect of fertilizer P applied to Oxisols and associated Entisols varying in texture on the extractable P concentrations with time; 2) to determine the effect of fertilizer Zn applied to Oxisols varying in pH and texture on the extractable Zn concentrations with time; 3) to determine P retention by Oxisols as influenced by clay content; 4) to develop a model to predict the necessary P rates to reach and maintain adequate soil test P levels for maximum soybean economic returns; and 5) to validate the model with field data.

Soil Test for P

In soil test interpretations for P, the critical level, the concentration below which there will be a positive response to fertilization, is known to be lower on fine textured or clayey soils than on coarse textured or sandy ones. Clayey soils sorb more P than sandy ones, and therefore have a greater capacity to replenish solution P as it is used by plants. This greater capacity allows the critical level to be lower for clayey soils than sandy ones. Though the relationship between the P critical level and texture is known, it is seldom considered in the soil test interpretation.

A preliminary economic model was developed that considered the value of corn and soybean crops as a function of soil P, and soil P as a function of P fertilization rate and cost, current soil test P level, and time. Net value was determined from these relationships, and the optimum rate of fertilization calculated at the maximum net value. When the optimum P rate was calculated for a few soils that varied in clay con-