Research article

Influence of Native Trees on Soil Fertility at a Rainforestation Site in Mailhi, Baybay City, Leyte, Philippines

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Abstract The Philippines is one of the few countries in the world which was originally and thoroughly covered by rain forest. The conversion of natural forests to agricultural land uses has led to land degradation. Soil is a vital resource for human survival in that it is the medium in which most plants grow, it cleans and stores water, detoxifies pollutants, and plays a key role in the regulation of the Earth's temperature. One of the intentions of rainforestation farming (planting of native tree species) is to regenerate soil fertility. However, the effect of native forest trees on soil fertility is still poorly understood. Hence, this study was conducted to evaluate the influence of native trees on the fertility status of the soil in Mailhi, Baybay City, Leyte, Philippines. Two adjacent sites were evaluated and sampled. These were the 22-year-old rainforestation farm and the nearby coconut plantation. At each site, a 20 m x 20 m plot for sampling purposes was established which was divided into four parts. In each part, four (4) composite soil surface samples were collected from a soil depth of 0-20 cm using a soil auger. Each of the four composite samples came from three (3) subsamples. The subsamples were mixed, and one-half kilogram was placed in properly labelled plastic bags and brought for processing and laboratory analysis. Results revealed that the rainforestation farm did not have an effect on water holding capacity and soil pH but significantly increased the organic matter and total N contents of the soil, when compared with the nearby coconut plantation. On the other hand, available P and exchangeable K were lower in the soil under native tree species compared to the coconut plantation. The results indicate that indeed, the native trees in the rainforestation site have caused important changes to the fertility status of the soils.

Keywords rainforestation, native trees, soil fertility

INTRODUCTION

The Philippines is one of the few countries in the world that was originally and thoroughly covered by rainforests (Schulte, 2002). In the past decades, forests were considered one of the most important resources of Leyte Island. But after the conversion of part of Leyte's original forest vegetation to secondary forest due to logging operations, kaingin or slash-and-burn cultivation, forest fire, and other natural phenomena such as pest diseases, and natural calamities, large parts of the upland areas were colonized by farmers (Contreras-Hermosilla, 2000). The conversion of natural forests to agricultural land uses has led to land degradation.

Asio et al. (2009) explained that soil is a vital resource for human survival in that it is the medium in which most plants grow, it cleans and stores water, detoxifies pollutants, and plays a key role in the regulation of the Earth's temperature. Soil is also the habitat of a multitude of soil organisms necessary for the cycling of elements and for keeping a healthy environment for human beings (Blum, 2007). Worldwide, soil resources are degraded at an unprecedented rate due to various human activities. Soil degradation means the deterioration of soil properties to the extent that the soil is no longer productive (Fullen and Catt, 2004).

The Philippines as one of the most severely deforested countries worldwide (Kummer and Turner, 994 as cited by Marohn, 2007), has officially adopted Rainforest Farming for its natural governing program. As defined in the Memorandum Circular No. 2004-06 issued by the Department of Environmental and Natural Resources (DENR), rainforestation farming is a concept in forest restoration, wherein only indigenous and endemic tree species are used as planting materials which include but are not limited to dipterocarp species, premium tree species, etc. It is a kind of reforestation whose aim is to preserve biodiversity expand Philippine forests and simultaneously sustain human food production. One of the intentions of rainforestation farming is to regenerate soil fertility. Asio and Milan (2002) reported that rainforestation farming is a helpful strategy to improve soil quality.

Therefore, this study was conducted to focus on the effects of native trees as rainforestation species on the nutrient status of the soil. Likewise, the study validated the hypothesis that rainforestation farming improves the soil nutrient status.

OBJECTIVE

The objective of this study is to evaluate the influence of native trees as rainforestation species on the fertility status of the soil and to determine the soil properties affected by planting native trees in the marginal upland site in Mailhi, Baybay City, Leyte, Philippines.

METHODOLOGY

Sampling Site Selection

The field study was conducted in 2016 in the Rainforestation site in Mailhi, Baybay City, Leyte (Fig. 1) about 23 km southwest of Baybay at 351 m asl elevation. A preliminary field survey was done to assess and select the sampling area. The rainforestation site was established twenty-two (22) years ago in 1995.

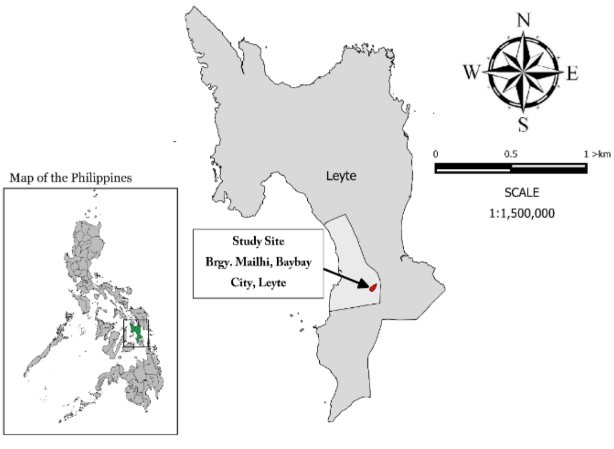


Fig. 1 Location of the sampling site in Mailhi, Baybay City, Leyte, Philippines

Note: the location was a marginal upland under the coconut plantation before the rainforestation site was established.

Soil Collection and Preparation

Two adjacent sites were selected. One is inside the rainforestation farm, and the other is under the coconut plantation which is typical of the area. A 20 m x 20 m plot was measured and then divided into four parts. In each part, four (4) composite soil surface samples were collected from the 0-20 cm soil depth using a soil auger. Each of the four composite samples came from three (3) subsamples. The subsamples were mixed, and one-half kilogram was placed in properly labelled plastic bags and brought for processing and laboratory analysis.

Laboratory analysis includes soil physical properties such as particle size distribution using the hydrometer method (ISRIC, 1995), water holding capacity (Alef and Nannipieri, 1995), and soil chemical properties such as soil pH analyzed potentiometrically using the soil-to-water ratio of 1:2.5 (ISRIC, 1995), soil organic matter obtained using Loss of Weight on Ignition (Schlichting et. al, (1995), total nitrogen using Micro-Kjeldahl method (ISRIC, 1995), available phosphorus analyzed using Bray 2 method (Bray and Kurtz, 1945) and exchangeable potassium using Metson method (Metson, 1956).

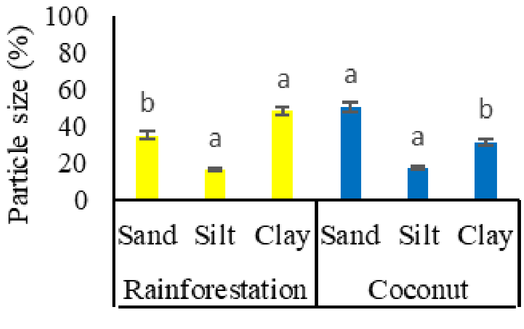
Data Encoding and Statistical Analysis

All data gathered were collated, encoded, and summarized using an electronic spreadsheet editor, Microsoft Excel 2013. The data were analysed using the Statistical Package for Social Science (SPSS version 20). The variability of the mean of soil properties was analysed using the one-way analysis of variance (ANOVA). Moreover, in a case where significant variations at $p \leq 0.05$ were identified, Tukey and Least Squares Differences (LSD) were carried out to compare means.

RESULTS AND DISCUSSION

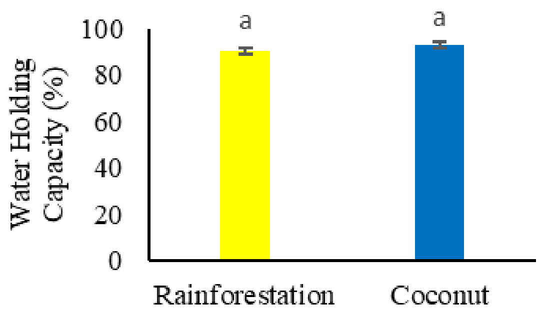
Soil Physical Properties

Figure 2 shows the particle size distribution of the two sampling sites. Results revealed that in terms of particle size distribution, the soil in the rainforestation had clay and sand contents of 48.3 ±1.98 % and 35.2 ±1.40 %, respectively, while the soil in the coconut plantation had 31.61 ±1.98 % and 50.78 ±1.40 %, respectively (Fig. 2). The soil textural class was clay and sandy clay loam, respectively. Based on the results of the statistical analysis, there was a significant difference ($p \leq 0.05$) between the soils in the rainforestation and coconut plantation in terms of the sand and clay contents but no significant difference in the silt.



Note: Values with different superscript letters(a-b) of particle size within the site are significantly different at $p \leq 0.05$; N=32

Fig. 2 Particle size distribution of soil rainforestation farm and coconut plantation



Note: Values with a different superscript letter (a-b) of WHC within the site are significantly different at $p \leq 0.05$; N=32

Fig. 3 Water holding capacity in the soil in the rainforestation farm and coconut plantation

Clays have a large specific surface, often predominantly negatively charged, that retains water and nutrients. The clay itself may be a source of plant nutrients when it degrades. On the results, rainforestation soil had higher clay content which indicates good water and nutrient retention.

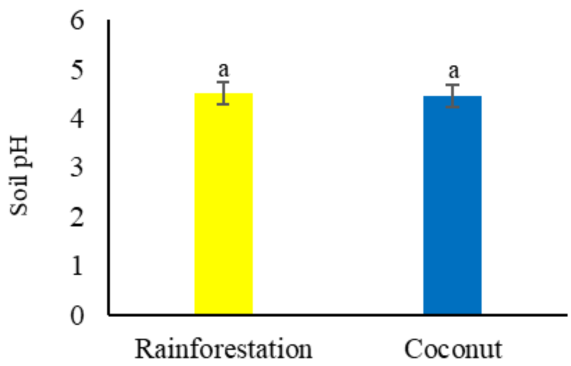
On the other hand, Fig. 3 reveals that the water holding capacity in the coconut plantation and the rainforestation farm had average values of 93.19 ±3.02 % and 90.21 ±3.02 %, respectively. This result suggests that the kind of land use has not yet influenced the water-holding capacity of the soil.

Soil Chemical Properties

Figure 4 shows slight variations in the pH of the soil. Results showed that the soils in the rainforestation site and the coconut plantation had comparable pH values. This indicates that the kind of land use has not yet caused a significant change in the soil reaction.

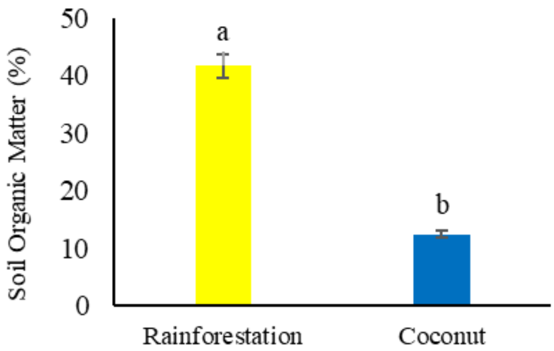
Soil properties are usually improved when trees are grown due to the increase in surface soil organic matter (Huxley, 1999). Organic matter refers to all decomposed, partly decomposed, and undecomposed materials of plant and animal origin (FAO, 2006).

Figure 5 shows that the soil in the rainforestation farm had higher organic matter content than the soil in the coconut plantation ($p \leq 0.05$). The higher amount of OM of the rainforestation farm could be due to its higher organic material addition in the form of litterfall than in the coconut plantation. The amount of OM in the soil depends on the litter fall (leaves, twigs, bark, etc.) contributed by trees as the primary vegetation in the area and the consequent losses through the decomposition of these materials.



Note: Values with different superscript letters (a-b) of soil pH within the site are significantly different at $p \leq 0.05$; N=32

Fig. 4 Soil pH values of rainforestation farm and coconut plantation



Note: Values with a different superscript letters (a-b) OM within the site are significantly different at $p \leq 0.05$; N=32

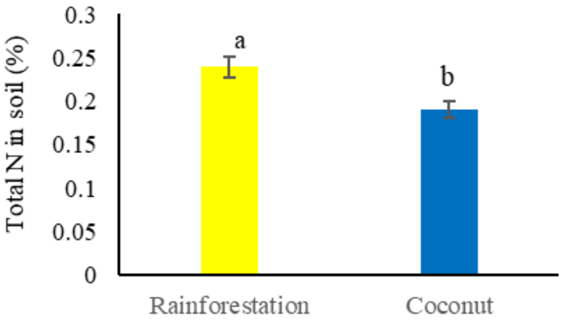
Fig. 5 Soil organic matter contents of the soils under rainforestation farm and coconut plantation

Soil Nutrient Status

Figure 6 shows higher soil nitrogen content in the rainforestation farm than in the coconut plantation ($p \leq 0.05$). It agrees with the study of Atup (2016) where total N contents of the soils under coconut plantation were low. Bande (2004) reported that during his study the soil in the rainforestation had 0.17% nitrogen content according to Landon (1991) the sufficiency ranges in soil, soils with values within the range between 0.1-.20 classified as low, while the nitrogen content in the current study had 0.24 ±.01 % classified as medium in sufficiency ranges in soil. The nitrogen content in the soil of rainforestation significantly improves. Apart from the application of N fertilizers, the main source of N in soils is the breakdown and humification of organic matter. The results on total N can therefore be attributed to the higher OM content of the rainforestation farm compared to the coconut plantation.

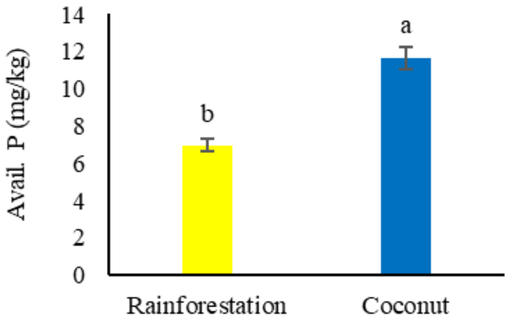
The soil in the coconut plantation had a higher available P level compared to the soil in the rainforestation farm (Fig. 7). The difference is significant at $p \leq 0.05$. This level of available P cannot easily be explained since P fertilizer application is not being practiced by the coconut owner (Fig. 7). This may be explained by the periodic burning that occurs in the coconut plantation. It is also possible that the cycling of P is faster in the coconut plantation. As coconut is burned, it produces ash which is a residual material produced when it is burned for energy production. According to Erich (1991), ashes were found to be more similar to conventional P fertilizer materials and the addition of coconut ashes to the surface soil in the coconut can increase the availability of P.

As can be seen in Figure 7, available phosphorus in rainforestation farms is 6.97 ±1.08 mg kg^{-1} while, in coconut plantations, it is 11.66 ±1.08 mg kg^{-1}. According to Landon (1991), the sufficiency ranges in soil, soils with values within the range between 5-9 mg kg^{-1} are classified as low. However, the presently available phosphorus in the soil of the rainforestation is higher than the previous result reported by Bande (2004) 3.4 mg kg^{-1} values range <5 classified as very low. This indicates an improvement in the availability of P due to the native trees.



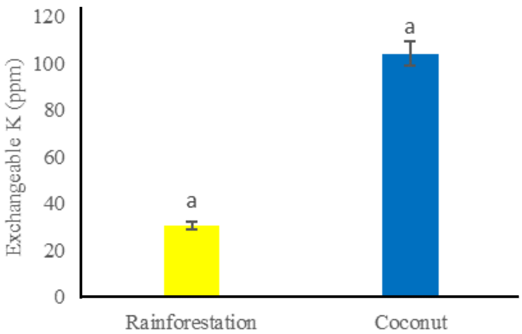
Note: Values with different superscript letters (a-b) of N within the site are significantly different at p≤0.05; N=32

Fig. 6 Total N (%) of soils in the rainforestation farm and under coconut plantation



Note: Values with a different superscript letter (a-b) of P within the site are significantly different at p≤0.05; N=32

Fig. 7 Available P of the soil in the rainforestation farm and under coconut plantation



Note: Values with the different superscript letter a of K within the site are significantly different at p≤0.05; N=32

Fig. 8 Exchangeable K of soils in the rainforestation farm and under coconut plantation

Figure 8 shows the average value of exchangeable potassium in the soils in the rainforestation farm which is 30.57 ±36.74 mg kg^{-1}. It is classified as very low available potassium in the soil based on Landon (1991). On the other hand, the average value of exchangeable K in the soil under coconut which is 104.16 ±36.74 mg kg^{-1} classified as medium in the sufficiency ranges in soil according to Landon (1991). In addition, Bande (2004) reported that the soil in the rainforestation during his study had 130.5 mg kg^{-1} which is higher than the current available potassium. This may be explained that during the current study, some potassium is still in the leaves and the uptake of the potassium is slow, while in the soil in the coconut plantation, the possible reason could be the periodic burning of the coconut husk. Coconut husk ash will never totally replace K fertilizer; however, it can recycle a substantial proportion of nutrients in a coconut plantation.

CONCLUSION

Planting native trees as rainforestation species has changed the fertility status of the soil after twenty-two (22) years from its establishment.

The results also revealed that the rainforestation farm when compared with the nearby coconut plantation did not have an effect on water holding capacity and soil pH but significantly increased the organic matter and total N contents of the soil. On the other hand, available P and exchangeable K were lower in the soil under native tree species compared to the coconut plantation. However, based on the previous results of Bande (2004) rainforestation increased total nitrogen and available P but decreased the exchangeable K of the soil.

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