Bangladesh J. Agri. 2022, 47(2): 133-142 *DOI: https://doi.org/10.3329/bjagri.v47i2.63332*

EEECT OF TREE LEAF BIOMASS ON SQR6 HYBRID RICE IN AGROFORESTRY SYSTEM

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Abstract

A field experiment was conducted in the Agroforestry Field Laboratory of Bangladesh Agricultural University (BAU), Mymensingh, during the period from November 2016 to April 2017 to find out the response of Rain tree (*Samanea saman*), Ipil-Ipil (*Leucaena leucephala*), and Minjiri (*Senna siamea*), leaves biomass with different fertilizers dose applications to yield and yield contributing character of Chinese Hybrid Rice cv. SQR6. Ten treatments were used for the Randomized Complete Block Design (RCBD) with three replications. The results showed that green LB had a significant effect on crop characters viz., plant height, panicle length, no. of tillers hill^{-1}, no. of leaves hill^{-1}, no. of panicles hill^{-1}, no. of effective tillers hill^{-1}, no. of non-effective tillers hill^{-1}, no. of spikelets panicle^{-1} and 1000-grain weight. The panicle length varied from 22.30 to 25.11 cm. The number of leaves on hill^{-1} varied from 62.00-26.00. The number of effective tillers on hill^{-1} varied from 12.23-10.24 whereas the number of non-effective tillers on hill^{-1} varied from 3.10-1.29. The maximum grain yield of 8.96 t ha^{-1} was obtained from Treatment T_{10} followed by T_6 where Ipil-Ipil of LB with 45% RFD was applied with a grain yield of 8.63 t ha^{-1}. Therefore, this study suggests that the green LB of Ipil-Ipil and Minjiri could be used the improvement of yield contributing characteristics of rice.

Keywords: Agro-forestry, Ipil-Ipil, Minjiri, Rice Yield, Yield attributes

Introduction

Bangladesh is a small country with a large population. The current population of Bangladesh is 165.15 million and the growth rate is 1.22% (BBS, 2022). Most of the people of our country depend on agriculture. Most farmers cannot always afford the high input cost of cultivation or modern high-yielding varieties. Sustainable crop production gets more attention in Bangladesh through the introduction of an agroforestry system, whereby tree litter is used as a supplement and to enhance crop production.

Exhaustive soil farming has worldwide resulted in the degradation of agricultural soils, with decreases in soil organic matter and loss of soil structure, adversely affecting

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soil functioning and causing a long-term threat to future yields (Pagliai *et al.,* 2004). Moreover, intensive tillage operations over a long period cause a detrimental effect on surface soil as well as hastening the decomposition of soil organic matter (Slentel *et al*., 2007).

Organic matter is called the life of the soil and plays an important role in sustainable soil fertility and crop productivity. The organic matter of Bangladesh soils is decreasing day by day. Different tree leaf biomasses such as the Rain tree, Ipil-Ipil, and Minjiri, etc. are good sources of organic matter and can play a vital role in soil fertility improvement as well as supplying nutrients, especially N, P, K, and S (Khan *et al*., 2020). The leaf litter supplies the carbon, nitrogen, phosphorus, potassium, and other nutrients in the soil that are further considered important indicators of soil productivity and ecosystem health. Through decomposition, the nutrients within leaf litter are converted into an available form for uptake by vegetation and thereby exercising a critical control on vegetation productivity (Chatzistathis, and Therios, 2013). In an agroforestry system, nutrients may be released from leaf litter by leaching or mineralization.

Now farmers are more attentive to practicing agroforestry systems in homestead areas, fallow land, etc. In the homestead, there are many trees such as kalo koroi, mahogoni, neem, sada koroi, raintree, krishnochura, and Ipil-Ipil, etc. for various purposes. Farmers have opportunities 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. It is so much proven that decomposed leaves have a good impact on the yield of rice. Besides the farmers can avoid the cost of fertilizer, organic matter, pesticides, etc. The study aimed to the effect of green leaf biomass of different trees on the growth performance, yield, and physical and chemical properties of Chinese hybrid rice.

Materials and Methods

Experimental site and design

The experiment was conducted at the Agroforestry Farm, Department of Agroforestry, Bangladesh Agricultural University (BAU), Mymensingh from November 2016 to May 2017 of AEZ-09 (Old Brahmaputra Floodplain). The experiment was conducted in a Randomized Complete Block Design (RCBD) with three replications.

Test variety

Rice cv. SQR6 (Jonok Raj) a modern variety of rice, was used as the test crop in this experiment. The variety was released from Chongqing Zhong Yi Seed Co., Ltd.

Treatments and the tree LB collection

The treatments as the tree LB like Rain tree (*S. saman*), Ipil-Ipil (*L. leucephala*), and Minjiri (*S. siamea*) LB with 15, 30, and 45% RFD and the LB were collected from the trees of BAU, Mymensingh (Table 1). These LB were chopped by hand and mixed uniformly with soil during final land preparation and then left to decompose for ten days.

Table 1. Treatments of the study

Treatments	Dose
T1 = Raintree	LB 2 kg /plot + 15% RFD
T2 = Raintree	LB 2 kg/plot + 30% RFD
T3 = Raintree	LB 2 kg/plot + 45% RFD
T4 = Ipil-Ipil	LB 2 kg/plot + 15% RFD
T5 = Ipil-Ipil	LB 2 kg/plot + 30% RFD
T6 = Ipil-Ipil	LB 2 kg/plot + 45% RFD
T7 = Minjiri	LB 2 kg/plot + 15% RFD
T8 = Minjiri	LB 2 kg/plot + 30% RFD
T9 = Minjiri	LB 2 kg/plot + 45% RFD
T10= Control (100% RFD)	-

Note: RFD=Recommended fertilizer dose, LB= Leaf biomass

Tree leaf biomass and fertilizer application

The whole amount of various tree LB such Ipil-Ipil, Minjiri, and Rain tree leaves were incorporated in experimental plots before final land preparation. The recommended doses of all fertilizers were applied in control plots during final land preparation. Urea was top dressed in three equal splits i.e.,15, 30, and 55 days after transplanting (DAT).

Chinese transplanting and method of seedlings

Thirty-three (33) day-old seedlings of cv. SQR-6 was collected from the Agronomy Field of BAU. Seedlings were uprooted with care from the slightly irrigated seedbed and transplanted on 05 January 2017 with a hill-to-hill and line-to-line distance of 20cm x 20cm and 33cm distance after two rows.

Harvesting and yield data collection

Harvesting was done on 9 May 2017 at its full maturity. The plants of individual treatment as tagged previously were separately harvested and threshed as well as yield contributing components as per requirement for each treatment. The ten hills were randomly selected from each plot at maturity to record the yield and yield contributing characters.

Recording data

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

Characteristics of rice

Plant height

Plant height was recorded in three stages such as 30, 60 DAT, and after harvest (Fig. 1). At the initial growth stage or 30 DAT, the height plant was noted in 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 Raintree LB with 15% RFD was applied where soil fertility status was also low. At 60 DAP, the height plant was observed in treatment T_{10} (92.28) cm and followed by treatment T_6 (90.15) cm where Raintree, LB decomposed and added 45% RFD. The lowest height was observed in treatment T_1 (81.07) cm. At the final growth stage or harvest stage, the highest plant height of 94.83cm was observed in the treatment T_{10} because of RFD. The second highest plant height in T_6 (93.37) cm where Raintree, LB decomposed and added 45% RFD. The lowest height was observed in treatment T_1 (83.63) cm Raintree LB with 15% RFD 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.

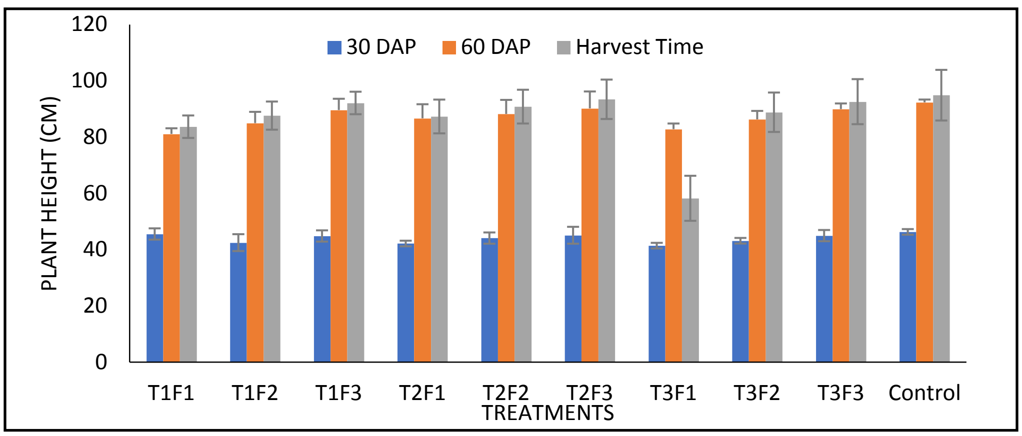

Fig. 1. Plant height of rice in different treatments

Note: T1F1=Raintree (LB 2 kg/plot) + 15% RFD, T1F2= Raintree (LB 2 kg/plot) + 30% RFD, T1F3= Raintree (LB 2 kg/plot) +45% RFD, T2F1=Ipil-Ipil (LB 2 kg/plot) + 15% RFD, T2F2=Ipil-Ipil (LB 2 kg/plot) + 30% RFD, T2F2=Ipil-Ipil (LB 2 kg/plot) +45 % RFD, T3F1=Minjiri (LB 2 kg/plot) + 15% RFD, T3F2=Minjiri (LB 2 kg/plot) + 30% RFD and T3F3=Minjiri (LB 2 kg/plot) +45 % RFD

The number of leaves per hill

The effect of green LB of different trees on the number of leaves on hill^{-1} varied from (41.56-26.00, and 62.00-44.00) in the treatment of T_{10} and T_1 at 45 and 60 DAT, respectively (Table 2). The highest number of leaves hill^{-1} was observed in T_6 (38.43) because Ipil-Ipil LB with 45% RFD and the lowest number of leaves hill^{-1} was observed in T_1 (26.00). The highest number of leaves hill^{-1} was observed in T_6 (58.33) because of Ipil-Ipil LB with 45% RFD and the lowest in the treatment T_1 (44.00). Similar results were observed by Islam *et al*., 2019 and the number of tillers on hill^{-1} varied from 11.67- 21.00.

Panicle length

The panicle length of rice (cv. SQR6) was significantly influenced by the incorporation of tree LB. The control treatment produced the maximum length of panicle followed by (T_6). The panicle length varied from 22.30 to 25.11 cm (Table 2). The treatment of RFD (T_{10}) produced a panicle length of 25.11 cm followed by 24.59, 24.41, 24.21, 24.08, 23.87, 23.77, 23.46, and 22.92 in the treatments of (T_6, T_9, T_3, T_5, T_8, T_2, T_4, T_7). The lowest panicle length was 22.30 cm in the treatment of T_1.

The number of effective tillers per hill

The number of effective tillers of rice was significantly influenced by the incorporation of tree LB which varied from 12.27 to 10.24 in T_{10} and T_1 due to different treatments (Table 2). The highest number of tillers was found at 11.82 in the treatment of T_9 because of the use of Minjiri LB with 45% RFD and the lowest number of tillers was found at 10.24 in T_1. These results were supported by the findings of Bhuiyan *et al*., 2014.

The number of non-effective tillers per hill

The non-effective tiller hill^{-1} varied from 2.10 to 1.29 (Table 2). The non-effective tiller was higher in the treatment T_9 (1.88) and the lowest number of non-effective tillers was T_1 (1.29) in the LB. The treatments T_3, T_4, T_5, T_9, T_2, and T_8 have no significant differences.

Table 2. The effect of leaf biomass on vegetative characteristics of rice production provenance and spacing in agroforestry systems

Treatments	No. of leaves hill^{-1} 45 DAT	No. of leaves hill^{-1} 60 DAT	Panicle length (cm)	Effective tillers hill^{-1}	Non-effective tillers hill^{-1}
T1F1	26.00h	44.00h	22.30i	10.24f	1.29f
T1F2	30.50f	50.33ef	23.77f	11.38bcd	1.59d
T1F3	35.95d	55.67c	24.21cd	11.92ab	1.84c
T2F1	27.92g	48.00fg	23.46g	11.45bcd	1.45e
T2F2	32.60e	54.00cd	24.08de	11.32cde	1.81c
T2F3	38.43b	58.33b	24.59b	12.13a	1.97b
T3F1	27.10g	46.67g	22.92h	10.79ef	1.41e
T3F2	30.90f	52.33de	23.87ef	10.95de	1.68d
T3F3	36.12cd	56.00bc	24.41bc	11.82abc	1.88bc
Control	41.56a	62.00a	25.11a	12.23a	2.10a
CV%	2.76	2.92	0.52	2.86	3.44
Significance Level	**	**	**	**	**

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

T1F1=Raintree (LB 2 kg/plot) + 15% RFD, T1F2= Raintree (LB 2 kg/plot) + 30% RFD, T1F3= Raintree (LB 2 kg/plot) +45% RFD, T2F1=Ipil-Ipil (LB 2 kg/plot) + 15% RFD, T2F2=Ipil-Ipil (LB 2 kg/plot) + 30% RFD, T2F2=Ipil-Ipil (LB 2 kg/plot) +45 % RFD, T3F1=Minjiri (LB 2 kg/plot) + 15% RFD, T3F2=Minjiri (LB 2 kg/plot) + 30% RFD and T3F3=Minjiri (LB 2 kg/plot) +45 % RFD

The number of tillers per hill

The number of tillers hill^{-1} of rice (cv. SQR6) was significantly affected by the different treatments (Fig. 2). The maximum number of tillers hill^{-1} was found in T_{10} (7.07) at 30 DAT because of applying RFD followed by 6, 5.63, 5.33, 5.13, 4.73, 4.70, 4.57, and 4.17 in the treatment of T_6, T_9, T_3, T_5, T_2, T_8, T_4, and T_7. The lowest T_1 (3.83) for applying Raintree LB with 15% of RFD at 30 DAT. The maximum number of tillers hill^{-1} was found in T_{10} (13.33) at 45 DAT because of applying RFD followed by 13.00, 12.77, 12.53, 12.07, 11.90, 11.77, 11.50, and 11.13 in the treatment of T_6, T_9, T_3, T_5, T_2, T_8, T_4, and T_7. The lowest T_1 (9.8) for applying Raintree LB with 15% of RFD at 45 DAT. The maximum number of tillers hill^{-1} was found in T_{10} (14.33) at 60 DAT because of applying RED followed by 14.10, 13.77, 13.70, 13.13, 12.97, 12.90, 13.63, and 12.20 in the treatment of T_6, T_3, T_9, T_5, T_2, T_4, T_8, and T_7. The lowest T_1 (11.53) for applying Raintree LB with 15% of RFD at 60 DAT. The results are supported by the findings of Bhuiyan *et al*., 2014.

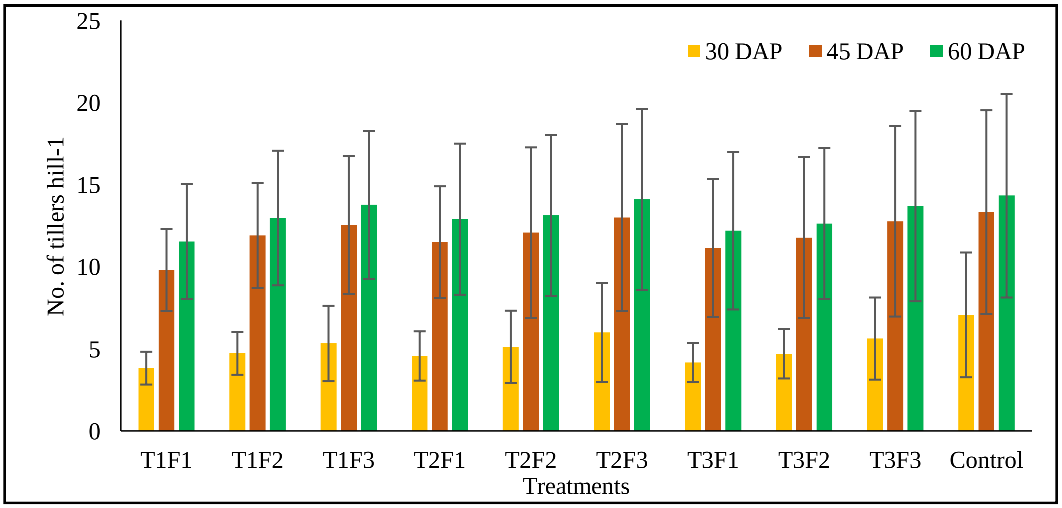

Fig. 2. Number of tillers in different treatments

Note: T1F1=Raintree (LB 2 kg/plot) + 15% RFD, T1F2= Raintree (LB 2 kg/plot) + 30% RFD, T1F3= Raintree (LB 2 kg/plot) +45% RFD, T2F1=Ipil-Ipil (LB 2 kg/plot) + 15% RFD, T2F2=Ipil-Ipil (LB 2 kg/plot) + 30% RFD, T2F2=Ipil-Ipil (LB 2 kg/plot) +45 % RFD, T3F1=Minjiri (LB 2 kg/plot) + 15% RFD, T3F2=Minjiri (LB 2 kg/plot) + 30% RFD and T3F3=Minjiri (LB 2 kg/plot) +45 % RFD

The Number spikelet per panicle

The number of spikelet panicle^{-1} was significantly affected by the different treatments. The number of spikelet panicle^{-1} was divided into three categories such as total, filled, and unfilled. The number of total spikelets in panicle^{-1} varied from 265.27 to 291.87. The highest number of total spikelet panicle^{-1} was found in the treatment T_{10} (291.87) for applying RFD and followed by 288, 281.27, 280.07, 279.67, 267.73, and 267.70 in the treatments of T_6, T_9, T_3, T_5, T_2, and T_4, and T_7, respectively. The lowest one in the treatment T_1 (265.27) where fertilizer plus 15% LB of Raintree was applied. The highest number of filled spikelet panicle^{-1} ^{was} obtained from the treatment T_{10} (277.67) and the lowest in T_1 (220.70). The unfilled spikelet panicle^{-1} was highest in treatment T_7 (44.57) and the lowest in T_{10} (14.20) (Fig. 3).

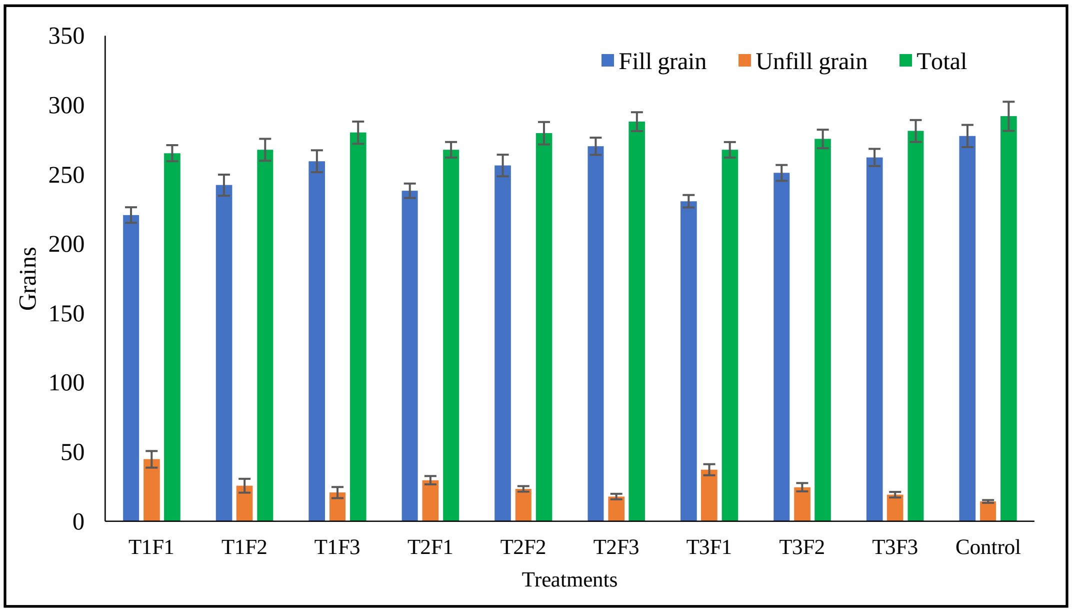

Fig. 3. Grain performance of spikelet rice in different treatments

Note: T1F1=Raintree (LB 2 kg/plot) + 15% RFD, T1F2= Raintree (LB 2 kg/plot) + 30% RFD, T1F3= Raintree (LB 2 kg/plot) +45% RFD, T2F1=Ipil-Ipil (LB 2 kg/plot) + 15% RFD, T2F2=Ipil-Ipil (LB 2 kg/plot) + 30% RFD, T2F2=Ipil-Ipil (LB 2 kg/plot) +45 % RFD, T3F1=Minjiri (LB 2 kg/plot) + 15% RFD, T3F2=Minjiri (LB 2 kg/plot) + 30% RFD and T3F3=Minjiri (LB 2 kg/plot) +45 % RFD

1000-grain weight

The highest fresh weight varied from 35.00 to 29.00 g of 1000-grains (Fig. 4). The maximum fresh weight was 35.00 in T_{10} and followed by 33.83, 33.13, 32.53, 32.17, 31.80, 31.77, 30.97, and 30.10 in the treatment of T_6, T_9, T_3, T_2, T_5, T_8, T_7, and T_4, respectively. The lowest fresh weight was 35.00 in T_1. The higher dry weight varied from 26.97 to 23.23 g of 1000-grains. The maximum fresh weight was 26.97 g in T_{10} and followed by 26.17, 25.93, 25.60, 25.30, 25.13, 24.90, 24.53, and 23.83 in the treatment of T_6, T_9, T_3, T_2, T_5, T_8, T_7, and T_4, respectively. The lowest fresh weight was 23.23 in T_1. These results are in agreement with that of Tian *et al*., 2017.

Grain yield

The maximum dry grain yield with the application RFD of rice was found in the treatment T_{10} (8.96 t ha^{-1}) followed by 8.63, 8.46, 8.15, 7.59, 7.11, 6.60, 6.47, and 6.16, in the treatment of T_6, T_9, T_3, T_5, T_8, T_2, T_4, and T_7. The lowest yield (5.87) t ha^{-1} was found in T_1 (Fig. 5). The maximum fresh grain yield with the application RFD of rice.

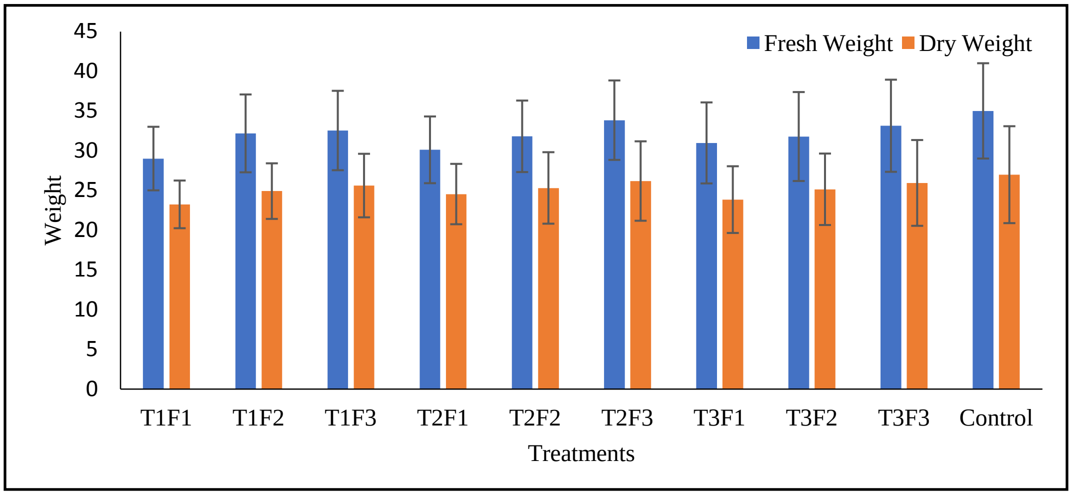

Fig. 4. 1000- grains weight of rice in different treatments

Note: T1F1=Raintree (LB 2 kg/plot) + 15% RFD, T1F2= Raintree (LB 2 kg/plot) + 30% RFD, T1F3= Raintree (LB 2 kg/plot) +45% RFD, T2F1=Ipil-Ipil (LB 2 kg/plot) + 15% RFD, T2F2=Ipil-Ipil (LB 2 kg/plot) + 30% RFD, T2F2=Ipil-Ipil (LB 2 kg/plot) +45 % RFD, T3F1=Minjiri (LB 2 kg/plot) + 15% RFD, T3F2=Minjiri (LB 2 kg/plot) + 30% RFD and T3F3=Minjiri (LB 2 kg/plot) +45 % RFD

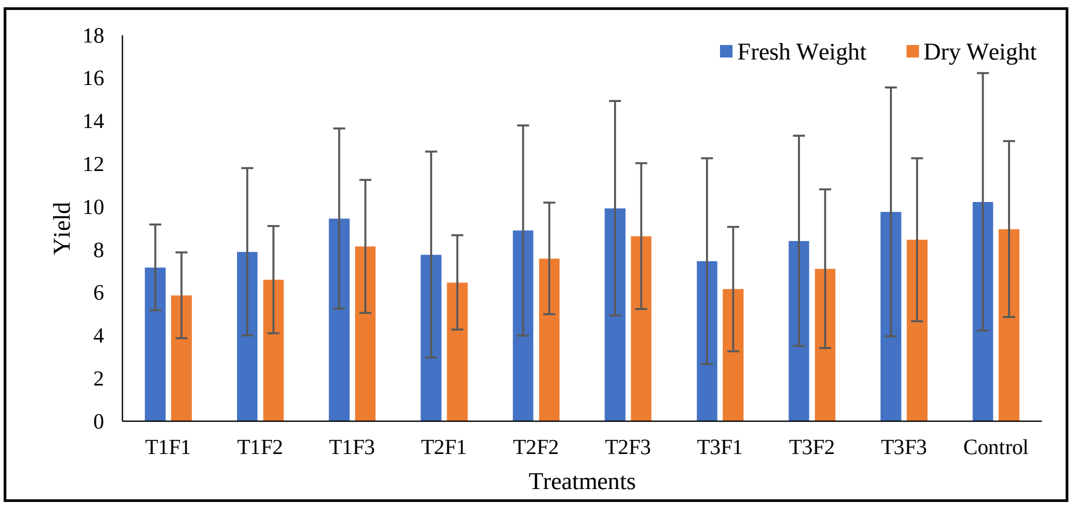

Fig. 5. Grain yield of rice in different treatments

Note: T1F1=Raintree (LB 2 kg/plot) + 15% RFD, T1F2= Raintree (LB 2 kg/plot) + 30% RFD, T1F3= Raintree (LB 2 kg/plot) +45% RFD, T2F1=Ipil-Ipil (LB 2 kg/plot) + 15% RFD, T2F2=Ipil-Ipil (LB 2 kg/plot) + 30% RFD, T2F2=Ipil-Ipil (LB 2 kg/plot) +45 % RFD, T3F1=Minjiri (LB 2 kg/plot) + 15% RFD, T3F2=Minjiri (LB 2 kg/plot) + 30% RFD and T3F3=Minjiri (LB 2 kg/plot) +45 % RFD SQR6) was found in the treatment T_{10} (10.23 t ha^{-1}) followed by 9.93, 9.76, 9.45, 8.89, 8.41, 7.90, 7.77, and 7.46 in the treatment of T_6, T_9, T_3, T_5, T_8, T_2, T_4, and T_7. The lowest yield (7.17) t ha^{-1} was found in T_1. These results are similar to Tian *et al.*, 2017.

Conclusion

The Chinese cultivar SQR6 produced a much higher grain yield than inbred rice cultivars at similar leaf biomass with dissimilar doses of RFD rate, due mainly to improve rice yielding characteristics per unit area caused by more rice yield per panicle in leaf biomass. The outcome of the experiment exposes that the growth parameter and yield of rice gave the highest value in the Ipil-Ipil leaf biomass. It is experiential that soil nutrient status was amended where green leaf biomass was applied and reduced fewer fertilizer doses were applied and the highest yield in the control treatment where endorsed fertilizer doses were practical. The growth parameter and yield of rice were highest in the treatment where RFD was applied. Therefore, this study proposes that the green leaf biomass of Ipil-Ipil and Minjiri can smear to the development of soil properties and yield contributing characteristics of rice.

Conflicts of Interest

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

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