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Effect of agroforest tree leaf biomass on yield and yield contributing characters of wheat *cv. Akbar*

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Abstract

A field experiment was conducted at the Agroforestry Farm of Bangladesh Agricultural University, Mymensingh during November 2017 to March 2018 to evaluate the effects of agroforest tree leaf biomasses on yield and yield contributing characters of wheat cv. Akbar. Eight different treatments viz. T_1= Ipil-ipil (*Leucaena leucocephala*) tree leaf biomass, T_2 = Minjiri (*Cassia siamea*) tree leaf biomass, T_3 = Kalokoroi (*Albizia lebbeck*) tree leaf biomass, T_4 = Sadakoroi (*Albizia procera*) tree leaf biomass, T_5 = Eucalyptus (*Eucalyptus camaldulensis*) tree leaf biomass, T_6 = Akashmoni (*Acacia auriculiformis*) tree leaf biomass, T_7 = Mahogoni (*Swietenia macrophylla*) tree leaf biomass were used along with a recommended fertilizer dose referred as control (T_0) in a Randomized Complete Block Design with three replications. The results reveal that tree leaf biomasses significantly influenced the yield and yield contributing characters viz. plant height (cm), effective tillers/hill, spike length (cm), number of spikelets/spike, number of filled grains/spike, number of non-filled grains/spike, 1000-grain weight (g), grain yield (t/ha), straw yield (t/ha), biological yield (t/ha) and harvest index of wheat. The highest (2.83 t/ha) grain yield was recorded in the recommended fertilizer dose. Among the tree leaf biomasses, ipil-ipil tree leaf biomass produced the highest (2.47 t/ha) grain yield which was 12.71% decrease over control followed by 2.36, 2.21, 2.02, 1.89, 1.84 and 1.77 t/ha obtained in minjiri, sadakoroi, kalokoroi, eucalyptus, akashmoni and mahogany tree leaf biomass, respectively. However, it seems that the ipil-ipil tree leaf biomass would be possible to substitute of or apply in combination with inorganic fertilizer although there was some yield loss (12.71%) which was less significant compared to recommended fertilizer treatment. Therefore, it can be elucidated that for wheat production tree leaf biomass could use as a source of organic matter which is available in the agroforestry system, significantly reduces the considerable amount of chemical fertilizer.

Key words: Tree leaf biomass, decomposition, fertilizer, yield controlling characters

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Introduction

Wheat *(Triticum aestivum)* is one of the major cereal crops of the world including Bangladesh. It ranks first both in acreage and production among cereal crops. Geographic and agronomic conditions of Bangladesh are favourable for wheat cultivation. Wheat cultivated area is 0.88 million ha having total production of 1.91 million tons with an average yield of wheat in Bangladesh (BBS, 2016). However, it is the need of time to increase wheat production by increasing the yield per unit area to feed the rapidly growing population. There are many constraints responsible for the low yield of wheat in Bangladesh. Poor farmers cannot always afford the high input cost of cultivation required for modern high yielding varieties. Selection among alternative sources of nutrients and methods for sustaining soil fertility, including green manuring, is an economic decision that depends upon factor such as land, labor, and water which are used as inputs to the production system, as well as the prices of inorganic nutrient sources. In Bangladesh, about 60% of arable soils have below 1.5% organic matter whereas a productive mineral soil should have at least 2.5% organic matter (Rijpma and Jahiruddin, 2004) and the decreasing trend of soil organic matter is continuing. Organic matter depletion is observed in 7.5 million ha of land and declining soil fertility affects 5.6-8.7 million hectares of land (BARC, 2000). Organic matter called the life of the soil and plays an important role to improve physical, chemical and biological properties of soils and ultimately enhance the crop productivity. Organic matter content of the soils is constantly lessening by repeated farming which leads to hardpan formation of soil. Further, soil particles become compact and are not able to retain nutrients due to repeat and overuse of chemical fertilizers (Deka Medhi and De Detta, 1996). That is why organic farming is more suitable to avoid environment pollution and at the same time to obtain a higher and sustainable yield (Dupiach, 1991). Organic farming is the alternate method to reduce the cost of fertilizer and also can improve the soil. Leaf biomass is a very important organic source of soil fertility improvement. The decomposition of leaf litters influences the amount of N availability for plant uptake. Leaf litter supplies the carbon, nitrogen, phosphorus, potassium and other nutrients in the soil that is further considered as important indicators of soil productivity and the ecosystem health. Decomposition refers to both the physical and chemical breakdown of leaf biomass and the mineralization of nutrients (Boulton and Boon, 1991). (Lousier and Parkinson, 1976) stated that litterfall is the most important source of energy and organic matter transfer from the tree canopy to decomposer organisms of the soil surface. Maharudrappa *et al.* (2000) reported that tree litter application enhanced nutrient availability in the incubation experiment and the rate of decomposition of leaf litter was of the order *Tectona grandis*> *Acacia auriculiformis*> *Eucalyptus* hybrid> *Casuarina equisetifolia.* The release of N from the litter followed the similar order. However, the release of P and K into the available pool was higher in *Casuarina* than *Eucalyptus*. The exchangeable Ca and Mg were highest in Eucalyptus leaf litter treated soils followed by *Tectona*, *Acacia,* and *Casuarina*. Paul *et al*. (2015) conducted an experiment to find out the effect of different doses of ipil-ipil (*Leucaena leucocephala*) tree green leaf biomass on rice yield and soil chemical properties and showed that the ipil-ipil tree green leaf biomass was performed better than recommended fertilizer dose in case all yield contributing characters of rice except grain yield. Therefore, it thought necessary to determine the effect of agroforest tree green leaf biomass on wheat yield. Keeping in view of the above facts the study was undertaken to examine the effects of common agroforest tree leaf biomasses on yield and yield contributing characteristics of wheat cv. *Akbar*.

Materials and Methods

The experiment was conducted at the Agroforestry Field Laboratory, Department of Agroforestry, Bangladesh Agricultural University, Mymensingh during the period from November 2017 to March 2018. The experimental site is characterized by non-calcareous and dark grey flood plain with silty loam texture soil having a pH value of ranged from 6.5 to 6.8. The experiment was carried out in a Randomized Complete Block Design (RCBD) with three replications. There were eight treatments used in this experiment:

T_0 = Control (Recommended fertilizer dose, RFD)
T_1= Ipil-ipil (*Leucaena leucocephala*) tree leaf biomass
T_2 = Minjiri (*Cassia siamea*) tree leaf biomass
T_3 = Kalokoroi (*Albizia lebbeck*) tree leaf biomass
T_4 = Sadakoroi *(Albizia procera*) tree leaf biomass

T_5 = Eucalyptus (*Eucalyptus camaldulensis)* tree leaf biomass
T_6 = Akashmoni *(Acacia auriculiformis*) tree leaf biomass
T_7 = Mahogany (*Swietenia macrophylla*) tree leaf biomass

The total numbers of plots were 24. The unit plot size was 1.25m × 1.25m. A local variety Akbar of wheat (*Triticum aestivum*) was selected as a test crop. Seeds were collected from the Central Farming System Office at Bangladesh Agricultural University, Mymensingh. The selective tree leaf biomasses were collected from the representative trees of BAU Campus, Mymensingh. Then the tree leaf biomasses were chopped by hand and incorporated 15 days before of final land preparation The recommended dose of all fertilizers except urea were applied in control plots during final land preparation. Urea was applied top dressing in three equal installments i.e. 15, 30 and 50 days after transplanting (DAT). Seeds of the variety Akbar were directly sown in the experimental plot. The seeds were sown on 01 December 2017 at the rate of 120 kg/ha. Continuously line sowing was done and line to line distance was 20cm. After sowing all necessary intercultural operations were done as required. At full maturity stage, the wheat was harvested plot-wise on 15 March 2018. Ten hills were randomly selected from each plot at maturity to record the yield and yield contributing characters viz. plant height (cm), number of effective tillers/hill, spike length (cm), number of spikelets/spike, number of filled grains/spikes, number of non-filled grains/spike, 1000-grain weight (g), grain yield (t/ha), straw yield (t/ha), biological yield (t/ha). The selected hills were collected before crop harvest and necessary information recorded accordingly. Grain and straw yields were recorded plot-wise and expressed as t/ha. The recorded data were compiled and analyzed by RCBD design to find out the statistical significance of experimental results. The means for all the recorded data were calculated and analyzed statistically by using the Microsoft Excel and Statistical Package For Social Science (SPSS) software. The mean differences were compared by Duncan's New Multiple Range Test (DMRT) (Gomez and Gomez, 1984) and also by Least Significance Difference (LSD) test.

Results and Discussion

Effect of tree leaf biomass on vegetative characteristics of wheat cv. *Akbar*

***Plant height (cm)*:** The plant height of wheat was significantly influenced due to the effects of different tree leaf biomasses (Table 1). The results revealed that in the control plot, where only the recommended fertilizer dose was used, the recorded plant height (93.70 cm) was produced. Among the tree leaf biomass, the highest plant height (91.87 cm) was found in the treatment of ipil-ipil which was statistically similar to minjiri treatment. While the lowest plant height (85.27 cm) was obtained in the treatment mahogany (Table 1). Hasan *et al.* (2007), Parvin *et al.* (2007) found that the plant height of rice was significantly affected due to the application of tree leaf biomasses alone or in combined with chemical fertilizers in their study which was supportive to the study findings. Significantly higher plant height of rice was also reported by Arifin *et al.* (2012) in their study.

***Number of effective tillers per hill*:** The number of effective tillers/hill increased consistently and significantly with the application of tree leaf biomasses (Table 1). The highest (3.67) numbers of effective tillers/hill were found in the control treatment. Among the tree leaf biomass treatments, the highest (3.00) number of effective tillers/hill was found in the treatment of ipil-ipil which was statistically similar to control and minjiri treatment while the lowest number of effective tillers/hill (2.00) was found in the treatment of mahogany (Table 1). Similar results found by Hasan *et al*. (2007); Parvin *et al*. (2007) and Arifin *et al.* (2012) in their study where they recorded the highest number of effective tillers/hill was obtained in fertilizer dose treatment and the application of tree leaf biomasses alone or in combined with chemical fertilizers were performed better.

***Spike length (cm)*:** Spike length of wheat was influenced significantly due to the incorporation of tree leaf biomasses (Table 1). The highest (9.07 cm) spike length was recorded in the control treatment and the lowest (6.37 cm) spike length was recorded in treatment mahogany tree leaf biomass. Among the tree leaf biomass treatments, the highest (8.27 cm) spike length was recorded in the treatment ipil- ipil which was statistically similar with minjiri and kalokoroi (Table 1). (Singh and Agarwal, 1983) reported that application of manures and fertilizers in wheat cultivation increased the spike length over control and the increase was significantly higher when applied with tree biomass.

***Number of spikelets per spike*:** The number of spikelets/spike showed a marked increase due to the application of tree leaf biomass on wheat (Table 1). The results showed that significantly the highest (18.67) number of spikelets/spike was observed in the treatment of recommended fertilizer dose while the lowest (13.67) number of spikelets/spike was produced in the treatment of mahogany tree leaf biomass. The results also revealed that the treatment of minjiri gave the highest (17.00) number of spikelets/spike which was statistically similar to the treatment of ipil-ipil among the tree leaf biomasses (Table1). Parvin *et al*. (2007) conducted an experiment to find out the effect of green leaf biomass along with recommended fertilizer dose in different combinations on rice cultivation and found that the tree leaf biomass significantly influenced on spikelet/panicle.

Table 1. Effect of tree leaf biomass on vegetative characteristics of wheat cv. *Akbar.*

Treatment	Plant height (cm)	No. of effective tillers/hill	Spike length (cm)	Spikelet/spike (no)	Filled grain/spike (no)	Non-filled grain (no)
T_0	93.70a	3.67a	9.07a	18.67a	42.00a	6.00
T_1	91.87ab	3.00ab	8.27b	16.67bc	38.67b	5.66
T_2	91.17b	3.00ab	8.17b	17.00b	38.33bc	5.33
T_3	88.63c	2.33bc	7.53c	15.33cd	36.00cde	5.66
T_4	88.76c	2.67bc	7.70bc	15.33cd	37.00bcd	5.00
T_5	87.63c	2.33bc	6.87d	15.00de	34.67de	4.66
T_6	87.39cd	2.00c	6.43d	15.00de	34.00e	4.66
T_7	85.27d	2.00c	6.37d	13.67e	33.67e	4.33
Level of sig.	**	**	**	**	**	**NS**

Note: Figures in the column having the same letter (s) do not differ significantly; **= Significant at 1% level of probability; NS= Non-significant; sig= significance.

***Number of filled grains per spike*:** A number of filled grains/spike was significantly influenced due to the incorporation of different tree leaf biomasses in wheat cultivation (Table 1). The result showed that the number of filled grains/spike was found to vary from 33.67 to 42.00. The highest (42.00) number of filled grains/spike was obtained in the control treatment where the recommended fertilizer dose was applied. The treatment ipil- ipil was produced the second highest (38.67) filled grains/spike which was the highest among the tree leaf biomasses and it was statistically similar to the treatment of minjiri. The lowest number (104.67) of filled grains/spike was obtained in the treatment of mahogany (Table 1). Hasan *et al*. (2007); Parvin *et al*. (2007) and Paul *et al.* (2015) found that the filled grains/panicle was significantly influenced due to the application of tree leaf biomasses alone or in combined with chemical fertilizers in their study which was supportive to the study findings.

***Number of non-filled grains per spike*:** The results showed that the number of non-filled grains/spike was not significantly affected due to the application of different tree leaf biomasses in wheat cultivation. The number of non-filled grains/spike was found to a range from 4.33 to 6.00 (Table 1). The highest (6.00) number of non-filled grains/spike was obtained in control treatment while the lowest (4.33) was recorded in the treatment of mahogany tree leaf biomass (Table 1).

Effect of different tree leaf biomass on reproductive characters of wheat cv. Akbar

***1000-grain weight (g)*:** The result showed that the weight of 1000-grains was not significantly affected by different treatments and found to a range from 36.38 g to 37.60 g (Table 2). The highest (37.60 g) weight of 1000-grains was obtained in the control treatment and the second highest (37.51 g) from the treatment of ipil-ipil tree leaf biomass. While the lowest (36.38 g) weight of 1000-grains was recorded in the treatment of mahogany (Table 2). (Kant and Kumar, 1994) reported that 1000-grains weight of wheat was also significantly increased over control when farmyard manure applied @ 30 t/ha.

***Grain yield (t/ha)*:** The yield of wheat grain was significantly influenced due to the application of tree leaf biomass (Table 2). The results showed that the wheat grain yield ranged from 1.77 to 2.83 t/ha and the highest (2.83 t/ha) grain yield was obtained in the treatment of recommended fertilizer dose. The treatment of ipil-ipil produced the highest (2.47 t/ha) grain yield among the tree leaf biomass which was 12.71% decrease over recommended fertilizer doses while the minjiri tree leaf biomass produced the second highest (2.36 t/ha) grain yield which was statistically similar to the treatment of ipil-ipil. The lowest (1.77 t/ha) grain yield was obtained in the treatment of mahogany tree leaf biomass (Table 2).

Table 2. Effect of different tree leaf biomass on reproductive characters of wheat cv. *Akbar.*

Treatments	1000-grain weight (g)	Grain yield (t/ha)	Straw yield (t/ha)	Biological yield (t/ha)	Harvest Index (%)
T_0	37.60	2.83a	3.43a	6.27a	45.21
T_1	37.51	2.47b	3.09b	5.56b	44.48
T_2	37.28	2.36b	2.90bc	5.26c	44.92
T_3	36.92	2.02cd	2.49d	4.51e	44.85
T_4	37.04	2.21bc	2.74c	4.95d	44.67
T_5	36.53	1.89d	2.43d	4.32ef	43.68
T_6	36.67	1.84d	2.34de	4.18fg	44.02
T_7	36.38	1.77d	2.21e	3.98g	44.54
Level of sig.	NS	**	**	**	NS

Note: Figures in the column having the same letter (s) do not differ significantly; **= Significant at 1% level of probability; NS= Non-significant; sig= significance.

Hasan *et al.* (2007) recorded the highest grain yield (4.95 t/ha) in the recommended fertilizer dose followed by ipil-ipil, minjiri, akashmoni, eucalyptus and mahogany tree leaf biomasses treated plots (4.33, 4.07, 3.91, 3.88 and 3.83 t/ha) respectively. They also reported that among the tree leaf biomass, ipil-ipil performed better yield which was the nearest of the recommended fertilizer dose and the treatment of mahogany gave the lowest yield. Paul *et al*. (2015) and Arifin *et al*. (2012) found similar results in their study which was very much supportive of the present study result.

***Straw yield (t/ha)*: ** Like grain yield, straw yield was significantly affected due to the application of different tree leaf biomasses (Table 2). The highest (3.43 t/ha) straw yield was found in the control treatment where the recommended fertilizer dose was applied. The treatment ipil-ipil tree leaf biomass produced the straw yield 3.09 t/ha which was the highest among the tree leaf biomass. The lowest (2.21 t/ha) grain yield was found in the treatment mahogany which was statistically similar to treatment akashmoni (Table 2). Similar result found by Hasan *et al.* (2007) and Samsuzzaman *et al*. (2002) which were supportive of the present study findings.

***Biological yield (t/ha)*:** The biological yield of wheat was significantly influenced by the application of tree leaf biomass (Table 2). The biological yield of wheat ranged from 3.98 to 6.27 t/ha. The maximum value was noted with the control treatment. The next highest (5.56 t/ha) yield was observed in the treatment of ipil- ipil which followed by the treatment of minjiri. The minimum value (1.77 t/ha) was observed in the treatment of mahogany which was statistically similar to the treatment of akashmoni tree leaf biomass (Table 2).

***Harvest index (HI) (%)*:** Harvest index was not significantly influenced by the application of different agroforest tree leaf biomasses for wheat cultivation (Table 2). The highest harvest index (45.21%) was observed in control treatment where the recommended fertilizers dose was applied. Among the tree leaf biomass, the treatment of minjiri gave the highest harvest index (44.92%) and the lowest harvest index (43.68%) was found in treatment eucalyptus (Table 2).

Conclusions

The yield and yield contributing characters of wheat such as plant height (cm), number of effective tillers/hill, spike length (cm), number of spikelets/spike, number of filled grains/spike, grain yield (t/ha), straw yield (t/ha) and biological yield (t/ha) were significantly influenced due to the incorporation of different tree leaf biomasses. From the present study, it was noted that the recommended fertilizer dose always gave the highest yield than tree leaf biomass. On the other hand, among the tree leaf biomasses, the treatment of ipil-ipil was found the best and minjiri was the second best. Leaf biomass is a very important organic resource for soil fertility improvement. It supplies essential nutrients in soil considering important indicators of soil productivity and ecosystem health. We can use tree leaf biomass a source of organic matter for wheat cultivation, as is available in the agroforestry system, significantly reduces a considerable amount of chemical fertilizers. So, it can be concluded that the tree leaf biomass influences on yield and yield contributing characters of wheat. Tree leaf biomass and its effect on yield of wheat cultivation need to be studied further under different locations of Bangladesh along with different cultivar.

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