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Integrated use of raintree leaves with urea on BRRI dhan 41 rice

Md. Raju Ahmad[1]*, Md. Azam Uddin[2], Md. Anwarul Islam Juwel[3], Tahamina Sultana[4], Md. Abul Hashem[5], Abu Zofar Md. Moslehuddin[5]

[1]Horticulture Centre, Horticulture Wing, Department of Agricultural Extension, Gulshan, Dhaka, Bangladesh
[2]Department of Agricultural Extension, Planning, Project Implementation & ICT Wing, Khamarbari, Dhaka-1215, Bangladesh
[3]Pesticide Regulation Officer, Department of Agriculture Extension, Khamarbari, Dhaka-1215, Bangladesh
[4]Faculty of Agriculture, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
[5]Department of Soil Science, Faculty of Agriculture, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh

ABSTRACT

A field Experiment was carried out at the Soil Science Field Laboratory of Bangladesh Agricultural University, Mymensingh during the aman season of 2008 to study the effect of integrated use of raintree (*Albizia saman)* leaves with urea on BRRI dhan 41 rice. The experiment was laid out in a randomized complete block design with seven treatments and three replications. The treatments were; T_1: Control, T_2: Recommended Fertilizer Dose (RFD), T_3: 80% Recommended Dose of Nitrogen (RDN) from urea + 20% RDN from raintree leaves, T_4: 60% RDN from urea + 40% RDN from raintree leaves, T_5: 40% RDN from urea + 60% RDN from raintree leaves, T_6: 20% RDN from urea + 80% RDN from raintree leaves and T_7: 100% RDN from raintree leaves. The raintree leaves were applied 10 days before transplanting of rice seedlings. The recommended doses of chemical fertilizers applied were 80 kg N, 15 kg P, 50 kg K, 12 kg S and 2 kg Zn ha^{-1}. N, P, K, S and Zn were applied as urea, TSP, MoP, Gypsum and ZnO respectively. Yield contributing characters of BRRI dhan 41 like plant height, number of tillers $hill^{-1}$, panicle length, number of grains $panicle^{-1}$and 1000-grain weight were significantly influenced by the treatments. The results of the study indicated that most of the yield contributing characters was the maximum in treatment having 60% RDN from urea + 40% RDN from raintree leaves. The grain and straw yields of BRRI dhan 41 were also significantly influenced by the treatments. The maximum grain yield of 5.04 t ha^{-1} was observed in treatment T_4 (60% RDN from urea + 40% RDN from raintree leaves) and the minimum of 3.64 t ha^{-1} was in treatment T_1 (control). Nitrogen contents in BRRI dhan 41 rice and its uptake were significantly increased by the treatments. The results indicated that the use of 60% RDN from urea and 40% RDN from raintree leaves had a better performance on the nitrogen content, nitrogen uptake and yields of BRRI dhan 41 rice.

Key words: Raintree, urea., BRRI dhan 41.

*Corresponding author.
E-mail address: mdhmd62@gmail.com (MR Ahmad)

INTRODUCTION

Agriculture in Bangladesh is dominated by intensive rice (*Oryza sativa* L.) cultivation. Globally, rice is the second most important cereal crop next to wheat in terms of area but as food it is the most important since it provides more calories than any other cereals. Rice is the staple food of Bangladesh and geographical situation as well as the climate and edaphic conditions are favorable for year round rice cultivation. Although Bangladesh ranks 4^{th} in the world in terms of both acreage and production but the yield of rice is much lower (2.35 t ha^{-1}) compared to that in other leading rice growing countries such as China (6.23

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t ha^{-1}), Korea (6.59 t ha^{-1}), Japan (6.7 t ha^{-1}) and USA (7.04 t ha^{-1}) (FAO, 2004).

Fertilizers are indispensable for the crop production systems of modern agriculture. Chemical fertilizers today hold the key to the success of the crop production systems of Bangladesh agriculture, being responsible for about 50% of the total production (BARC, 1997). Nitrogen is the key element which plays a vital role in vegetative growth, development of yield components and yield of rice (BRRI, 1990). But continuous use of N fertilizer alone to the soil had a deleterious effect on soil productivity and a steadily declining trend in rice productivity associated mainly within the loss of inherent soil fertility (Nambiar et al., 1998). The important role of nitrogen fertilizers in increasing yield has been widely recognized, particularly after the development of modern varieties. There are two sources of N, inorganic (chemical fertilizers) and organic (soil organic matter, biological nitrogen fixation, crop residues and other organic wastes).

The farmers of Bangladesh apply urea as a main source of nitrogen. But the efficiency of applied N in rice is very low. Of all the nutrients required for plant growth, N is by far the most mobile and subject to loss from the soil-plant system through denitrification, NH_3 volatilization, leaching and erosion. Even under the best circumstances, no more than two thirds of the N added as fertilizer can be accounted for crop removal or in the soil at the end of growing season; losses of as much as one-half are not uncommon (Stevnson, 1985). The production of nitrogenous fertilizers requires large amounts of natural gas, coal, petroleum, all non-renewable energy sources. Nitrogen fertilizers, therefore, are expensive inputs costing agriculture more than 45 billion US $ per year (Ladha et al., 1997). Large addition of those fertilizers contributes to environmental pollution. Moreover, long-term intensive use of chemical fertilizers creates some fertility problems through interactions with other elements (Rahman and Abedin Mian, 1997).

Considering the high cost and toxicity of chemical fertilizer, it would be better to use natural organic fertilizer to minimize fertilizer cost and environmental pollution by reducing the dependence on chemical fertilizer. Generally annual legume crops are used as green manure throughout the world. Green manuring can also be practiced through the application of leaves and twigs from perennial legume trees. The trees can be grown along with field crops or alone and prunings can be incorporated to supply N and organic matter. Among them, raintree is quick growing and biomass producing legume tree. It is very common in Bangladesh and its leaves and twigs contain substantial amounts of N, P, K, S and other micronutrients. Raintree leaves can be used in soil as green or brown manure to increase soil and crop productivity (Haque et.al., 1999). The use of raintree leaves and their proper management may reduce the need for chemical fertilizers allowing the small farmers to save a part of the cost of production. The integrated use of fertilizer and manure is quite promising not only in providing greater stability in production, but also in maintaining soil fertility (Nambiar, 1991). BRRI dhan 41 rice, is one of the modern varieties of *T. aman* rice developed by the Bangladesh Rice Research Institute (BRRI), Gazipur in 2003 and was released by the national Seed Board (NSB) in the same year. This variety was developed from the crossing between BR 23 and BR1185-2B-16-1. In the light of the above, the present research work was undertaken with aims to study the effect of integrated use of raintree leaves with urea on growth and yields of BRRI dhan 41 rice and determine the nitrogen content and uptake by BRRI dhan 41 rice.

MATERIALS AND METHODS

Experimental site

The experiment was conducted in the farm soil of the Soil Science Field Laboratory of Bangladesh Agricultural University, Mymensingh, during the aman season of 2008. Geographically it is situated at 24.75°N latitude and 90.50^0E longitude at an altitude of 18 m above the mean sea level.

Soil

The land of experimental field was medium high, belonging to the Sonatala soil series of Non-calcareous Dark Grey Floodplain Soil under the Agro Ecological Region of Old Brahmaputra

Floodplain. The soil belongs to order Inceptisol having only few horizons, developed under aquic moisture regime and variable temperature regime. The physical properties of the initial soil were **s**and (12.6 %), silt (76.3%), clay (11.1%) and textural class silt loam.

Table 1
Chemical properties of the initial soil

Constituents	Values
pH (soil: water = 1:2.5)	6.63
Organic carbon (%)	0.95
Organic matter (%)	1.62
Total nitrogen (%)	0.17
Available phosphorus (ppm)	12.2
Available sulphur (ppm)	13.8
Exchangeable potassium (cmole kg^{-1}soil)	0.11
Cation Exchange Capacity (cmole kg^{-1}soil)	14.9

Climate

The climatic condition of the experimental area is characterized by high temperature, humidity and heavy rainfall with occasional gusty wind during kharif season and low rainfall accompanied by moderately low temperature and humidity during rabi season.

Experimental procedure

Land preparation

The experimental field was first opened on 08 August 2008, with the help of a power tiller. Later, the land was saturated with irrigated water and prepared by three successive ploughings and cross-ploughings. Each ploughing was followed by laddering to have a good tilth. All kinds of weeds and residues of previous crop were removed from the field. The experimental plots were laid out as per treatment and design.

Raising of seedlings

A common procedure was followed in raising of seedlings in the seed bed. For this purpose a previously prepared well leveled land was selected. The nursery bed was prepared by puddling the wetland with repeated ploughing followed by laddering. The seeds were dipped in water for about 21 hours and there after these were taken out and kept in shade in two moist gunny bags for sprouting. At the expiry of three days, seeds were broadcast on the prepared seedling nursery. The seeds were sown as uniformly as possible and covered with a thin layer to fine earth. Then two irrigations were gently provided to the seed bed.

Treatments

There were 7 treatments out of which one control treatment in which no fertilizer was used, one contained inorganic fertilizer only, one contained raintree (*Albizia saman)* leaves only, four included raintree leaves with fertilizer having different recommended dose of N (RDN). The treatment combinations for the experiment were as follows:

T_1: Control (No fertilizer)
T_2: Recommended Fertilizer Dose (RFD)
T_3: 80% Recommended Dose of N (RDN) from urea + 20% RDN from raintree leaves
T_4: 60% RDN from urea + 40% RDN from raintree leaves
T_5: 40% RDN from urea + 60% RDN from raintree leaves
T_6: 20% RDN from urea + 80% RDN from raintree leaves
T_7: 100% RDN from raintree leaves

Design and layout of the experiment

The experiment was laid out in a randomized complete block design (RCBD) with three replications. Unit blocks were separated from one another by 0.5 m drains. Each block was sub-divided into seven unit plots. The treatments were randomly distributed to the unit plots in each block. The total number of plots was 21 (7 × 3). The unit plot size was 2.5 m × 4 m. The spacings between plots were 0.25 m.

Application of raintree leaves and fertilizers

The full dose of triple super phosphate (TSP), muriate of potash (MoP), gypsum and zinc oxide (ZnO) were applied before transplanting as basal dose to all the experimental plots except control plots. The amounts N (4.0%), P (0.07%), K (1.36%) in raintree leaves were also deducted from recommended N, P, K doses.

Transplanting of seedlings

Thirty five days old seedlings were carefully uprooted from a seedling nursery and transplanted on the 18 August, 2008 in the well puddled plot maintaining plant spacing of 20 cm x 20 cm. Three healthy seedlings were transplanted in each hill. Gap filling was done 8 days after transplanting to maintain a uniform plant population and density in each plot.

Intercultural operations

Intercultural operations were done for ensuring and maintaining the normal growth of the crop (Table 2). Necessary irrigation was provided in the experimental plots from the deep tubewell as and when required during the growing period of rice crop. The experimental plots were infested with some common weeds, which were removed by uprooting from the field 3 times during the period of the experiment. There was no infestation of insects, pests and diseases in the field and so no control measure was required.

Table 2
Intercultural operations done during the field study

Intercultural operations	Date
First ploughing of the field	04.08.2008
Second ploughing and laddering	06.08.2008
Third ploughing and application of raintree leaves	08.08.2008
Fourth ploughing and laddering	13.08.2008
Final ploughing, plot preparation and application of fertilizers (TSP, MoP, gypsum and zinc sulphate).	16.08.2008
Transplanting of seeding (BRRI Dhan 41)	18.08.2008
First split application of urea	03.09.2008
First weeding	07.09.2008
Second split application of urea	18.09.2008
Second weeding	23.09.2008
Third split application of urea	03.10.2008
Harvesting and Threshing	18.12.2008

The crop was harvested at maturity. The harvested crop was threshed plot-wise. Grain and straw yields were recorded plot-wise and moisture percentage was calculated after sun drying. Dry weight of both grain and straw were recorded and expressed as t ha^{-1} on sun dry basis. Grain and straw samples were preserved for chemical analysis.

Recording of yield components and yield

The data were recorded on yield and yield components of rice. The yield components plant height, number of tillers hill-1, and number of effective tillers hill-1, panicle length, grains panicle-1 and 1000-grain weight were measured according to the standard procedure described elsewhere. Grain and straw obtained from each plot were dried and weighed carefully. The yields were expressed as t ha-1 on 14% moisture basis. Biological yield was calculated by using the following formula:

Biological yield = Grain yield + Straw yield

Analysis of the initial soil

The initial soil samples were analyzed for both physical and chemical properties in the laboratory of the Department of Soil Science, Bangladesh Agricultural University, Mymensingh. The particle-size analysis (Piper, 1950), pH (Jackson, 1962), organic matter content (Walkley and Black, 1934), total N (micro-kjeldahl method- Page et. al., 1989), available P (Olsen et al., 1954), exchangeable K (Black, 1965), available S (Page et. al. (1989) and cation exchange capacity (Jackson 1962) were performed according to the procedure described by respected authors mentioned against each properties.

Chemical analysis of plant samples

Digestion and determination of total nitrogen from plant samples

For the determination of nitrogen 0.1g of oven dried ground plant sample (for both grain and straw) was taken in a micro-kjeldahl flask. 1.1 g of catalyst mixture (K_2SO_4: $CuSO_4$. $5H_2O$: Se powder = 100:10:1), 3 ml of 30% H_2O_2 and 5ml of conc.

H_2SO_4 were added into the flask. The flask was swirled and allowed to stand for about 10 minutes. Then the flask was heated until the digest become colorless. After cooling the digest was transferred into a 100 ml volumetric flask and the volume was made up to the mark with distilled water. A reagent blank was prepared in a similar way. The digest was used for determination of nitrogen.

Nitrogen content in the digest was determined by similar method as described in soil analysis.

After chemical analysis of straw and grain samples, the nitrogen uptake was calculated from the nitrogen content and yield of rice crop by the following formula:

$$\text{Nitrogen uptake} = \frac{(\text{Nitrogen content }(\%) \times \text{Yield (kg ha}^{-1}))}{100}$$

Statistical analysis

The analysis of variance for crop characters and also for the nitrogen content and nitrogen uptake by the grain and straw were done following the ANOVA technique and the mean results in case of significant F value were adjudged by the Duncan's Multiples Range Test (DMRT) (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Yield contributing characters

Plant height

The plant height of BRRI dhan 41 rice was significantly influenced by the different treatments. All the treatments significantly increased the plant height over control (Table 3). The plant height ranged from 91.5 to 116.1 cm. The highest plant height was recorded in the treatment T3 (80% RDN from urea + 20% RDN from raintree leaves) while the second highest value (113.2 cm) was recorded in the treatment T2 (RFD) and the lowest plant height was found in the treatment T1 (control). The treatment T5 (40% RDN from urea + 60% RDN from raintree leaves) and T6 (20% RDN from urea + 80% RDN from raintree leaves) produced plant height which were statistically similar. The plant height in the treatment T7 (100% RDN from raintree leaves) was 100.4 cm which was lower than those in all treatments except control. Raintree leaves with urea showed better performance in increasing the plant height compared to their single application. The results clearly showed that the application of organic manures with fertilizers increased the plant height which was comparable to that of recommended fertilizer dose. Babu et al. (2001) observed that the plant height was significantly influenced by the application of organic manures and chemical fertilizers.

Effective tillers hill^{-1}

The tillering of rice was significantly affected by the different treatments and the results are presented in the Table 3. The number of effective tillers hill-1 due to different treatments varied from 7.0 to 9.3. The highest number of effective tillers hill-1 was found in the treatment T_4 (60% RDN from urea + 40% RDN from raintree leaves) which was statistically identical to those recorded in the treatments T_2 (RFD), T5 (40% RDN from urea + 60% RDN from raintree leaves), T_3 (80% RDN from urea + 20% RDN from raintree leaves) with the values of 9.2, 9.0 and 8.9, respectively. The treatment T_1 (control) produced the lowest number of effective tillers hill-1. The results showed that application of various organic manure and fertilizer increased tillering. Satyanarayana et al. (2002) also found the increased number of effective tillers hill-1 with the application of inorganic and organic fertilizers. These results were also in agreement with those of Chettri et al. (2002) and Mishra et al. (2003).

Panicle length

Panicle length of BRRI dhan 41 rice was significantly influenced by different treatments (Table 3). The length of panicle varied from 22.5 cm to 26.0 cm. The highest panicle length was observed in T_3 (80% RDN from urea + 20% RDN from raintree leaves) which was statistically similar with the treatment T2 (RFD) and T_4 (60% RDN from urea + 40% RDN from raintree leaves). The panicle length recorded in treatment T_6 (20% RDN from urea + 80% RDN from raintree leaves) was also statistically similar to that recorded in the treatment T_5 (40% RDN from urea + 60% RDN from raintree leaves) and T_7 (100% RDN from raintree leaves). The lowest panicle length was recorded in the treatment T_1 (control). It appears that organic manure with fertilizer have significantly affected the panicle length which were comparable to the fully chemical fertilizer treatment T_2 (RFD). Umanah et al. (2003) observed that application of organic manure with chemical fertilizers increased the panicle length of rice.

Table 3
Effect of different treatments on yield contributing characters of BRRI dhan 41 rice.

Treatments	Plant height (cm)	Effective tillers hill^{-1} (no.)	Panicle length (cm)	Filled grains panicle^{-1} (no.)	1000-grain weight (g)
T_1	91.5f	7.0d	22.5c	97.5f	25.2c
T_2	113.2b	9.2ab	25.9a	136.3b	26.8a
T_3	116.1a	8.9ab	26.0a	132.5c	27.0a
T_4	110.6c	9.3a	25.5a	141.5a	27.1a
T_5	103.2d	9.0ab	23.9b	119.9d	26.6ab
T_6	104.5d	8.7b	24.0b	118.1e	26.3b
T_7	100.4e	8.0c	23.7b	116.8e	26.2b
SE (±)	0.60	0.17	0.30	0.49	0.14

Figures in a column having the similar letter (s) do not differ significantly at 5% levels of significant.
SE (±): Standard error of means

Filled grains panicle^{-1}

Results in the Table 3 show that the number of filled grains panicle-1 significantly influenced due to different treatments under study. The number of filled grain panicle-1 due to different treatments ranged from 97.5 to 141.5. The highest number of filled grains panicle-1 was obtained from the treatment T4 (60% RDN from urea + 40% RDN from raintree leaves). The number of filled grains panicle-1 due to treatment T_6 (20% RDN from urea + 80% RDN from raintree leaves) was significant over control and statistically was not different from treatment T_7 (100% RDN from raintree leaves). The lowest number of filled grains panicle-1 was obtained from the treatment T1 (control). All the treatments significantly increased the number of grains panicle-1 over control which reveals that organic manures had superior effect in producing grains panicle-1. Thus, the combined use of fertilizers and manures exerted considerable influence on the number of grains panicle-1. Similar results were reported by Chettri et al. (2002) and Umanah (2003)

1000-grain weight

Results in Table 3 indicate that the 1000-grain weight of rice responded significantly to the different treatments. The 1000-grain weight ranged from 25.2 to 27.1 g. The highest 1000-grain weight was observed in the treatment T4 (60% RDN from urea + 40% RDN from raintree leaves) which was statistically identical to that found in the treatments T3 (80% RDN from urea + 20% RDN from raintree leaves), T2 (RFD) and T5 (40% RDN from urea + 60% RDN from raintree leaves). The 1000-grain weight recorded in treatment T6 (20% RDN from urea + 80% RDN from raintree leaves) was also statistically identical to that recorded in treatment T7 (100% RDN from raintree leaves).The lowest weight of 1000-grain was noted in the treatment T1 (control). From results, it was found that combined application of organic and inorganic sources of nitrogen showed better performance in increasing 1000-grain weight than control treatment. Mishra et al. (2003) agreed that organic manure increased 1000-grain weight of hybrid rice.

Grain, straw and biological yields

Grain yield

Results in Table 4 show that grain yield of BRRI dhan 41 rice was significantly influenced due to different treatments. The grain yield due to various treatments ranged from 3.64 to 5.04 t ha-1. The highest grain yield was obtained in the treatment T_4 (60% RDN from urea + 40% RDN from raintree leaves) which was statistically identical to that found in the treatments T_3 (80% RDN from urea + 20% RDN from raintree leaves) and T_2 (RFD) with the values of 5.02 and 4.96 t ha-1, respectively. The lowest grain yield was obtained in the treatment T_1 (control) which was statistically different from all other treatments. The grain yield of 4.85 t ha-1 was recorded in the treatment T_5 (40% RDN from urea + 60% RDN from raintree leaves) which was statistically identical to that recorded in treatment T6 (20% RDN from urea + 80% RDN from raintree leaves) with the value of 4.69 t ha-1. The grain yield due to different treatments followed the order $T_4> T_3> T_2> T_5> T_6> T_7> T_1$. The increase in grain yield over control ranged from 28.3 to 38.5% (Table 4.2). The highest percentage of increased grain yield over control was recorded in the treatment T_4 (60% RDN from urea + 40% RDN from raintree leaves). The lowest percentage of increased grain yield over control was recorded in the treatment T_7 (100% RDN from raintree leaves). The results revealed that the 60% RDN from urea + 40% RDN from raintree leaves was more efficient in producing higher grain yield than other treatments but the combination of 80% RDN from urea + 20% RDN from raintree leaves produced grain yield near to the RFD and the combination of 40% RDN from urea + 60% RDN from raintree leaves produced lower yield compared to RFD. The present findings are in agreement with the results of the previous study. Integrated application of organic manures and chemical fertilizer significantly increased the grain yield of rice (Laxminarayan, 2000).

Table 4
Effect of different treatments on grain, straw and biological yields of BRRI dhan 41 rice.

Treatments	Grain yield ($t\ ha^{-1}$)	Increase over control (%)	Straw yield ($t\ ha^{-1}$)	Increase over control (%)	Biological yield ($t\ ha^{-1}$)	Increase over control (%)
T_1	3.64e	-	4.60e	-	8.24e	-
T_2	4.96ab	36.3	6.72a	46.1	11.7a	41.8
T_3	5.01ab	37.6	6.75a	46.7	11.8a	42.7
T_4	5.04a	38.5	6.80a	47.8	11.8a	43.7
T_5	4.85bc	33.2	6.50b	41.3	11.4b	37.7
T_6	4.69cd	28.9	6.10c	32.6	10.8c	31.0
T_7	4.67d	28.3	5.90d	28.3	10.6d	28.3
SE (±)	0.06		0.08		0.15	

Figures in a column having the similar letter (s) do not differ significantly at 5% levels of significant.
SE (±): Standard error of means

Straw yield

Results presented in the Table 4 show that straw yield of BRRI dhan 41 rice was significantly influenced by different treatments under study. The straw yield obtained from different treatments ranged between 4.60 to 6.80 t ha-1. All the treatments gave higher straw yield over control. It was observed that the treatment T_4 (60% RDN from urea + 40% RDN from raintree leaves) gave the highest straw yield which was statistically identical to those recorded in the treatment T_3 (80% RDN from urea + 20% RDN from raintree leaves) and T_2 (RFD) with the values of 6.75 and 6.72 t ha-1, respectively. The lowest straw yield was recorded in the treatment T_1 (control). The percent increase of straw yield over control ranged from 28.3 to 47.8% and the highest and lowest value was recorded in the treatment T_4 (60% RDN from urea + 40% RDN from raintree leaves) and

T_7 (100% RDN from raintree leaves), respectively. Again, the combinations of (80% RDN from urea + 20% RDN from raintree leaves) and (40% RDN from urea + 60% RDN from raintree leaves) decreased the straw yield over RFD. The combination of 40% RDN from urea + 60% RDN from raintree leaves decreased straw yield which was very negligible. The straw yield due to different treatments ranked in the order of $T_4 > T_3 > T_2 > T_5 > T_6 > T_7 > T_1$. Thus, the results revealed that the straw yield of BRRI dhan 41 rice was markedly influenced by the application of organic manures and urea fertilizer. Rajput et al. (1992) reported that the application of organic manures and fertilizers increased straw yield of rice.

Biological yield

Table 4 shows that biological yield of BRRI dhan 41 rice responded significantly. The biological yield varied widely among the treatments, ranged from 8.24 to11.8 t ha-1. The highest biological yield was obtained in the treatment T_4 (60% RDN from urea + 40% RDN from raintree leaves) which was statistically identical to those recorded in the treatment T_3 (80% RDN from urea + 20% RDN from raintree leaves) and T_2 (RFD) with the values of 11.76 and 11.68 t ha-1, respectively. The lowest biological yield was obtained in the treatment T_1 (control) which was statistically different from all other treatments. The increase in biological yield over control ranged from 28.3 to 43.7% (Table 4). The highest percentage of increased biological yield over control was recorded in the treatment T_4 (60% RDN from urea + 40% RDN from raintree leaves) and the lowest percentage of increased biological yield over control was recorded in the treatment T_7 (100% RDN from raintree leaves). The biological yield obtained from different treatments ranked in order of $T_4 > T_3 > T_2 > T_5 > T_6 > T_7 > T_1$. The results revealed that the application of organic manures and urea fertilizer increased biological yield of rice.

Nitrogen content in grain

Table 5 revealed that the nitrogen content in grain of BRRI dhan 41 rice was significantly influenced due to different treatments. The nitrogen content in grain ranged from 1.02% to 1.12%. The highest nitrogen content in grain was found in treatment T_4 (60% RDN from urea + 40% RDN from raintree leaves) which was statistically similar to those obtained in treatments T_3 (80% RDN from urea + 20% RDN from raintree leaves), T_2 (RFD) and T_5 (40% RDN from urea + 60% RDN from raintree leaves) with the values of 1.11%, 1.10% and 1.09%, respectively. The lowest nitrogen content in grain was observed in treatment T_1 (control). The nitrogen content recorded in the treatment T_6 (20% RDN from urea + 80% RDN from raintree leaves) of 1.07% was also statistically similar to that recorded in the treatment T_7 (100% RDN from raintree leaves) of 1.06%.

Nitrogen content in straw

In case of straw, the nitrogen content ranged from 0.42% to 0.60% (Table 5). The highest nitrogen content was recorded in treatment T_4 (60% RDN from urea + 40% RDN from raintree leaves) which was statistically similar to those obtained in treatments T_3 (80% RDN from urea + 20% RDN from raintree leaves), T_2 (RFD) and T_5 (40% RDN from urea + 60% RDN from raintree leaves) with the values of 0.58%, 0.57% and 0.56%, respectively. The nitrogen content in T_6 (20% RDN from urea + 80% RDN from raintree leaves) of 0.53% was also statistically identical to that recorded in the treatment T_7 (100% RDN from raintree leaves) of 1.06%. The minimum nitrogen content in straw was recorded in the control treatment (T_1).

Table 5
Effect of different treatments on nitrogen content in grain and straw of BRRI dhan 41 rice.

Treatments	N content (%)	
	Grain	Straw
T1	1.02c	0.42d
T2	1.10ab	0.57abc
T3	1.11a	0.58ab
T4	1.12a	0.60a
T5	1.09ab	0.56abc
T6	1.07b	0.53bc
T7	1.06b	0.51c
SE (±)	0.03	0.02

Figures in a column having the similar letter (s) do not differ significantly at 5% levels of significant.
SE (±): Standard error of means

The results show that the nitrogen content in grain was higher than that in straw of all the treatments. Kadu et al. (1991) observed that nitrogen content in rice did not decrease considerably compared to RFD with the reduced rates of urea application. Nitrogen content in grain and straw were increased significantly due to the application of organic manure and fertilizers (Azim, 1999).

Nitrogen uptake by grain

Results in Table 6 show a wide variation in nitrogen uptake by grain due to different treatments. The nitrogen uptake by rice grain ranged from 37.1 to 56.5 kg ha-1. The highest amount of nitrogen uptake by grain was observed in the treatment T_4 (60% RDN from urea + 40% RDN from raintree leaves) which was statistically similar to those obtained in treatments T_3 (80% RDN from urea + 20% RDN from raintree leaves) and T_2 (RFD) where the values were 55.6 and 54.6 kg ha-1, respectively. The nitrogen uptake (52.9 kg ha-1) in treatment T_5 (40% RDN from urea + 60% RDN from raintree leaves) was also statistically identical to that recorded in the treatment T_6 (20% RDN from urea + 80% RDN from raintree leaves) with value 50.2 kg ha-1. The lowest amount of nitrogen uptake by grain was observed in treatment T_1 (control).

Nitrogen uptake by straw

In case of straw, the nitrogen uptake ranged from 19.3 kg ha-1 to 40.8 kg ha-1. The highest nitrogen uptake by rice straw was recorded in T_4 (60% RDN from urea + 40% RDN from raintree leaves) which was statistically similar to those obtained in treatments T_3 (80% RDN from urea + 20% RDN from raintree leaves) and T_2 (RFD) where the values were 39.2 and 38.3 kg ha-1, respectively. The nitrogen uptake in treatment T_6 (20% RDN from urea + 80% RDN from raintree leaves) with value 32.3 kg ha-1 was also statistically identical to that recorded in the treatment T_7 (100% RDN from raintree leaves) of 30.1 kg ha-1. The lowest amount of nitrogen uptake by straw was observed in treatment T_1 (control) which was statistically different from all other treatments.

Table 6
Effect of different treatments on nitrogen uptake by grain and straw of BRRI dhan 41 rice.

Treatments	N uptake (kg ha^{-1})		Total N uptake (kg ha^{-1})
	Grain	Straw	
T_1	37.1e	19.3d	56.5d
T_2	54.6ab	38.3ab	92.9ab
T_3	55.6ab	39.2ab	94.8a
T_4	56.5a	40.8a	97.3a
T_5	52.9bc	36.4b	89.3b
T_6	50.2cd	32.3c	82.5c
T_7	49.5d	30.1c	79.6c
SE (±)	1.04	1.04	1.53

Figures in a column having the similar letter (s) do not differ significantly at 5% level of significant.
SE (±): Standard error of means.

Total nitrogen uptake by grain and straw

The total nitrogen uptake by grain and straw of BRRI dhan 41 rice ranged from 56.5 kg ha-1 to 97.3 kg ha-1. The highest amount of total nitrogen uptake was observed in treatment T_4 (60% RDN from urea + 40% RDN from raintree leaves) which was statistically similar to the value 94.8 kg ha-1 and 92.9 kg ha-1 observed in treatments T_3 (80% RDN from urea + 20% RDN from raintree leaves) and T_2 (RFD), respectively. The total nitrogen uptake in treatment T_6 (20% RDN from urea + 80% RDN from raintree leaves) and T_7 (100% RDN from raintree leaves) were 82.5 and 79.6 kg ha-1, respectively and they were statistically identical. The lowest amount of total nitrogen uptake was recorded in treatment T_1 (control). The total nitrogen uptake by BRRI dhan 41 rice due to different treatments ranked in order of $T_4 > T_3 > T_2 > T_5 > T_6 > T_7 > T_1$. Okamoto and Okada (2004) stated that nitrogen uptake by rice grain and straw increased by the application of organic nitrogen.

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