J. Agrofor. Environ. 2(1): 1-6, 2008 ISSN 1995-6983

Effect of different forms of teak leaf biomass on the yield of rice and nutrient release in the soil

M. O. Mojumder, G.M. M. Rahman, Morzia Begum[1], M. M. Rahman, M. S. I. Majumder
Department of Agroforestry, Bangladesh Agricultural University, Mymensingh , [1]Division of Entomology, Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh

Abstract: An experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh during December 2007 to May 2008 to evaluate the effect of different forms of leaf biomass of teak on the yield of rice cv. BRRI dhan 28 and nutrient release in the soil. There were five treatments viz. recommended fertilizer dose (F_o), dry form of teak leaf biomass (F_1), sub soil decomposed form of teak leaf (F_2), anaerobically decomposed form of teak leaf (F_3) and chopped green leaves of teak (F_4).The experiment was set up in a Randomized Complete Block Design (RCBD) with four replications. All the forms of leaf biomasses were applied @ 10 t ha^{-1} after land preparation. The results showed that the treatments influenced the yield and yield components viz. plant height, total tillers/hill, no. of effective tillers/hill, no. of non effective tillers/hill, grains/panicle and yield per hectare of rice. Panicle length and 1000 grains weight had no significant effect. The highest grain yield (4.72 t ha^{-1}) was recorded in the recommended fertilizer dose followed by 4.29 t ha^{-1}, 3.99 t ha^{-1}, 3.80 t ha^{-1}, 3.40 t ha^{-1} obtained in sub soil decomposed form, anaerobically decomposed form, dry form and Chopped green leaves, respectively. Among the different forms of biomass the sub soil decomposed form and anaerobically decomposed form treatments were the best. Analyses of post harvest soil samples revealed a slightly higher amount of total N, available P, exchangeable K and S due to the addition of leaf biomass. Thus, it can be said that teak leaf biomass either decomposed in sub-soil condition or anaerobic condition would be beneficial for rice production and subsequent soil improvement.
Key words: Teak leaf biomass, yield, boro rice, nutrient release, post harvest soil

Introduction

Rice (*Oryza sativa*) plays a significant role in the agricultural sector of Bangladesh covering 75% of the total area (BBS, 2005). However, the decreasing trend of organic matter content in Bangladesh soils causes nutrients imbalance including micronutrient deficiency resulting poor yield of rice. That is why the farmers are diverting to use more chemical fertilizers to meet up the deficiencies which ultimately deteriorating the soil health. Leaf biomass is an important source of nutrients which requires for soil fertility improvement. Leaf biomass supplies the carbon, nitrogen, phosphorus, potassium and other nutrients in soil. The decomposition of leaf biomass influences the amount of N availability for plant uptake. Decomposition refers to both the physical and chemical breakdown of litter, and the mineralization of nutrients (Boulton and Boon, 1991). Leaf biomass is converted into available form for uptake by vegetation and thereby exercising a critical on vegetation productivity (Mitch and Gosselink, 1993; Groffman *et al.*, 1996). In any agroforestry system, nutrient release is very important pre-condition in leaf biomass decomposition. Nutrients may be released from leaf biomass by leaching or mineralization (Swift *et al*., 1979). Leaf biomass plays a fundamental role in the nutrient turnover and in the transfer of energy between plants and soil the source of the nutrient being accumulated in the upper next layer of the soil (Singh *et al*., 1978). The rate at which nutrients are released depends on several factors as indicated by Seasted (1984) are the chemical composition of the litter, the structural nature of the nutrients in the litter matrix, the microbial demand for nutrient and the availability of exogenous sources of the nutrients. With this view in mind, the present research work was undertaken to observe the effects of different forms of teak leaf biomass on the yield of rice and to determine the status of post harvest soil as influenced by the incorporation of teak leaf biomass.

Materials and Methods

The experiment was set up at the South Western side of Agronomy Field Laboratory, Department of Agronomy, Bangladesh Agricultural University, Mymensingh during the Boro season (December to May) of 2007-2008. The experiment was conducted in Randomized Complete Block Design (RCBD) with four replications. Green, healthy, mature teak leaves were collected from different locations of BAU campus. There are four forms of treatment (F_1 = Dry form, F_2 = sub soil decomposed form, F_2= anaerobically decomposed form and F_4 = chopped green leaves) were then prepared as per need of the experiment and incorporated to the assigned plot before transplanting. Simultaneously, a treatment of recommended fertilizer dose was also applied. BRRI dhan 28 was used as the test crop in this experiment. Data on yield contributing characters such as plant height, no. of total tillers $hill^{-1}$, no. of effective tillers $hill^{-1}$, no. of non effective tillers $hill^{-1}$, number of grains $panicle^{-1}$, 1000 grains weight, grain, straw yield, biological yield and harvest index etc. were recorded .Chemical analyses of post harvest soil samples were also done to find out N, P, K, S release from biomasses. The total N, available P, exchangeable K were determined through semi-micro Kjeldahl method, modified Olsen method, NH_4OAc extraction method, respectively. The data collected throughout the period of the experiment were computed and analyzed following the appropriate design of the experiment. The mean results were tested by Duncan's multiple range test (DMRT) and ranking was indicated by letters (Zaman *et al.*, 1982).

Results

Effect of Tree Leaf Biomass on yield and yield contributing characters of rice cv. BRRI dhan 28

Plant height: Plant height was significantly influenced due to the effect of different treatments (Table 1). In the plots, where only recommended fertilizer dose was applied, the recorded plant height was 78.63 cm which was the highest among the different treatments. Among the different form of Teak leaf biomass the highest plant height (76.50 cm) was found in the treatment of sub soil decomposed form of teak leaf biomass. The second highest treatment was found in anaerobically decomposed form of teak leaf biomass (74.30 cm) among the different forms of leaf biomass which was statistically similar with the treatment of dry form and green leaves form of biomass. The lowest plant height (73.05 cm) was found in the treatment of chopped green leaves form.

Table 1. Effect of different forms of Teak leaf biomass on different yield and yield contributing characters of rice variety cv. BRRI dhan 28

Treatments	Plant height (cm)	Total tillers hill-1 (no.)	Effective tillers hill-1 (no.)	Non-effective tillers hill-1 (no.)	Panicle length (cm)	Grain/ panicle	1000-grain wt. (gm)	Grain yield (t/ha)	Straw yield (t/ha)	Biologic al yield (t/ha)	Harves t index (%)
F_0	78.63^a	9.30^a	8.85^a	0.45^d	20.45	68.00^a	22.55	4.72^a	7.03^a	11.76^a	40.14^a
F_1	73.13^c	8.60^{bc}	6.55^d	2.05^b	19.65	62.81^c	22.44	3.80^d	5.98^c	9.78^d	38.85^a
F_2	76.50^b	8.32^{cd}	7.65^b	0.68^d	20.06	65.75^b	22.57	4.29^b	6.51^b	10.80^b	39.72^a
F_3	74.30^c	8.80^b	7.07^c	1.73^c	19.72	64.02^{bc}	22.43	3.99^c	6.30^b	10.28^c	38.81^{ab}
F_4	73.05^c	8.02^d	5.68^e	2.35^a	19.51	62.38^c	22.53	3.40^e	5.69^d	9.09^e	37.40^b
Level of significance	**	**	**	**	NS	**	NS	**	**	**	**
CV%	3.72	2.37	3.12	12.70	2.42	3.06	1.26	3.20	4.39	3.57	4.30

In a column figures having the same letter(s) do not differ significantly, ** = Significant at 1% level of probability, CV = Coefficient of Variation, NS = Not significant

Number of total tillers hill^{-1}: The tillering of rice cv. BRRI dhan 28 was significantly affected by the different treatments. The number of total tillers hill^{-1} due to the different treatments ranged from 9.30 in RFD to 8.02 in green leaves form treatment. The highest total tillers (9.30) was produced by RFD and the lowest number of total tillers hill^{-1} (8.02) was produced by green leaves form. Among the tree biomass, the sub soil decomposed form of biomass treatment produced the highest number of total tillers hill^{-1} (8.80) and the lowest number of total tillers hill^{-1} (8.02) was produced by green leaves form. The second highest was produced in the dry form of biomass treatment was 8.60 (Table 1).

Number of effective tillers hill $^{-1}$: The number of effective tillers hill^{-1} increased significantly with the incorporation of different form of Teak leaf biomass. Fig.2 indicated that the treatment of RFD gave the highest number of effective tillers hill^{-1} (8.85) while the lowest number of effective of tillers hill^{-1} (5.68) was found in the treatment of green leaves. The treatment of anaerobically decomposed form gave the second highest effective tillers hill^{-1} (7.07) among the different form of biomass treatment.

Number of non effective tillers hill $^{-1}$: The number of effective tillers hill^{-1} decreased significantly in all the leaf biomass treatments from that of RFD treatment. Table 1 indicates that the treatment of RFD gave the lowest number of non effective tillers hill^{-1} (0.45) while the highest number of non effective tillers hill^{-1} (2.35) was found in the treatment of green leaves.

Panicle length: The panicle length of rice cv. BRRI dhan 28 was not significantly affected by the incorporation of different form of leaf biomass. The panicle length varied from 20.45 to 19.51cm due to the different treatments. The treatments of RFD produced the highest panicle length of 20.45cm. Among the different form of Teak leaf biomass, the highest panicle length (20.06 cm) was found in the treatment of sub soil decomposed form. The lowest panicle length (19.51) was recorded in the treatment of green leaves form (Table 1).

Grains panicle $^{-1}$: The number of grains panicle $^{-1}$ of rice cv. BRRI dhan 28 was significantly affected by the different treatments. Table 1 showed that the grains panicle $^{-1}$ ranged from 68.00 to 62.38 and the highest (68.00) was obtained in the treatment where recommended fertilizer dose was used. The treatment of sub soil decomposed form was produced the highest grains panicle^{-1} which was the highest among the different form of leaf biomass and it was statistically similar to the treatment of anaerobically decomposed form. The lowest number (62.38) of grains panicle^{-1} was obtained in the treatment of green leaves form.

1000 grains weight: Table 1 showed that weight of 1000 grains was not significantly affected by different treatments. The highest weight of 1000 grains (22.57g) was obtained in sub soil decomposed form of biomass and the second highest (22.55g) from the treatment of RFD. The lowest weight of 1000 grains (22.43 g) was observed in the anaerobically decomposed form of biomass.

Grain yield: Table 1 showed that there is significant effect of different forms of leaf biomass on the grain yield of rice cv. BRRI dhan 28 due to the different treatments. The highest grain yield (4.72 t ha^{-1}) was obtained in the plots where recommended fertilizer dose was applied. The sub soil decomposed form produced the highest grain yield (4.29 t ha^{-1}) among the different forms of Teak leaf biomass and the anaerobically decomposed form produced the second highest (3.99 tha^{-1}). The lowest grain yield (3.40 tha^{-1}) was obtained from the treatment of green leaves form.

Straw yield: The highest straw yield (7.03 t ha^{-1}) was produced by the recommended fertilizer dose treatment. The sub soil decomposed form of treatment was produced straw yield (6.51 t ha^{-1}) which was the highest among Teak leaf biomass treatments and the second highest (6.30 t ha^{-1}).The lowest straw yield (5.69 t ha^{-1}) was produced in the treatment of green leaves form. The straw yield of sub soil decomposed form and anaerobically decomposed treatments were statistically similar (Table 1).

Biological yield: The biological yield was affected by the incorporation of different forms of Teak leaf biomass (Table 1). The highest biological yield was found 11.76 in RFD and the lowest yield 9.09 was found in the green leaves of forms.

Harvest index: Significant effect due to different treatments on harvest index have been presented in (Table 1).The highest harvest index (40.14 %) was observed in RFD which was statistically similar to the treatments of dry form and sub soil decomposed form treatments. The probable reason of highest harvest index might due to its highest grain yield of the treatments.

Table 2. Properties of post harvest soil sample as affected by different treatments

Treatments	pH	Total N (%)	Available P (ppm)	Exchangeable K (me/100g)	Available S (ppm)
F0	7.0	0.125	2.62	0.173	5.08
F1	7.0	0.144	3.66	0.253	8.23
F2	7.5	0.156	4.72	0.270	10.79
F3	7.5	0.151	4.05	0.261	10.61
F4	7.0	0.131	2.95	0.210	8.15
Initial soil sample	7.0	0.101	2.45	0.143	4.40

Nutrient status of post harvest soil

Different treatments significantly influenced P^H value which was 7.5 in sub soil decomposed form and anaerobically decomposed form of post harvest soil sample. Before the incorporation of biomass in the experimental plots, the pH was 7.0 in the initial composite soil sample (Table 2). Teak leaf biomass significantly influenced total N content in post harvest soil as against the initial content of 0.101% (Table 2). The available P was significantly influenced due to the application of different treatments while the available P was 2.45 ppm in the composite soil sample. Table 2 indicated that after harvesting of rice, available P was highest (4.72 ppm) in Sub soil decomposed form and anaerobically decomposed form was second highest available P (4.05 ppm). The treatment where recommended fertilizer dose was used the lowest available P (2.62 ppm). At first, the exchangeable K was 0.143 m.e./100g in the composite sample. Later, application of Teak leaf biomass increased the exchangeable K in post harvest soils. Table 2 revealed that exchangeable K in post harvest soils ranged from 0.270 to 0.173 m.e./100g). The treatment of sub soil decomposed form gave the highest exchangeable K (0.270 m.e./100g).The lowest exchangeable K (0.173 m.e./100g) where the treatment recommended fertilizer dose was used. The Available Sulphur was significantly influenced due to the application of different treatments of biomass. Table 2 indicated that after harvesting of rice, available S was highest (10.79 ppm) in Sub soil decomposed form and anaerobically decomposed form showed the second highest available P (10.61ppm).The treatment where recommended fertilizer dose was used the lowest Available Sulphur (5.08 ppm).Initially, the Available Sulphur was 4.40 ppm in the initial composite soil sample.

Discussion

It was observed that the treatments had marked influence on plant height, total tillers $hill^{-1}$ effective tillers $hill^{-1}$, non effective tillers $hill^{-1}$, grain $panicle^{-1}$, biological yield, grain yield, harvest index and straw yield (Table. 1). The Plant height is related to the Nitrogen content of soil. The more N in the soil, the more the plant increases in height. Teak leaf biomass added huge amount of N. The result was in agreement with Sonkar (2004) who found that the percent concentration of nutrients N was found to be higher in the leaf litter of plantation area than the leaf litter of natural forest area.

The highest number of total tillers $hill^{-1}$, effective tillers $hill^{-1}$, number of grains $panicle^{-1}$ was observed in the treatment of recommended fertilizer dose-RFD and the lowest results were observed in the chopped green leaves form. Among the biomass treatments sub soil decomposed form showed the highest result. These results were agreed with that of Apostol (1989) who reported that combined application of organic matter and organic fertilizer increased the number of litter hill^{-1}, panicle length, grain panicle^{-1} but separately inorganic fertilizer was best. Among the biomass treatments, sub soil decomposed form and anaerobically decomposed form showed better result because of their sufficient decomposition. The result was agreed with Montagnini *et al.* (1993) who found that the most important factors that affect litter decomposition are temperature, humidity and aeration which affect soil biota activity and as well as litter composition and quality. The results were also agreed with Lousier and Parkinson, 1976 who said that nutrient content of litter is determined by mineral content of foliar tissues and time and mode of decomposition.

Among the different forms, the highest yield (4.29 t ha^{-1}) was found in the plots where sub soil decomposed form was applied. Other plots where biomasses were incorporated also gave good rice yield. The results support the findings of Rajendran *et al.* (2003) who found that teak can be successfully intercropped with rice under irrigated and rainfed conditions in the sub-humid and semiarid zones.

N, P and K were found more in the plots where Teak biomasses were applied. The results support the findings of Murugesh *et al.* (1999) who found that organic matter and available N, P and K were higher in all Teak stands than in the barren site and exchangeable Ca and Mg were generally greater at all ages of Teak stands than in fallow and agricultural soils. The results support Sonkar (2004) who observed that the percent concentration of nutrients (N, P, K and Ca) was found to be higher in the leaf litter of plantation area than the leaf litter of natural forest area.

From the overall results, it can be concluded that the sub soil decomposed form was the best in terms of yield and improvement of post harvest soil.

References

Apostol, E. D. F. 1989. Influence of mirasol organic and x-rice liquid fertilizer in combination with inorganic fertilizer on IR66 and BPIR 12 rice varieties. Malabeu, Metro, Manila, Phillipines: 73.

BBS (Bangladesh Bureau of Statistics). 2005. Statistical Yearbook of Bangladesh, Ministry of Planning, Government of the People's Republic of Bangladesh. Dhaka pp.56-60.

Lousier, J. D. and Parkinson, D. 1976. Litter decomposition in a cool temperate deciduous forest. Canadian J. Bot. 24: 419-436.

Groffman, P.M., Hanson, G.C., Kiviat, E. and Stevens, G. 1996. Variation in microbial biomass and activity in four different wetland types. Soil Sci. Soc. Am. J. 60: 622-629.

Mitch, W. J. and Gosselink, J. G. Wetlands. Second edition. Van. Nostrand Reinhold, New York. pp. 205-240.

Montagnini, F., Reamstad, K. and Sancho, F. 1993. Literfall, Litter decomposition and the use of mulch of four indigenous tree species in the Atlantic lowlands of Costa Rica. Agrof. Sys.

Murugesh, M., Srinivasan, V. M., Rai, R. S. V. and Parthiban, K. T. 1999. Teak on farm land and its effect on soil fertility advances In Horticulture and Forestry. 6:153-161.

Rajendran, K., Gunasekaran, T.and Devaraj, P. 2003. Performance of teak (Tectona grandis) and rice (Oryza sativa) in the agri-silvicultural system in Southern Tamil Nadu. Range Managementand Agroforestry. 24(1): 74-76.

Seasted, T.R. 1984. The role of microarthropods in decomposition and mineralization processes. Annals Rev. Entomol. 29: 25-46.

Singh, A. K. and Gupta, B. N. 1978. Biomass production ands nutrient distribution in some important tree species on Bhatta soil of Raipur (Madhya Pradesh) India. Ann. For. 1 (1): 47-53.

Sonkar, S. D. 2004. Litter production and nutrient return in the plantations of Tectona grandis and adjoining natural forest in Madhya Pradesh. Environment and Ecology. 22(1):116-124.

Swift, M. J., Heal, O.W. and Anderson, J. M. 1979. Decomposition in terrestrial ecosystems.University of California, USA. p. 372

Zaman, S .M .S, Rahim, K. and Howlader, M. 1982. Simple lessons from Biometry . Bangladesh Rice Research Institute .Publication No. 54. p.