Research article

Nitrogen and Phosphorus Released from Coconut Husk during Retting Treatment

JULIAN E. TORILLO JR.
Graduate School of Agriculture, Tokyo University of Agriculture, Tokyo, Japan
Email: juliantorillo@yahoo.com

MACHITO MIHARA*
Faculty of Regional Environment Science, Tokyo University of Agriculture, Tokyo, Japan
Email: m-mihara@nodai.ac.jp

Received 14 January 2012 Accepted 12 March 2012 (*: Corresponding Author)

Abstract Upland fields in Bohol of the Philippines are mostly located on areas with high slopes resulting in soil erosion. Although coconut husk has been applied as buffer strips for eliminating soil erosion, attention has been paid to the loss of nitrogen and phosphorus components not only discharged from synthetic fertilizer applied in upland fields but also those released from coconut husk. The leached nutrients associated with surface runoff and percolation water may cause pollution downstream. Thus, efficient utilization of the nutrient components from coconut husk is necessary from a view point of conservation agriculture in Bohol, Philippines. This study sought to find out the amounts of nitrogen and phosphorus in coconut husk, to quantify the amounts of nitrogen and phosphorus released from coconut husk during the pretreatment by retting process and to observe the optimum period of releasing nutrients from coconut husk. Retting of coconut husk were carried out for 140 days and small amounts of ret liquor was sampled at certain days of interval for nitrogen and phosphorus analyses. Based on the experimental results, it was observed that releasing nutrients from coconut husk rapidly increased from the starting day up to ten days of retting. Even after ten days, nutrient components released from coconut husk tended to increase gradually. It was also proven that about 87% of its phosphorus and 10% of its total nitrogen was released from the coconut husk. Therefore, it was concluded that coconut husk has a high tendency to release nutrients during the retting process, particularly for phosphorus component that can be a source for bio-fertilizer.

Keywords coconut husk, retting, nitrogen, phosphorus, bio-fertilizer

INTRODUCTION

Upland fields with protruding stones and rocks on ground surfaces as well as abandoned farmlands are dominant particularly in the southwestern part in the island of Bohol (Torillo and Mihara, 2011). Moreover, these lands are mostly located on slopes of areas with 8-18% and even some portions with more than 18% slope, particularly for subsistence agriculture (OIDC, 2006). Together with high squalls, uplands in the island are susceptible to soil erosion causing rapid degradation of land with the decrease of crop quality and yields.

To replenish the nutrients required by crops and to increase crop yields, local farmers choose to apply synthetic fertilizers. However, high prices of synthetic fertilizers lead to scarcity of these resources, particularly on phosphorus. Cordell et al. (2009) reported that phosphorus is mainly obtained from mined rock phosphate and its reserves could be exhausted in the next 50-100 years (Steen, 1998; Smil, 2000b) thus an effective approach to the management of phosphorus cycle is necessary. On the other hand, coconut husks that were installed as buffer strips for soil erosion control tended to release nitrogen and phosphorus. This tendency was observed during the slope modeling under artificial rainfall simulator (Torillo and Mihara, 2011). Those nutrients released from the coconut husk may leach through percolation and surface runoff resulting water pollution in downstream. Therefore, treating of coconut husk before its installation as buffer strips through

retting has been recommended. However, improper management on the treatment process may cause pollution to surface waters as well. Bijoy (1997) reported that coconut husk retting activity has caused large scale organic pollution with the mass destruction of flora and fauna, foul smelling stagnant waters in Kerala, India. Also, Ambika and Gopalakrishna (1990) added that pectin, pectosan, fat, tannin and also toxic polyphenols are liberated into ambient water by the activity of bacteria and fungi in the coconut husk retting area in backwaters at Cochin, India.

Thus, making use of the nutrient component in coconut husk for liquid bio-fertilizer has been desired. The objectives of this study were 1) to find out the amounts of nitrogen and phosphorus in coconut husk at different portions and layers, 2) to quantify the released amounts of nitrogen and phosphorus from the coconut husk during the retting treatment, and 3) to determine the optimum period for retting of coconut husk.

MEHODOLOGY

To find out the total amounts of nitrogen and phosphorus in the coconut husk, a preliminary analysis was carried out. The following procedure was also aimed to find out which portions and layers of the coconut husk have lower concentration of total nitrogen (T-N) and total phosphorus (T-P) that could be applicable as buffer strips for soil erosion control in order to mitigate the releasing of nutrients from coconut husk. As shown in Fig. 1, coconut husk were cut into three portions as bottom, middle and top then were sliced into three layers as inner, middle and outer then the bark layer. Pith and fiber were segregated, and were crushed into powder. Crushed pith and fiber were then analyzed for T-N and T-P components.

a) Cross-section of coconut husk *b) Segregated fiber, pith and bark* *c) Pulverizing of fiber, pith and bark*

Fig. 1 Preparation process for preliminary analysis of total nitrogen (T-N) and total phosphorus (T-P) in coconut husk

a) Minor pounding by hammer *b) Retting into cylinders with distilled water*

Fig. 2 Procedure of pretreating coconut husks

The coconut husks utilized as buffer strips for soil erosion control had released nutrient components, so it was proposed to carry out the pretreatment of the coconut husks by retting before installing into the site. To quantify the amount of T-N and T-P released from the coconut husk

during the retting treatment, the analysis of those nutrients in the ret liquor was carried out. Retting of coconut husk was performed using the following procedures; firstly, coconut husks were moderately pounded by hammer (Fig. 2) to produce porous material similar to that being installed into the site as buffer strips. Pounded coconut husks of 119.22 g in dry mass were then immersed into the 4,600 ml of distilled water.

Secondly, sampling of water soaked with coconut husk or so called ret liquor was done at certain days of intervals within 140 days. Thirdly, ret liquor samples were analyzed for T-N and T-P after the decomposition with sodium hydroxide (NaOH) and potassium peroxodisulfate ($K_2S_2O_8$) then the concentrations of T-N and T-P were measured by spectrometric methods (Mihara and Ueno, 2000).

RESULTS AND DISCUSSION

Amount of nitrogen and phosphorus in coconut husk

Coconut husks were portioned, layered and then pith, fiber and bark were segregated for analyzing the amount of total nitrogen (T-N) and total phosphorus (T-P). Based on the experimental results, it was found out that every portion of the coconut husk has different concentrations of T-N and T-P (Figs. 3 and 4).

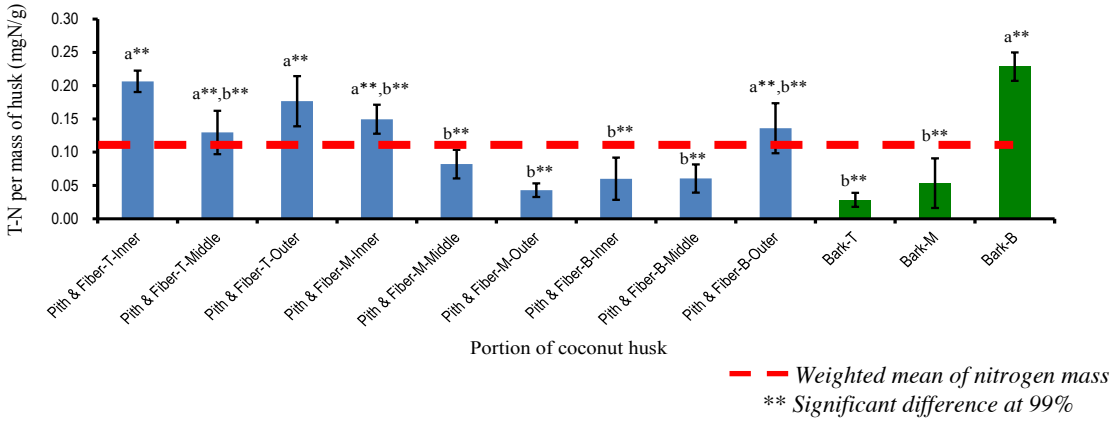

Fig. 3 Amount of total nitrogen (T-N) per dry mass of pith, fiber and bark at top (T), middle (M) and bottom (B) portions of coconut husk

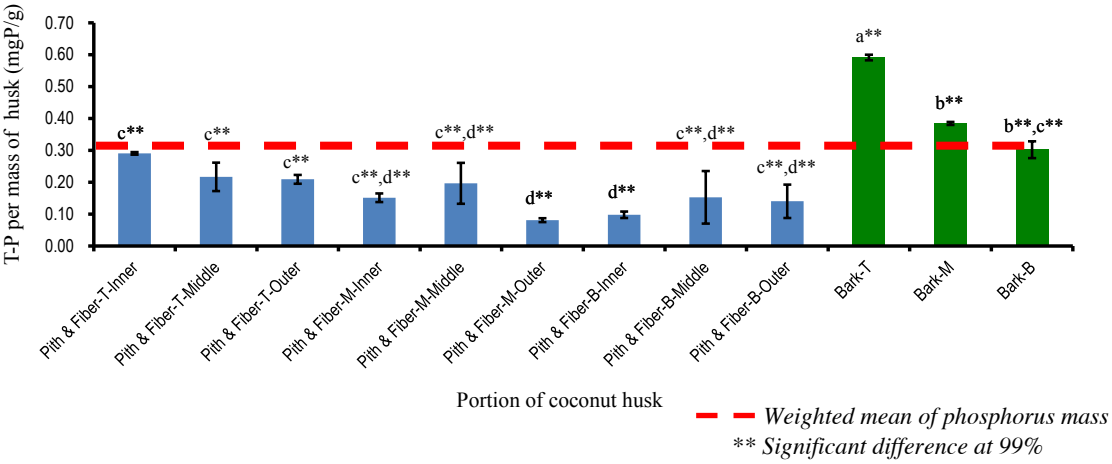

Fig. 4 Amount of total phosphorus (T-P) per dry mass of pith and fiber, and bark at top (T), middle (M) and bottom (B) portions of coconut husk

Most of the top portions showed significantly higher in the amounts of T-N and T-P than that of the middle and bottom portions. Top portion of the coconut husk is highly concentrated with T-N and T-P, it may be because of the pedicel and embryo (Fig. 1a) that are located in the top portion of the husk and nut. As Rancic et al. (2010) reported that water and nutrients which fruit growth depends on is transported from the stem into the fruit through the pedicel by xylem and phloem. The embryo which germinates at microphyle (Chan and Elevitch, 2006) develops a haustorium that provides a conduit for the supply of nutrients from kernel into the germinating embryo (Foale, 2003). These conditions might be the factors that most nutrients are accumulating at the top portion of the coconut husk.

As shown in Fig. 3, the weighted mean of T-N in the coconut husk was 0.1138 mgN/g and a significant difference at 99% was observed among portions. For the amounts of T-P, a weighted mean at 0.3037 mgP/g and also a significant difference at 99% were observed among the portions of coconut husk (Fig. 4).

Optimum retting period of coconut husk

Coconut husks were retted within 140 days and then the ret liquor samples were collected at certain days of interval for nitrogen and phosphorus analyses. It was observed that a remarkable increase in total nitrogen (T-N) and total phosphorus (T-P) components in coconut husk ret liquor from the starting day of retting up to a certain period of time then tended to increase gradually further.

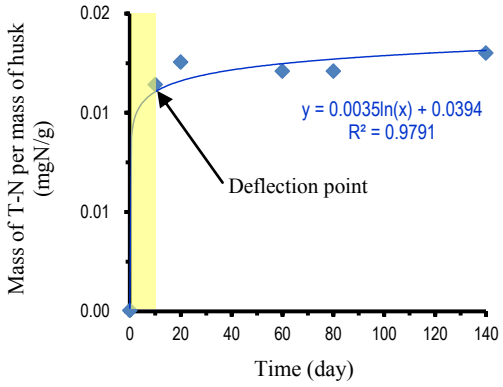

Fig. 5 Amount of T-N released from coconut husk into ret liquor

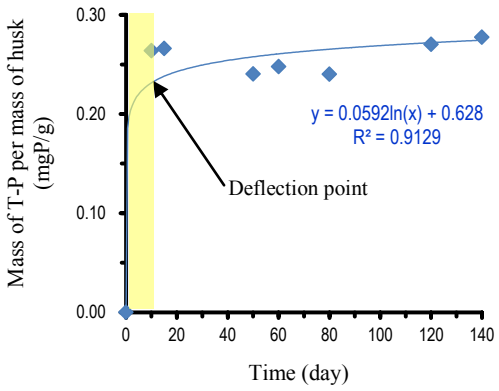

Fig. 6 Amount of T-P released from coconut husk into ret liquor

Based on the logarithmic curve as shown in Figs. 5 and 6, the deflection point lies approximately on the tenth day of retting. This trend indicates that up to the tenth day from the starting day of retting, T-N and T-P rapidly released from coconut husk. After then, the trend changed to release gradually of those nutrients. The results suggested that ten days of retting is an adequate period of pretreating the coconut husk when its nutrient components are mostly released.

Amounts of nitrogen and phosphorus released from coconut husk during the retting treatment

Coconut husks were retted in distilled water and ret liquor samples were collected at certain days of interval for total nitrogen (T-N) and total phosphorus (T-P) analyses. It was suggested that ten days retting of coconut husk is an adequate period of pretreating the material. As shown in Fig. 5, the amount of T-N released into the ret liquor was 0.0114 mgN/g during the tenth day. Based on the weighted mean of T-N in coconut husk as shown in Fig. 3 was 0.1138 mgN/g therefore it was proven that 10.01% of T-N was released from the coconut husk during the retting treatment.

Fig. 6 shows the amount of T-P in the ret liquor where 0.2639 mgP/g was released into the ret liquor during the tenth day of retting which is 86.89% in the weighted mean of 0.3037 mgP/g that is being shown in Fig. 4. Although, it was clearly observed that T-N and T-P were released from

the coconut husk during the retting treatment, a confidence interval was not observed. It was also indicated that the amounts of T-P released from the coconut husk during the retting period was significantly higher than that of T-N.

CONCLUSION

For sustainable use of resources, utilizing the nutrient components from the coconut husk which is locally available and a renewable resource in the region has good value. So, this study dealt with the optimum retting period of coconut husk to release its nitrogen and phosphorus components. The quantification of the amounts of nitrogen and phosphorus released from coconut husk into the ret liquor during the retting treatment were also sought to be found out of this study. However, as a fundamental basis on the quantification of nitrogen and phosphorus released into the ret liquor, finding out the amounts of T-N and T-P in the coconut husk is necessary. Thus, analyses on the amounts of T-N and T-P in the coconut husk were also carried out.

It was found out that the weighted mean of T-N and T-P in coconut husks were 0.1138 mgN/g and 0.3037 mgP/g, respectively. The experimental results also indicated that rapid release of nutrient from coconut husk during the tenth day of retting. During the tenth day period, 0.0114 mgN/g accounted for about 10% of 0.1138 mgN/g in coconut husk was released into the ret liquor. Meanwhile, phosphorus component was 0.2639 mgP/g accounted for about 87% of 0.3037 mgP/g in coconut husk has been released from the retted coconut husk into the ret liquor.

Therefore, it was concluded that ten days is enough period of treating the coconut husk by retting treatment. At this period, about 87% of T-P component from the coconut husk while about 10% of T-N were released during the retting treatment. Thus, rich amount of nutrient component particularly on phosphorus could be extracted from the coconut husk by retting method within ten days which could be the suitable source for bio-fertilizer.

ACKNOWLEDGEMENT

We would like to acknowledge the support of President Dr. Elpidio T. Magante of Bohol Island State University for his meaningful guidance and advice.

REFERENCES

Ambika, D.M. and Gopalakrishna, P.N. 1990. Effect of pollution due to coconut husk retting on the south-west coast of India. Indian Journal of Fisheries, 37(2), 145-149.

Bijoy, N.S. 1997. Retting of coconut husk: A unique case of water pollution on the southwest coast of India. International Journal of Environmental Studies, 52, 335-355.

Chan, E. and Elevitch, C.R. 2006. Cocos nucifera (coconut). Species Profiles for Pacific Island Agroforestry, 2-1, 1-27.

Cordell, D., Drangert, J.O. and White, S. 2009. The story of phosphorus: Global food security and food for thought. Global Environmental Change, Elsevier, 19, 292-305.

Foale, M. 2003. The coconut odyssey: the bounteous possibilities of the tree of life. Australian Centre for International Agricultural Research, 44-46.

Mihara, M. and Ueno, T. 2000. Nitrogen and phosphorus transfer in soil erosion processes, IAHS Publication, No. 263, 109-115.

Orient Integrated Development Consultants Inc. 2006. Bohol Agriculture Master Plan, CY2006-2026.

Rancic, D., Pekic, S. and Pecinar, I. 2005. Anatomy of tomato fruit and fruit pedicel during fruit development. Microscopy: Science, Technology, Applications and Education, 851-861.

Smil, V. 2000b. Phosphorus in the environment: Natural plows and human interferences. Annual Review of Energy and the Environment, 25, 53-88.

Steen, I. 1998. Phosphorus availability in the 21st Century: Management of a non-renewable resource. Phosphorus and potassium, 217, 25-31.

Torillo, J.Jr. and Mihara, M. 2011. Soil erosion control by coconut husk buffer strip in Bohol island of Philippines. International Journal for Environmental and Rural Development, 2(1), 25-30.