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Effect of *Tectona grandis* leaf litter on the yield of boro rice and subsequent soil improvement

M. S. I. Majumder, G.M. M. Rahman, M.W. Zaman[1], M. S. O. Mojumder, M. M. Rahman

Department of Agroforestry, Bangladesh agricultural University.Mymensingh, [1]Department of Agricultural Chemistry, Bangladesh agricultural University, Mymensingh-2202

Abstract: A field experiment was carried out at the Agronomy Field Laboratory, Department of Agronomy, Bangladesh Agricultural University, Mymensingh during the period from January to May 2008 to study the effect of different doses of tree leaf litter on the yield and yield contributing characters of transplant Boro rice cv. BRRI Dhan28. The experiment was laid out in a Randomized Complete Block Design with four replications. There were five treatments viz. recommended fertilizer dose, 5 ton leaf litter ha^{-1}, 7.5 ton leaf litter ha^{-1}, 10 ton leaf litter ha^{-1}, 12.5 ton leaf litter ha^{-1} in this experiment. Different Leaf litter doses of *Tectona grandis* significantly influenced the yield and yield contributing characters of transplant Boro rice cv. BRRI Dhan28. Highest amount of nutrients was released from 12.5 ton ha^{-1} leaf litter and 5 ton ha^{-1} was lowest. The highest grain yield (5.24 t ha^{-1}) was recorded under recommended fertilizer dose followed by 4.98, 4.78, 4.66, 4.50 obtained out of the treatments of 12.5 ton leaf litter ha^{-1} (4.98 t ha^{-1}), 10 ton leaf litter ha^{-1} (4.78 t ha^{-1}) 7.5 ton leaf litter ha^{-1} (4.66 t ha^{-1}) and 5 ton leaf litter ha^{-1} (4.50 t ha^{-1}), respectively. Organic matter of the post harvest soil increased considerably due to the treatments as compared to initial soil.
Key words: *Tectona grandis*, leaf litter, boro rice, BRRI dhan28

Introduction

Rice is the leading cereal crop in the world and the staple food crop for more than two billion people in Asia. Rice is extensively grown in all three seasons viz. Aus, Aman and Boro. For rice production, presence of organic matter in soil is important. A good soil should have organic matter content of more than 3.5 percent. But in Bangladesh, most of the soils have less than 1.7 percent and some soils have even less than 1 percent organic matter (Sattar, 2002). Now it is well agreed that depleted soil fertility is a major constraint for higher rice production in Bangladesh and indeed, yield of several crops are declining in most soils (Bhuiyan, 1991).

After the introduction of chemical fertilizers in the last century, farmers were happy of getting increased yield in agriculture in the beginning. But slowly chemical fertilizers started displaying their ill-effects such as leaching out and polluting water basins destroying micro-organisms and friendly insects, making the crop more susceptible to the attack of diseases, reducing the soil fertility and thus causing great damage to the overall system. A number of intellectuals throughout the world started working on the alternatives and found that bio-fertilizer can helping increasing the yield without causing the damage associated with chemical fertilizer.

Organic matter does not add any "New" plant nutrients, but release nutrients in a plant available from through the process of decomposition. Litter fall and decomposition are two primary mechanisms through which nutrient pool of forest ecosystem gets maintained (Mohan Kumar and Deepu, 1992). The rate of decomposition plays a vital role in two of its major function i.e., mineralization of essential elements and formation and soil organic matter. In moist deciduous regime or the sites under study average rate of decomposition is 0.29% per days. The litter was analyzed for major nutrients and the mean annual litter fall contained the following amounts of plant nutrients N- 90.9, P 10, K 71, Ca 188 Mg 21.6 and Na 2.1 kg/ha over 90% of these nutrients is contained in teak litter.

In Bangladesh, for rice cultivation we are fully dependant on the synthetic fertilizer. It is responsible for diminishing the fertility of soil. But there are little efforts to solve the problem. Hence the present study is undertaken to observe the effect of *Tectona grandis* leaf biomass on the yield and yield contributing characters of rice & to explore the possibility of organic method for increasing the fertility of soil

Materials and Methods

The experiment was conducted at the Agronomy Farm, Department of Agronomy, Bangladesh Agricultural University, Mymensingh during January to May 2008. The rice cv. BRRI dhan28 was used as the test crop. The experiment was conducted in a Randomized Complete Block Design (RCBD) with four replications. Each block was subdivided into 5 unit plots. The total numbers of plots were 20. The unit plot size was 1m × 1m. Five different treatments were randomly distributed to the unit plots in each block. Treatments (Different doses of *Tectona grandis* leaf litter) were, D_0 = Recommended fertilizer dose, D_1 = 5 ton leaf litter ha^{-1}, D_2 = 7.5 ton leaf litter ha^{-1}, D_3 = 10 ton leaf litter ha^{-1}, D_4 = 12.5 ton leaf litter ha^{-1}. Tree leaf biomass of *T. grandis* was collected from the Bangladesh Agricultural University Campus, Mymensingh. *T. grandis* leaf biomasses were dried for some days then made it dust form, finally mixed uniformly with soil during final land preparation and then left to decompose. The leaf biomasses were incorporated in different plot before 10 days of transplanting. Forty (40) days old seedlings were uprooted & transplanted on 14 January 2008. Two healthy seedlings per hill were transplanted in all the experimental plots. The rice plants were harvested on 28 April 2008. The crop was harvested at its full maturity. The yield contributing characters viz. plant height (cm), number of total tillers $hill^{-1}$, number of

effective tillers hill^{-1},non effective tiller hill^{-1}, panicle length (cm), number of grains panicle^{-1},1000-grain weight (g), grain and straw yield (t ha^{-1}), biological yield (t ha^{-1}), harvest index(%) were recorded. The grain and straw were separated by hand threshing and plot wise weight of grain and straw were recorded in kg plot^{-1}and converted as t ha^{-1}. The post harvest soil samples were collected to analyze N, P, S, and K etc. Data were analyzed using a computer package programme MSTAT-C, and mean differences were adjudged by Duncan's Multiple Range Test.

Results

Growth parameters

Plant height: *T. grandis* leaf litter release a significant amount of N, P, K and S which influenced the plant height significantly (Table 1). Tallest plant (78.63 cm) was produced with the recommended fertilizer dose and the second highest plant (77.63 cm) was produced with the 12.5 tha^{-1}and the 3rd highest 10 ton/ha and then 7.5 tha^{-1} and 5 tha^{-1} which was statistically similar. It could be observed from result the use of increasing doses of *T. grandis* leaf litter was found to produce taller plants.

Table 1. Effect of different forms of *T. grandis* leaf biomass on different yield contributing characters of rice

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)	Biological yield (t/ha)	Harvest t index (%)
D0	78.63 a	11.75 a	9.88 a	1.88	21.15 a	68.44 a	22.54	5.24 a	7.04 a	11.27 a	37.62
D1	75.56 d	10.32 c	8.19 c	2.14	18.90 d	63.75 c	22.37	4.50 e	5.72 e	9.22 d	37.96
D2	76.19cd	10.61 c	8.40 c	2.21	19.39 c	65.29bc	22.44	4.66 b	5.98 d	9.64 cd	37.97
D3	76.90bc	11.00bc	8.95 b	2.05	20.02 b	65.82 b	22.59	4.78 c	6.20 c	9.98 c	37.88
D4	77.63 b	11.38ab	9.27 b	2.10	20.05 b	66.48 b	22.41	4.98 b	6.55 b	10.53 b	37.80
Level of significance	**	**	**	NS	**	**	NS	***	**	**	NS
CV%	0.69	4.10	3.59	5.51	1.38	1.59	1.02	9.14	1.81	3.54	5.55

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

Total tillers hill^{-1}: Application of different doses of *T. grandis* leaf litter had significant effect on production of number of total tillers hill^{-1}. The highest number of total tillers per hill 11.75, 10.32, 10.61, 11.00, 11.38 at recommended dose, 12.5, 10, 7.5 and 5 tha^{-1}, respectively. The results showed that recommended dose produced highest number of total tillers hill^{-1} and the second highest (Table 1) number of total tillers hill^{-1} with the 12.5 tha^{-1} and the lowest with the 5 tha^{-1}.

Number of effective tiller: The number of effective tillers hill^{-1} increased consistently and significantly with the incorporation of different doses of tree leaf litter. Table 1 indicated that recommended fertilizer dose (9.88) gave the highest number of effective tillers hill^{-1}. While the lowest number of effective tillers hill^{-1} (8.19) found in D_1. The treatment of 12.5 tha^{-1} gave the second highest effective tillers hill^{-1}.

Non-effective tillers hill^{-1}: The highest production of non-effective tiller hill^{-1} was observed (2.21) from 7.5 tha^{-1} and the lowest non-effective tiller (1.88) and produced in control treatment (Table 1).

Panicle length (cm): Different doses of *T. grandis* leaf litter had significant effect on panicle length. However the longest panicle (21.15 cm) was found from RFD followed by 12.5 tha^{-1} was the shortest obtained from 5 tha^{-1} (18.90 cm). Where the second longest panicle (20.05 cm) found in 12.5 tha^{-1} (Table 1) .

Grain panicle^{-1}: The number of grains panicle^{-1} of rice cv. BRRI dhan28 was significantly affected by the different treatments. Table 1 showed that the grain panicle^{-1} ranged from 66.48 to 68.44 and the highest number was obtained in the treatment where recommended fertilizer dose was used. The treatment of D_4 was produced the second highest grain panicle^{-1} (66.48). No. of grain per panicle^{-1} in D_2 and D_3 was statistically similar and lowest found in D_1 (63.75).

1000 grain weight: Table 1 showed that the effect of tree leaf litter on 1000-grain weight was found non-significant. The 1000-grain weight obtained from different treatment ranged from 22.37 to 22.59g where all are statistically similar.

Grain yield: The effect of tree leaf litter on the yield of rice cv. BRRI dhan28 was revealed a significant variation due to the different treatments. The highest grain yield (5.24 ton/ha) obtained from RFD. Among the doses of leaf litter 12.5 ton/ha (4.98 ton/ha) showed the highest grain yield. Another three treatments (D_3, D_2 and D_1,) produced 4.78, 4.66, 4.50 tha^{-1} grain yield (Table 1).

Straw yield: The straw yield was markedly influenced by the application of tree leaf litter. The highest straw yield (7.04 tha^{-1}) recorded from RFD. The treatment D_4 produced 6.55 tha^{-1} straw which was the highest among tree leaf litter doses and 3rd highest (6.2 tha^{-1})

was recorded from D_3 and another two treatments use statistically similar (Table 1).

Biological yield: The biological yield was affected by the incorporation of leaf litter on different doses. The highest biological yield was found 11.27 ton/ha in RFD and the lowest yield 9.22 $tha^{-1}$was found in 5 ton leaf litter per ha^{-1} (Table 1).

Harvest index: The harvest index showed non-significant effect in this experiment. Harvest index obtained from the different treatments varied from 37.62-37.97%, where highest Harvest index found in 7.5 ton leaf litter per ha^{-1} (37.97%). Another treatment showed statistically similar result (Table 1).

Nutrient status of soil after harvesting of rice

pH: Table 2 showed that the different treatments significantly influenced P^H value which was 7.5 in 12.5 ton leaf litter ha^{-1}. Before the application of biomass in the experimental plots, the P^H was 6.9 in the initial soil sample.

Total nitrogen: *T. grandis* released an influential amount of nutrient in soil after the incorporation. It is showed that *T. grandis* leaf litter was rich in nitrogen content. The release of total N after harvest varied from 0.069 to 0.155 due to the different treatments (Table 2). The treatment of 12.5 t ha^{-1} released highest amount of N (0.155%) and the second highest was released from 10 ton/ha treatment which was statistically similar with D_2 and D_1 treatments. The lowest amount of N released from recommended fertilizer dose. In initial soil sample it was found total nitrogen is 0.068%.

Available phosphorus: It was observed that the experimental result of releasing of phosphorus satisfactory. The release of P was influenced significantly due to different treatments. D_4 treatment released a huge amount of P like 4.75 ppm and in D_3 it was 4.10 ppm. Statistically similar P was observed in D_2 and D_1 treatments. The lowest amount found in standard fertilizer dose (2.64 ppm). Available P founded in initial soil sample was 2.45 ppm (Table 2).

Exchangeable potassium: It is showed that the exchangeable K was releases significantly with the application of *T. grandis* leaf litter. Application of leaf litter increased the exchangeable K in post harvest soil. It ranged from 0.171 to 0.272 me/100g (Table 2).

Available sulphur: Just before the incorporation of leaf litter in soil the sulphur status of soil was 4.41ppm and after harvesting of rice it was found a significant influence of applying *T. grandis* leaf litter. Highest 10.81 ppm S found in the treatment D_4 which was statistically similar with treatment D_3 (Table 2).

Discussion

Different doses of *T. grandis* leaf litter showed a significant positive effect in soil.

Total N, available P, exchangeable K and available S level in the post harvest soil was higher than initial status. Guan (1989) found that the available N and P content in soil sample taken from plots with the application of organic materials were significantly higher than the control. These results also in agreement with that of Maharudrappa *et al*. (2000) reported that in the incubation experiment, litter application enhanced nutrient availability.

The different doses of tree leaf litter showed significant effect on yield and yield contributing characters. The highest yield was obtained from Recommended dose (5.24 t ha^{-1}) among the different leaf litter doses highest yield obtain in the addition of 12.5 t ha^{-1} leaf litter followed by 10 t ha^{-1}, 7.5 t ha^{-1} and 5 t ha^{-1}, respectively. Yields under different treatments almost statistically similar with recommended yield of rice (BRRI dhan28). This indicates *T. grandis* leaf litter can release sufficient nutrients to the soil which is required rice cultivation. Ralhan and Singh (1987) also reported tree litter can release significant amount of nutrient in the natural forest soil. So, leaf litter is an important source of organic matter content which enhances the soil fertility. In rice field, we can use the tree leaf litter for getting compact return. So, vigorous attention should be given on relevant research in different parts of Bangladesh.

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

Treatments	Total N (%)	Available P (ppm)	Exchangeable K (me/100g)	Available S (ppm)	pH
D0	0.069	2.64	0.171	5.10	7.0
D1	0.145	3.55	0.210	8.15	7.0
D2	0.145	3.95	0.262	8.16	7.3
D3	0.149	4.10	0.265	10.43	7.4
D4	0.155	4.75	0.272	10.81	7.5
Initial soil sample	0.068	2.45	0.143	4.41	6.9

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