Hedgerow Pruning Management Effects on Soil Carbon and Nitrogen in Alley Cropping

L. ISAAC*, C.W. WOOD, and D.A. SHANNON, Auburn University.

ABSTRACT

We determined cumulative effects (3.5 yr) of Lousana 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 regimen were arranged in a 3 x 3 factorial with a control (stone walls) in a randomized complete block with 3 replicates. In Alley cropping, X fertilizer treatment in an adjacent trial was included for comparison. Soil samples collected in 8.5, 10, 10 and 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 CO₂ were measured after incubation. Prunings applied as mulch or incorporated at planting had, respectively, 20 and 16 % greater surface soil organic C, 14 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. Soil under the 40 DAP regimen of 40 DAP had highest organic C in the 0-20 cm layer whereas the toe-cut (0-30 DAP) had highest C turnover. With depths, C and N activities were higher in the 0-10 cm beneath pruning 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

Deposition of soil fertility is a major constraint 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-fallow practices and cropping intensity to increase soil organic C and N in the surface (Wood et al., 1998). Understanding the impacts of hedgerow management on soil C and N dynamics may provide means for improving resource management and sustaining soil productivity under continuous cultivation.

OBJECTIVES

- To measure effects of 3.5 years of Lousana hedgerow 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 (39° N, 73° W, 1300 mm rainfall).

Plots: Sample of 8.5m x 6.5m. Hedgerows (8.5 m long) located 2 m from upper and lower boundary of the plot leaving a center alley of 4 m.

Hedgerow pruning management

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.

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.
- C mineralization followed 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 mulch 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.
- 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 60 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 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


Acknowledgments

Research funded as part of the project: SOIL MANAGEMENT PRACTICES FOR SUSTAINABLE PRODUCTION ON DENSELY POPULATED TROPICAL STEPPES, by Soil Management Collaborative Research Support Program of USAID/Washington, and by the PROACTIVE LAND USE SYSTEMS PROJECT, USAID.