Using decomposition of household items as an indicator of soil health and educational tool in Kamuli district, Uganda

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Introduction

Soil health has received a lot of attention in recent years, due in large part, our increased understanding and recognition of importance of soil biology. The Natural Resources Conservation Service (under the United States Department of Agriculture) defines soil health as “continued capacity of soil to function as a vital living ecosystem which can support plant, animal, and human life.” The soil itself is alive, mainly seen through earthworms, termites, and the ‘unseen majority’ of soil microorganisms. These organisms inhabiting soil are crucial to soil fertility and environmental quality, and recently scientists and soil testing laboratories are searching for the most accurate way to measure their activity and response to soil management practices (such as tillage and crop rotation). However, costs of these soil biological health tests remain expensive.

Within the impoverished district of Kamuli, Uganda, school gardens have used as source of local food and education opportunity. Our goal was to test decomposition of household items as an inexpensive, yet scientifically-robust, indicator of soil health and as an education tool.

Materials and Methods

Over the course of the past five years, land at Naluwoli Primary School has been transitioned from uncultivated land to land used for gardening. The school garden grows grain amaranth, cowpeas, maize, collard greens, and sweet potatoes. We decomposed four house-hold materials within hand-tilled and untilled soils to examine the impacts of cultivation upon soil health. We decomposed birch wood sticks, cotton fabric, and rooibos and green tea were buried for 4, 7, 14, and 21 days within hand-tilled and untilled soils on the school grounds of Naluwoli Primary School in Naluwoli, Uganda. Each sample was buried in a randomized structure at a depth of 8 cm below the soil surface for the duration of experiment time (Figure 1).

The two teas differ in carbon-to-nitrogen ratio (Keuskamp et al. 20013), and were chosen because of their similarity to maize and bean residue, both crops largely used in agricultural systems throughout the world in industrialized and developing countries. Cotton underwear was chosen as a household cotton fabric. Birch wood popsicle sticks were chosen as a ‘low-quality’ residue (high in lignin). We hypothesized that materials buried under untilled, natural vegetation would decompose more quickly than materials buried in hand-tilled soils because of greater biological activity (McDaniel et al. 2014).

Discussion

Surprisingly, birch wood sticks decomposed the quickest and reached a lower mass loss than the cotton (see Figs. 2,3,8,9). These wood sticks followed general decomposition curves, with untilled soil decomposing sticks 0.86% faster per day than hand-tilled soils.

Throughout the course of the study, we encountered issues with insects and other unknown organisms. More specifically, the rooibos tea samples had holes and missing tea and added organic material that added error to our final mass loss measurements (Figs. 6 & 7). This made interpretation difficult due to contamination from soil contamination and excess organic material mixed with tea. While termites, caterpillars, and insect larvae are essential to the decomposition process, their ability to burrow and chew through the tea bag made it difficult to assess tea decomposition. Additionally, as all samples were buried within school gardening plots, there is a likelihood that samples were disturbed slightly during the experiment process, particularly in terms of the cotton fabric. Cultural consideration was taken into account while choosing the cotton fabric, and the underwear was partially disassembled in attempts to mitigate cultural taboos related to seeing undergarments. However, school-aged children were intrigued by the experiment materials and, at times, attempted to extract materials before their proper extraction date which could have impacted accuracy of data sets.

Conclusions and Recommendations

Tea bag decomposition is challenging in Uganda due to activity of termites and other local insects. In future decomposition experiments in the Kamuli district, non-biodegradable nylon tea bags might mitigate this issue.

Cotton fabric decomposition was varied under hand-tilled and untilled management practices, and did not conform to standard exponential decay model (Fig. 9).

Birch wood decomposition fit the decomposition models somewhat better (Fig. 8), and showed greater decomposition in untilled soils confirming our hypothesis.

Decomposition of household materials shows potential as a measurement of biological activity and soil health, but more research is required to select the appropriate material. This includes finding a material that assesses soil microbial activity, and meso- and macro- organisms (e.g., insects), but also is inexpensive enough for use in developing countries.

Literature Cited


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Figure 1: A standard replicated block for decomposition measurement

Figure 2: Birch wood stick decomposition, day 4

Figure 3: Birch wood stick decomposition, day 21

Figure 4: Cotton fabric decomposition, day 4

Figure 5: Cotton fabric decomposition, day 21, untilled

Figure 6: Rooibos tea was contaminated by local insects infiltrating tea bags, causing a loss of data

Figure 7: Material decomposition was assisted by local insects such as termites, as seen here

Figure 8: Birch wood stick decomposition

Figure 9: Cotton fabric decomposition

DECOMPOSITION RATE OF BIRCH WOOD STICKS

DECOMPOSITION RATES OF COTTON FABRIC