Bangladesh J. Agri. 2022, 47(2): 44-52 *DOI: https://doi.org/10.3329/bjagri.v47i2.63325*

EFFECTS OF TREE LEAF BIOMASS ON THE YIELD AND ITS YIELD CONTRIBUTING CHARACTERS OF HYBRID RICE

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Abstract

A field experiment was conducted in the Agroforestry Field Laboratory of Bangladesh Agricultural University, Mymensingh during the period from November 2016 to April 2017 to find out the effects of Sadakoroi (*Albizia procera*), Kalokoroi (*Albizia lebbeck*) and Akashmoni (*Acacia auriculiformis*), leaves biomass with different fertilizers dose applications on the yield and yield contributing characters of Chinese Hybrid Rice. There were 10 treatments : T_1 = Sadakoroi (leaf biomass 2 kg /plot) + 15% RFD (Recommended fertilizer dose), T_2= Sadakoroi (leaf biomass 2 kg /plot)+ 30% RFD, T_3 = Sadakoroi (leaf biomass 2 kg /plot)+ 45% RFD, T_4 = Kalokoroi (leaf biomass 2 kg /plot) + 15% RFD, T_5 = Kalokoroi (leaf biomass 2 kg /plot) + 30% RFD, T_6 = Kalokoroi (leaf biomass 2 kg /plot) + 45% RFD, T_7 = Akashmoni (leaf biomass 2 kg /plot) + 15% RFD, T_8 = Akashmoni (leaf biomass 2 kg /plot) + 30% RFD, T_9 = Akashmoni (leaf biomass 2 kg /plot) + 45% RFD and T_{10}= Control (100% RFD). The boro hybrid rice var. SQR6 was used as a test crop. The experiment was conducted in a Randomized Complete Block Design (RCBD) with three replications. The result showed that green leaf biomass had a significant effect on the yield contributing characters. The panicle length varied from 21.0 to 25.5 cm. The number of leaves on hill^{-1} varied from 40.2-25.9. The number of effective tillers on hill^{-1} varied from 12.27-10.63. The highest grain yield of 8.87 t ha^{-1}was obtained from treatment T_{10} followed by 8.77 tha^{-1} noted with T_3 where Sadakoroi leaf biomass was applied. Therefore, this study suggests that the green leaf biomass of Sadakoroi and Kalokoroi can be applied to the improvement of yield and yield contributing characters of rice.

Keywords: Agroforestry**,** Akashmoni, Grain yield, Kalokoroi,

Introduction

Bangladesh's geographic and agronomic conditions favor rice cultivation in the world's fourth-largest rice producer. The average yield of rice is low in Bangladesh only 2.74 to 3.74 t ha^{-1} (BRRI, 2020), compared to other rice-yielding countries like South Korea and Japan where the average yield is 3.51 and 7.57 million metric tons respectively (USDA, 2022).

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In Bangladesh, about 60% of arable soils have below 1.5% organic matter whereas productive mineral soil should have at least 2.5% organic matter (Hussain *et al.,* 2013). Repeated tillage continuously reduces soil organic matter content leading to hard soils. Further, soil particles become compact and are not able to retain nutrients due to repeat and overuse of chemical fertilizers. The combined application of organic and inorganic fertilizers was found to increase the grain yield of rice over organic or inorganic fertilizers applied alone. Leaf biomass is a very vital organic source of soil fertility development. The decay of leaf biomass affects the amount of N availability for plant uptake. Rice plant mostly depends on organic N available in the soil and rice crop intakes about (50-80) % of their N from the soil (Hossain and Islam, 2022). The decay of leaf biomass provisions organic carbon, nitrogen, phosphorous, potassium, and other nutrients to the soil that are further measured as an important indicator of soil productivity and ecosystem health. Different leaf biomass such as Akashmoni, Sakoroi, and Kalokoroi leaves biomass are good sources of organic matter (Khan *et al*., 2021) and can play a vital role in soil fertility development as well as providing nutrients, especially N, P, and K. So, the use of Agroforestry tree leaf biomass as a source of organic matter and other nutrients for agriculture, as available in agroforestry, significantly reduces a considerable number of chemical fertilizers. The decomposition of leaf biomass is a basic and significant part of biological nutrient cycling and food webs of floodplain forests. Decomposition refers to both the physical and chemical breakdown of leaf biomass and the mineralization of nutrients (Asigbaase *et al.,* 2021). Climatic factors influencing litter decomposition rates include soil temperature and soil moisture (Petraglia *et al.*, 2019). Agroforestry is a fitting and flexible technology that is environmentally sound and ecologically stable because it allows trees in the crop field to add organic matter to the soil. Farmers have openings to use these leaves as green manure for rice cultivation and it is easy to cultivate rice with green leaf biomass. In Bangladesh, there is scope for using green leaf biomass in rice cultivation. Green leaf biomass recovers the soil fertility status, increases the nutrient availability in soil, reduces the soil acidity, or has a great impact on soil adjustment and increases the yield of rice. The study aimed to the effect of green leaf biomass of different trees on the growth performance, grain yield, and fertility status of the soil of rice.

Materials and Methods

The experiment was conducted at the Agroforestry Farm, Department of Agroforestry, Bangladesh Agricultural University, Mymensingh during the period from November 2016 to April 2017. Tree leaf biomasses of Sadakoroi (*Albizia procera*), Kalokoroi (*Albizia lebbeck*), and Akashmoni (*Acacia auriculiformis*) were used to evaluate the yield and yield contributing characteristics of modern Rice cv. SQR-6 (Jonok Raj) from Chongqing Zhong Yi Seed Co., Ltd. It grows well in the Rabi season. The total growth duration of this variety ranges from 145-150 days with an average grain yield of 10-12 t/ha Islam *et al*., (2013). The experiment was conducted in a Randomized Complete Block Design (RCBD) with three replications. The total number of plots was 30 and the unit plot size was 5m x 2 m. The spacing between blocks was 60 cm and the plots were separated from each other by 40 cm. The monthly average temperature, humidity rainfall, and total sunshine hours prevailing at the experimental site during the period of study have been collected from Mymensingh.

Treatments

T1 (T1F1) = Kalokoroi + Leaf biomass 2 kg/plot + 15% RFD (Recommended fertilizer dose), T2= (T1F2) Kalokoroi + Leaf biomass 2 kg/plot + 30% RFD, T3(T1F3) = Kalokoroi + Leaf biomass 2 kg/plot + 45% RFD, T4 (T2F1) = Sadakoroi + Leaf biomass 2 kg/plot + 15% RFD, T5 (T2F2) = Sadakoroi + Leaf biomass 2 kg/plot + 30% RFD, T6 (T1F3) = Sadakoroi + Leaf biomass 2 kg/plot + 45% RFD, T7 (T3F1) =Akashmoni + Leaf biomass 2 kg/plot + 15% RFD, T8 (T3F2) = Akashmoni ++ Leaf biomass 2 kg/plot + 30% RFD, T9 (T3F3) = Akashmoni + Leaf biomass 2 kg/plot + 45% RFD and T10= Control (100% RFD).

Tree leaf biomass collection and maintenance

Tree leaf biomasses like Kalokoroi, Sadakoroi, and Akashmoni leaf biomasses were collected from Bangladesh Agricultural University Campus, Mymensingh and chopped by hand, and mixed uniformly with soil during final land preparation and then left to decompose for ten days.

Tree leaf biomass and fertilizer application

Total tree leaves biomass such as *A.procera*, *A.lebbeck*, and *A.auriculiformis* leaves were incorporated in experimental plots before final land preparation. The recommended doses of fertilizer as urea, TSP, gypsum, MoP, and Zine sulfate at the rate of 120, 90, 60, 80, and 10 kg ha^{-1} respectively were applied as basal. Urea was top dressed in three equal splits i.e.,15, 30, and 55 days after transplanting (DAT).

Transplanting of rice seedlings

Thirty-three (33) day-old seedlings of cv. SQR-6 were transplanted on 05 January 2017 with a hill-to-hill and line-to-line distance of 20 cm x 20 cm. Two or three healthy seedlings per hill were used.

Weeds were controlled by uprooting and removing them from the field. The crop was grown under irrigated conditions. Before each top dressing of urea fertilizers, plots were weeded manually.

The crop was harvested at its full maturity. Harvesting was done on 9 May 2017. The plants of individual treatment as tagged previously were separately harvested and threshed as well as yield contributing components.

Recording data and statistical analysis

The plant height was measured with the help of a meter scale from the ground level of the plant to the tip of the leaf. The number of leaves per hill was considered as the leaves present on the hill. The total number of tillers included effective and non-effective tillers. Panicle length was measured from the neck node to the tip of the panicle. One thousand grains were randomly selected from the harvest of each plot. The weight of grains was recorded by an electrical balance and adjusted to a 14% moisture level and converted to grain yield (kg ha-1). The recorded data were compiled and analyzed and the means for all recorded data were calculated. The mean differences were evaluated by Duncan's New Multiple Range Test (DMRT) (Gomez and Gomez, 1984).

Results and Discussion
Plant characteristics of rice
Plant height

Plant height was recorded in three stages such as 30, 60 DAT, and after harvest. At the initial growth stage or 30 DAT, plant height in the treatment was almost similar except for the control (Fig. 1). Heights plant height was observed in the treatment T_{10} (46.26 cm) because recommended fertilizer doses were applied to the soil. The lowest value was found in T_7 (40.52 cm) because Akashmoni leaf biomass with 15% RFD was applied and soil fertility status was also low. The maximum plant height was observed in treatment T_{10} (92.28 cm) where fertilizer supplied sufficient nutrients followed by treatment T_6 (90.15cm) where Akashmoni leaf biomass decomposed and added 45% RFD. The lowest height was observed in treatment T_1 (81.07 cm). AT harvest the maximum plant height of 94.83 cm was observed in the treatment T_{10} because of fertilizer application followed by T_6 (93.37 cm). The lowest height was observed in treatment T_1 (83.63 cm) Akashmoni leaf biomass with 15% RFD was applied. These results are in agreement with that of Win *et al.,* (2019) who reported that the addition of biochar and *Bacillus pumilus* strain TUAT-1 increased plant height significantly.

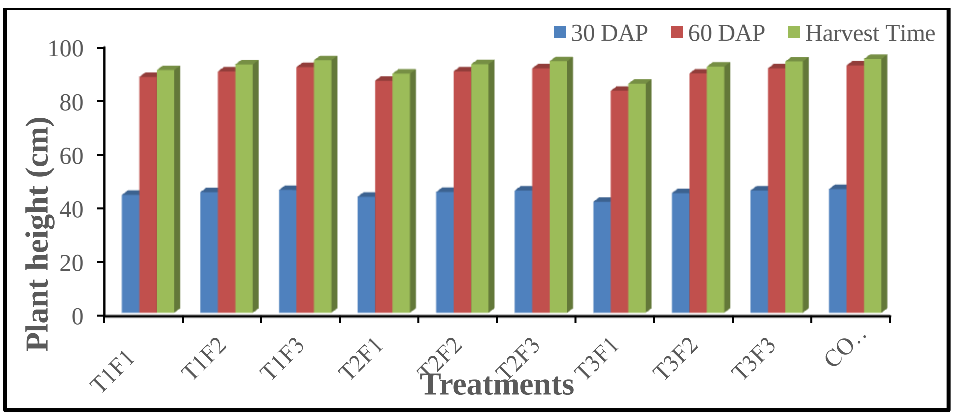

Fig. 1. Plant height of rice due to different treatments

Legend: T1 (T1F1) = Kalokoroi + Leaf biomass 2 kg/plot + 15% RFD (Recommended fertilizer dose), T2= (T1F2) Kalokoroi + Leaf biomass 2 kg/plot + 30% RFD, T3(T1F3) = Kalokoroi + Leaf biomass 2 kg/plot + 45% RFD, T4 (T2F1) = Sadakoroi + Leaf biomass 2 kg/plot + 15% RFD, T5 (T2F2) = Sadakoroi + Leaf biomass 2 kg/plot + 30% RFD, T6 (T1F3) = Sadakoroi + Leaf biomass 2 kg/plot + 45% RFD, T7 (T3F1) =Akashmoni + Leaf biomass 2 kg/plot + 15% RFD, T8 (T3F2) = Akashmoni ++ Leaf biomass 2 kg/plot + 30% RFD, T9 (T3F3) = Akashmoni + Leaf biomass 2 kg/plot + 45% RFD and T10= Control (100% RFD)

Panicle length

The panicle length of rice (cv. SQR6) was significantly influenced by the incorporation of tree leaf biomass. The result showed that the control treatment showed the maximum followed by T_6. The treatment of RFD (T_{10}) produced the highest panicle length of 25.99 cm whereas the lowest panicle length was 20.99 cm from T_7 which was less than all other treatments. These results agree with the report of Wijayanto and Briliawan (2022) that organic manure increased panicle length significantly.

Number of leaves hill^{-1}

The effect of green leaf biomass of different trees on the number of leaves hill^{-1} was non-significant in the treatment T_3 (35.95), and T_9 (36.12) at 30 DAT. At 60 DAT highest value was found in T_{10} (62.00). followed by T_6 (58.33) whereas the lowest was al in treatment T_1 (44.00). Similar results were observed by Islam *et al.*, 2019.

Number of effective tillers hill^{-1}

No. of effective tillers of rice was significantly influenced by the incorporation of tree leaf biomass. The no. of effective tillers varied from 12.27 to 9.72 due to different treatments. The maximum number of tillers was found in RFD (T_{10}) treatment followed by leaf biomass of Sadakoroi+ 45% of RFD. These results were supported by the findings of Bhuiyan *et al.*, (2014).

Table 1. Yield Contributing characters of rice as affected by the incorporation of leaf biomass in the agroforestry system

Treatments	Panicle length (cm)	Leaves/hill^{-1} at 30 DAT	Leaves/hill^{-1} at 60 DAT	Effective tillers hill^{-1}	Non- Effective tillers hill^{-1}
T1:T1F1	22.66e	27.32h	43.67 h	11.01c	1.29e
T2: T1F2	23.01de	32.65e	51.67 e	11.24c	1.59c
T3: T1F3	24.48b	37.37b	58.33 b	11.79b	1.81b
T4: T2F1	22.09f	26.62h	40.00i	10.63d	1.41de
T5: T2F2	22.95de	30.58f	48.33 f	10.99cd	1.77b
T6: T2F3	23.90c	35.49cd	56.33c	11.83b	1.83ab
T7: T3F1	20.99g	25.92hi	39.67i	9.72e	1.35e
T8: T3F2	22.85e	29.35fg	46.67 g	11.01c	1.56cd
T9: T3F3	23.41d	34.49d	54.67d	11.35c	1.79b
T10: Control	25.46a	40.24a	61.00a	12.27a	1.97a
CV (%)	1.18	1.88	1.50	1.94	5.61

Note: Means within the same letter (s) within a column do not differ significantly (P=0.05) according to DMRT.

Legend: T1 (T1F1) = Kalokoroi + Leaf biomass 2 kg/plot + 15% RFD (Recommended fertilizer dose), T2= (T1F2) Kalokoroi + Leaf biomass 2 kg/plot + 30% RFD, T3(T1F3) = Kalokoroi + Leaf biomass 2 kg/plot + 45% RFD, T4 (T2F1) = Sadakoroi + Leaf biomass 2 kg/plot + 15% RFD, T5 (T2F2) = Sadakoroi + Leaf biomass 2 kg/plot + 30% RFD, T6 (T1F3) = Sadakoroi + Leaf biomass 2 kg/plot + 45% RFD, T7 (T3F1) =Akashmoni + Leaf biomass 2 kg/plot + 15% RFD, T8 (T3F2) = Akashmoni ++ Leaf biomass 2 kg/plot + 30% RFD, T9 (T3F3) = Akashmoni + Leaf biomass 2 kg/plot + 45% RFD and T10= Control (100% RFD)

Number of non-effective tillers hill^{-1}

Non-effective tiller was higher in the treatment T_{10} (1.97) whereas lowest in T_1(1.29). The treatments T_3, T_4, T_5, T_9, T_2, and T_8 have no significant differences. Similar results were noted in a study by Barua *et al.*, 2014.

Number tillers hill^{-1}

The number of tillers hill^{-1} of rice (cv. SQR6) was significantly affected by the different treatments. The number of tillers hill^{-1} was initially more or less similar to all treatments. The highest no. of tillers hill^{-1} was found in T_{10} (5) at 30 DAT because of applying REF and the lowest T_7 (3.73) for applying 15% of RFD and leaf biomass of Akashmoni. Treatment T_2, T_6, T_8, T_3, T_5, and T_7 have no significant difference. At 60 DAP, no. of tillers, hill^{-1}of rice has increased where the maximum number of tillers hill^{-1} was found in T_{10} (14.23) followed by T_6 (13.67) applying 45% of RFD and leaf biomass of Sadakoroi whereas the lowest in T_7 (11) were applying 15% of RFD and leaf biomass of Akashmoni. Treatments T_3, T_6, T_2, T_5, and T_9 have no significant difference (Fig. 2). At harvest, the maximum number of tillers hill^{-1} (14) was produced by treatment T_{10} followed by 45% RFD because nutrients were released from Sadakoroi leaf biomass than another leaf biomass. The results are supported by the findings of Bhuiyan *et al.*, (2014).

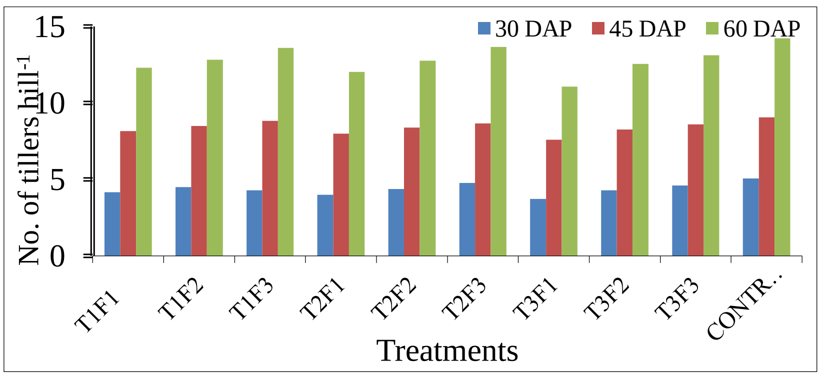

Fig. 2. Number of tillers due to different treatments

Number of spikelet panicle^{-1}

The number of spikelet panicle^{-1} was significantly affected by the different treatments. The number of spikelets panicle^{-1} was divided into three categories such as total, filled, and unfilled. The number of total spikelets in panicle^{-1} varied from 215.13 to 269.07. The highest no. of total spikelet panicle^{-1} (269.07) was found in treatment T_{10} for applying RFD and the lowest one was in treatment T_7 where fertilizer plus 15% leaf biomass of Akashmoni was applied. The treatments were T_2, T_5, T_1, T_4, and T_8 were statistically identical. The highest no. of filled spikelet panicle^{-1} was obtained from the treatment T_{10} (263.07) and the lowest in T_7 (193.07). Unfilled spikelet penile^{-1} was highest in treatment T_7 and lowest in T_{10} (Fig. 3).

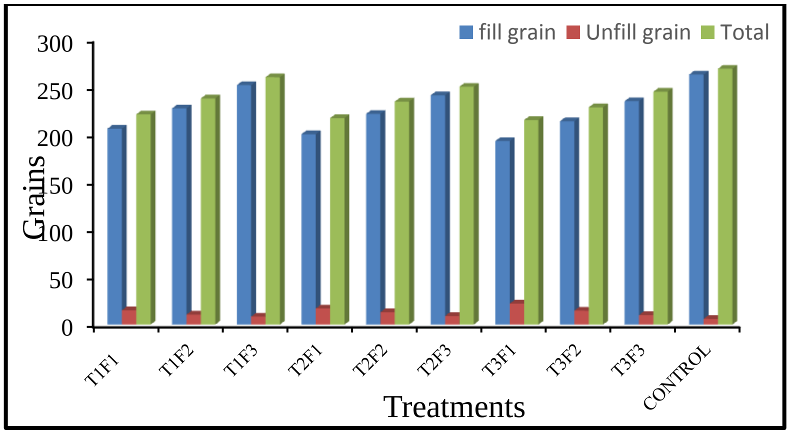

Fig. 3. Grains per panicle rice due to different treatments

1000-grain weight

The maximum fresh weight (34.42 g) of 1000-grain was obtained in treatment T_{10} followed by T_6 (33.48 g). The lowest fresh weight (30.04 g) of 1000 grains was observed in the treatment T_7 plot. Treatments T_3, T_6, and T_9 were statistically significant (Fig. 4). The maximum dry weight (28.40 g) of 1000-grain was obtained in treatment T_{10} followed by treatment of T_3 (28.17 g). The lowest dry weight (23.52 g) of 1000-grain was observed in the treatment T_7 plot. These results are similar to Tian *et al.*, 2017.

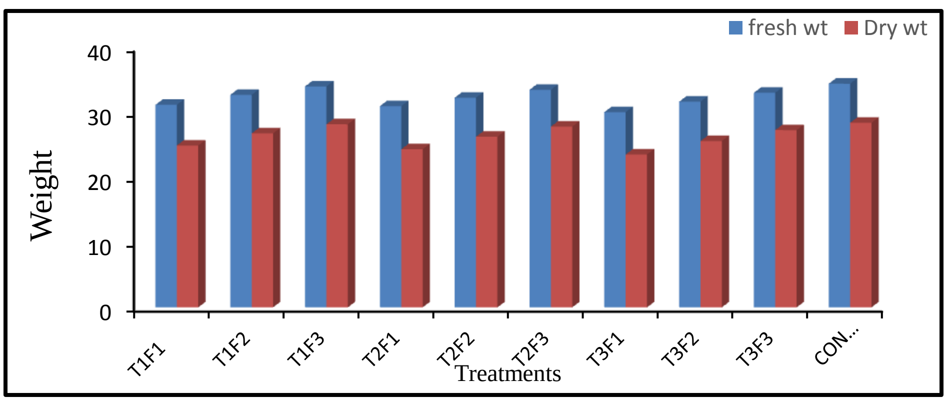

Fig. 4. 1000- grain weight of rice due to different treatments

Grain yield

The highest dry grain yield with the application RFD of rice (cv. SQR6) was found in the treatment T_{10} (8.87 t ha^{-1}) followed by T_7 (8.77 t ha^{-1}) where leaf biomass of Sadakoroi + 45% RFD was applied and the lowest grain yield (7.79 t $ha^{-1)}$ in T_7 (Fig. 5). In Treatment T_{10} and $T_{7,}$ Sadakoroi leaf biomass released nutrients, and 45% RFD applied for that plant got a considerable amount of nutrients which was beneficial for plant growth, development, and physiological process so, grain yield was comparatively better than other Treatments. These results are similar to those of Tian *et al.*, 2017.

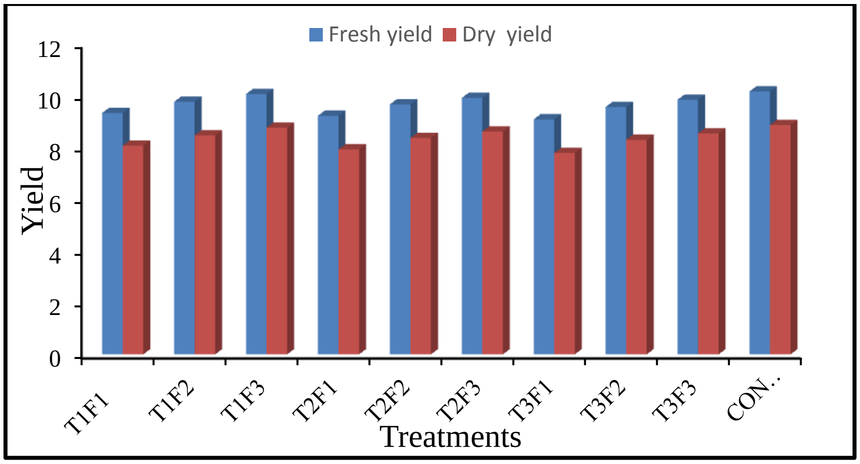

Fig. 5 Grain yield of rice due to different treatments

Legend: T1 (T1F1) = Kalokoroi + Leaf biomass 2 kg/plot + 15% RFD (Recommended fertilizer dose), T2= (T1F2) Kalokoroi + Leaf biomass 2 kg/plot + 30% RFD, T3(T1F3) = Kalokoroi + Leaf biomass 2 kg/plot + 45% RFD, T4 (T2F1) = Sadakoroi + Leaf biomass 2 kg/plot + 15% RFD, T5 (T2F2) = Sadakoroi + Leaf biomass 2 kg/plot + 30% RFD, T6 (T1F3) = Sadakoroi + Leaf biomass 2 kg/plot + 45% RFD, T7 (T3F1) =Akashmoni + Leaf biomass 2 kg/plot + 15% RFD, T8 (T3F2) = Akashmoni ++ Leaf biomass 2 kg/plot + 30% RFD, T9 (T3F3) = Akashmoni + Leaf biomass 2 kg/plot + 45% RFD and T10= Control (100% RFD)

Conclusion

The cultivar SQR6 produced higher grain yield with different doses of RFD, mainly its higher plant height (cm), total number of tillers, number of viable tillers Hill-1, ineffective tillers Hill-1, no. Leaf heel-1, panicle length (cm), number of spikelet panicles-1, full grain panicle-1, incomplete grain panicle-1, and 1000-grain weight (g). It was observed that soil nutrient status improved where green leaf biomass was applied and reduced at low fertilizer levels and maximum grain yield in the control treatment where recommended fertilizer was applied. Rice growth parameters and yield were highest where RFD was applied. Therefore, this study suggests that the green leaf biomass of Sadakoroi and Kalokoroi can be applied to improving soil properties and yielding characteristics of rice.

Conflicts of Interest

The authors declare no conflicts of interest regarding publication of this manuscript.

References

Asigbaase, M., Dawoe, E. L. K., Sjögersten, S. and B. H. Lomax. 2021. Decomposition and nutrient mineralisation of leaf litter in smallholder cocoa agroforests: a comparison of organic and conventional farms in Ghana. *J. of Soils and Sediments*. 21(1):1-14. Doi: 10.1007/s11368-020-02844-4.

Barua, R., Islam, M. N., Zahan, A., Paul, S. and Shamsunnaher. 2014. Effects of Spacing and Number of Seedlings Hill^{-1} on the Yield and Yield Components of BRRI dhan47. *Eco-friendly Agriculture J*. 7(06):65-68.

Bhuiyan, M. S. H., Zahan, A., Khatun, H., Iqbal, M., Alam, F. and M. R. Manir. 2014. Yield performance of newly developed test crossed hybrid rice variety. *Inter. J. of Agro. and Agric.Res*. 5(4):48-54.

BRRI (Bangladesh Rice Research Institute). 2020. http://www.knowledgebank-brri.org/riceinban.php

Gomez, K. A. and A. A. Gomez. 1984. Statistical Procedures for Agricultural Research, 2nd Edition. John Wiley and Sons Inc. Toronto, Canada.

Hossain, M. M. and M. R. Islam. 2022. Farmers' Participatory Alternate Wetting and Drying Irrigation Method Reduces Greenhouse Gas Emission and Improves Water Productivity and Paddy Yield in Bangladesh. Water. 14:1056. Doi: 10.3390/w14071056.

Hussain, M. S., Uddin, M. J. and A. M. Swe. 2013. Assessment of soil quality in Bangladesh with organic carbon as the indicator property. *Dhaka Univ. J. Biol. Sci*. 22(2):163-174. Doi: 10.3329/dujbs.v22i2.46292.

Islam, A., Akhter, N., Rahman, M. S. and M. M. Rahman. 2019. Evaluation of Conventional Cultivars and Hybrid Rice Varieties by Their Morpho-physiological Performance during *Aman* Season. *Annual Res. and Review in Bio*. 34(6):1-8.

Islam, N., Kabir, M. Y., Adhikary, S. K. and M. S. Jahan. 2013. Yield Performance of Six Local Aromatic Rice Cultivars. *IOSR J. Agri. Vet. Sci.* 6(3):58-62.

Khan, A. U., Ema I. J., Afsana, A. S. and A. U. Khan. 2021. Home Garden and Women Participation: A Mini Review. *CRAF*, 2(4):46-52. Doi: http://dx.doi.org/10.18782/2582-7146.152.

Petraglia, A., Cacciatori, C., Chelli, S., Fenu, G., Calderisi, G., Gargano, D., Abeli, T., Orsenigo, S. and M. Carbognani. 2019. Litter decomposition: effects of temperature driven by soil moisture and vegetation type. *Plant Soil*. 435:187-200. Doi: https://doi.org/10.1007/s11104-018-3889-x.

Tian, Z., Li, J., He, X., Jia, X., Yang, F. and Z. Wang. 2017. Grain Yield, Dry Weight and Phosphorus Accumulation and Translocation in Two Rice (*Oryza sativa* L.) Varieties as Affected by Salt-Alkali and Phosphorus. *Sustainability*. 9(8):1461.

USDA (United States Department of Agriculture). 2022. World Agricultural Supply and Demand Estimates. pp.1-40.

Wijayanto, N. and B. Briliawan. 2022. Study on the Growth of Falcatariamoluccana at 14-Month-Old and the Productivity Rice Plant (Oryza sativa) IPB 3S in Agroforestry System. *J. Sylva Lestari.* 10(3):372-388. Doi: https://doi.org/10.23960/jsl.v10i3.573.

Win, K. T., Okazaki, K., Ookawa, T. and Y. Ohwaki. 2019. Influence of rice-husk biochar and *Bacillus pumilus* strain TUAT-1 on yield, biomass production, and nutrient uptake in two forage rice genotypes. *PLoS ONE*. 14(7):e0220236.