



# Hedgerow Pruning Management Effects on Soil Carbon and Nitrogen In Alley Cropping

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## ABSTRACT

We determined cumulative effects (3.5 yr.) of *Leucaena* hedgerow management on soil organic C and N, C and N mineralization and turnover rates in an alley cropping experiment in Haiti. Treatments (pruning use X pruning regimes) were arranged as a 3 x 3 factorial with a control (stone walls) in a randomized complete block with 3 replicates. A hedgerow + fertilizer treatment in an adjacent trial was included for comparison. Soil samples collected in 0-5, 5-10 and 10-20 cm depths were sealed in mason jars and incubated at 25 °C for 30 days. Organic C and N and inorganic N were measured before incubation. Inorganic N and CO<sub>2</sub>-C were measured after incubation. Prunings applied as mulch or incorporated at planting had, respectively, 20 and 16 % greater surface soil organic C, 34 and 18 % greater organic N, and higher C, N and relative N mineralization than removal of prunings after 3.5 yr. There were no differences in soil C and N dynamics between application as mulch and incorporation at planting. Soils under the two-cut regime (0-40 DAP) had highest organic C in the 0-20 cm layer whereas the two-cut (0-30 DAP) had highest C turnover. Within depths, C and N activities were higher in the 0-5 cm under pruning application than under the control and pruning removal. There were no differences between the control and pruning removal at all depths. Addition of fertilizer in presence of prunings did not increase organic C and N but enhanced N activities in soil surface.

## INTRODUCTION

Depletion of soil fertility is a major constraints to crop production in the tropics. Alley cropping, which is production of food crops between rows of leguminous trees or shrubs, is used as a means to sustain soil productivity and stabilize crop yields. Among others, maintenance or increase of soil organic matter and recycling of plant nutrients are responsible for soil fertility improvement under alley cropping (Kang et al., 1997). Hedgerow management in alley cropping may affect amount and quality of biomass inputs altering soil organic matter levels as well as potential C and N mineralization. Increased pruning frequency reduces hedgerow vigor and consequently the amount of biomass available for soil application. Similarly, placement of organic materials may affect decomposition rate altering soil organic C and N pools. Previous studies have shown no-tillage practices and cropping intensity to increase soil organic C and N in the surface (Wood et al. (1990). Understanding the impacts of hedgerow management on soil C and N dynamics may provide means for improving residue management and sustaining soil productivity under continuous cultivation.

## OBJECTIVES

- To measure effects of 3.5 years of *Leucaena* pruning management on soil organic C and N and potential mineralization.
- To determine optimum hedgerow management that enhances soil C and N status in alley cropping system under humid conditions.

## MATERIALS and METHODS

- Location:** Lowland conditions in Haiti (18° N, 73° W, 1300 mm rainfall)
- Plots:** Plots of 8.0 x 6.5 m. Hedgerows (6.5 m long) located 2 m from upper and lower boundary of the plot leaving a center alley of 4 m. Stone walls (control) established in same way as hedgerows

### Design / Treatments:

Augmented factorial in a randomized complete block design (3 replicates of 11 treatments).

- Pruning Utilization (3) X Pruning Regimes (3)**
  - (1) Prunings removed (a) At planting and 30 DAP
  - (2) Applied as mulch (b) At planting and 40 DAP
  - (3) Incorporated / mulch (c) At planting, 30 and 60 DAP
- A control (Stone walls) - A hedgerow + fertilizer treatment from an adjacent trial.

In hedgerow + fertilizer treatment, 250 kg/ha of 20-20-10 were applied at each maize planting.

Maize (*Zea mays*) was planted twice a year for 3.5 years and hedgerows were cut to 50 cm height at each pruning.

### Incubation / Analysis:

- Soil samples were collected in 0-5, 5-10 and 10-20 cm depths.
- Sub-samples of 25 g (dry weight) were incubated in 1-L mason jars at 25 °C for 30 days. A vial with 8 ml of 1 M NaOH was placed into the jars to trap respired CO<sub>2</sub>-C.
- Organic C and N, NO<sub>3</sub>-N and NH<sub>4</sub>-N measured before incubation. Mineral N and CO<sub>2</sub>-C measured after incubation.
- Potential N and C mineralization, C turnover and relative N mineralization calculated.
- Analyses of variances performed using GLM procedure of SAS. Among treatments, orthogonal or balanced comparisons determined using contrast statement.



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## RESULTS

- Prunings applied as mulch or incorporated at planting led to 20 and 16 % greater soil organic C and 34 and 16 % higher soil N than removal of prunings, respectively, after 3.5 yr.
- Soil C mineralization followed a similar trend as organic C whereas N mineralization was highest when first pruning was incorporated into soil (Fig. 1).
- N mineralization was twice as high under pruning application than under removal of prunings.
- Highest C turnover was obtained when prunings were removed whereas incorporation of first pruning had greatest relative N mineralization (Fig. 1)
- There were no differences between incorporation of first pruning and application as mulch except for soil organic N.
- Within depth, soil N mineralization differed among application methods in the first 10 cm layer. Below 10 cm, no differences were obtained (Fig. 2).
- There were no differences between two and three pruning-regimes. Two cuts (at planting and 40 DAP) yielded highest biomass and led to highest soil organic C. Two cuts (at planting and 30 DAP) had highest soil C turnover (Fig. 3).
- Soil C and N mineralization and turnover rates were similar in control and plots where prunings were removed.
- Application of fertilizer in presence of the prunings did not increase soil organic C and N but enhanced soil N activities.

## CONCLUSIONS

- Application of prunings increased soil organic C and N, potential mineralization and turnover rates compared with removal of prunings or the control after 3.5 years.
- There is no beneficial effect to incorporate the first pruning.
- More time may be needed before pruning regimes can impact significantly soil C and N dynamics.
- No improvement in soil fertility can be expected in alley cropping if pruning biomass is not returned to the soil.

## Literature Cited

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- Wood, C.W., D.G. Westfall, G.A. Peterson, and I.C. Burke. 1990. Impacts of cropping intensity on potential C and N mineralization in no-till dryland agroecosystems.

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