



## Effect of Brown Manure and Level of Nitrogen on T. Aman Rice and Subsequent Effect on Wheat

S. Mondal<sup>1</sup> M. A. Salam<sup>1</sup> M. S. Islam<sup>2</sup> A. K. Chaki<sup>1</sup> M. Shahidul Islam<sup>3</sup> and M.F. Hossain<sup>4</sup>

<sup>1</sup>Bangladesh Agricultural Research Institute (BARI), Barind Station, Bangladesh-6206

Corresponding Author- Cell: +66 0834068305, Mail: mondalbari@gmail.com

<sup>2</sup>BARI, Pabna, Bangladesh-6600

<sup>3</sup>BARI, Patuakhali, Bangladesh-8600

<sup>4</sup>On-Farm Research Division, BARI, Gazipur, Bangladesh-1701

### บทคัดย่อ

การทดลองมีวัตถุประสงค์เพื่อศึกษาอิทธิพลของซากพืชและปุ๋ยไนโตรเจนอัตราต่างๆ ต่อข้าวนาต่ำ aman (ข้าวนาลุ่ม) และข้าวสาลีที่ปลูกตาม ทำการทดลองที่ ศูนย์วิจัยและพัฒนาระบบการทำฟาร์ม Kadamshahar, Godagari, Rajshahi, Bangladesh ระหว่าง ปี 2551-2552 และ ปี 2553-2554 พืชที่ปลูกก่อนข้าวปลูกในฤดู Kharif I (มีนาคม-พฤษภาคม) ข้าว T. aman (ข้าวนาปี) ปลูกในฤดู Kharif II (มิถุนายน-ตุลาคม) และข้าวสาลีปลูกในฤดู Rabi (ฤดูหนาว) พืชที่ปลูกก่อนข้าวคือ ถั่วเขียว (*Vigna radiata*) และถั่วเขียวผิวดำ (*Vigna mungo*) ทั้งข้าวและข้าวสาลีได้รับปุ๋ยไนโตรเจนที่อัตรา 0, 40, 80 และ 120 กิโลกรัมไนโตรเจนต่อเฮกเตอร์ ในรูปของปุ๋ยยูเรีย ถั่วเขียวให้ผลผลิตเมล็ดสูงกว่าถั่วเขียวผิวดำ แต่มีน้ำหนักชากน้อยกว่า ชนิดของซากพืชมีผลต่อข้าวที่ปลูกตามอย่างมีนัยสำคัญทางสถิติ กรรมวิธีการใส่ปุ๋ยไนโตรเจนที่อัตรา 120 กิโลกรัมไนโตรเจนต่อเฮกเตอร์ ร่วมกับซากพืช มีผลทำให้ผลผลิตเมล็ดข้าวสูงสุดซึ่งไม่แตกต่างทางสถิติกับกรรมวิธีการใส่ปุ๋ยไนโตรเจนที่อัตรา 80 กิโลกรัมไนโตรเจนต่อเฮกเตอร์ ร่วมกับซากพืชในอัตราเดียวกัน ไม่มีปฏิสัมพันธ์ระหว่างซากพืชชนิดต่างๆ กับอัตราปุ๋ยไนโตรเจนต่อผลผลิตข้าว การใส่ซากพืชต่างๆ กันไม่มีผลต่อข้าวสาลีที่ปลูกตาม

คำสำคัญ : กระบวนการทำปุ๋ยหมัก / ระดับไนโตรเจน / ข้าวและข้าวสาลี

### ABSTRACT

The experiment was conducted to evaluate the effect of different brown manuring crops and nitrogen levels on transplanted aman (low land rice) rice and their residual effect on the succeeding wheat crop at Farming System Research and Development site, Kadamshahar, Godagari, Rajshahi, Bangladesh, during 2009-10 and 2010-11. Brown manuring crops were grown in *Kharif I* (March to May), T. aman rice (wet season rice) in the *Kharif II* (June to October) and wheat in the Rabi (winter) season. Brown manuring crops tested were mungbean (*Vignaradiata*) and black gram (*Phaseolusmungo*). Nitrogen was applied to both rice and wheat crops at four different rates: 0, 40, 80 and 120 kg N ha<sup>-1</sup> in the form of urea. Mungbean was superior to blackgram in terms of seed yield but brown biomass production was reverse. Effect of both brown manuring crops to next rice crop was found significant. 120 kg N ha<sup>-1</sup> along with brown biomass produced the highest grain yield of rice which was statistically identical to 80 kg N ha<sup>-1</sup> with same biomass. Interaction of brown manuring crops with N level also showed similar effect. No effect of brown biomass was observed on wheat crop in the pattern.

**Keywords :** Brown Manuring Crop / Nitrogen Level / Rice and Wheat



## Introduction

Soil fertility in High Barind Tract (HBT) has declined over time. Most of the soils of HBT have low organic matter content, the value being usually below 1%. (Khan, M.S. et al. 2008) Improved soil fertility is a prerequisite for increasing crop productivity. Inclusion of leguminous crops into cereal based cropping system is important for their long-term sustainability. Legumes fix atmospheric nitrogen which would be useful to the following rice crop after incorporation of their residues. Further, legumes in rotation with crops can also increase organic matter content of soil. In tropical areas like Bangladesh, Black gram and Mungbean, which mature in 60-70 days, can easily be grown as a short duration summer pulse crop between wheat and rice. The inclusion of food legumes in Wheat-Fallow-T. aman rice will supply biomass to soil as well as protein for human consumption. In other word among various nutrients, nitrogen has the strongest influence on the growth and yield of rice and wheat. Adequate amount of nitrogen is required at different stages of growth and development of rice-wheat cropping system for better yields. But excess nitrogen results in lodging of plant and reduction in yield (Lal, R. and Singh, R.R. 1971). On the other hand, deficiency of nitrogen also hampers the production of rice and wheat. Among many factors, deficiency of N is now considered as major reason for low yield of rice and wheat in Bangladesh. Therefore, the present study was under taken to study brown manuring crops in terms of biomass production, seed yield and to determine optimum nitrogen dose for transplanted aman rice after incorporation of brown manuring crops.

## Materials and Methods

This experiment was conducted at Chabbishnagar under FSRD site, Kadamshahar, Godagari, Rajshahi, Bangladesh-6206 during the year of 2009-2010 and 2010-11. Before starting the experiment, initial composite soil sample (0-15 cm depth) were collected

from the experimental plots and were analyzed in SRDI laboratory, Shyampur, Rajshahi, Bangladesh. The soil contained pH value 5.7, 0.89% organic matter, 0.07% total nitrogen, available P, S, B and Zn were 12.43, 14.65, 0.16 and 0.85 micro mg/kg soil respectively. The experiment was laid out in a Randomized Complete Block (RCBD) design with split plot technique. Brown manuring crops were assigned to main plots and Nitrogen fertilizer doses were applied in sub-plots. Unit plot size was 5x8 m<sup>2</sup>. Green manuring crops were grown in the *Kharif -I* season where as T. aman rice in *Kharif -II* and wheat in *Rabi* season in this study. Two brown manuring crops namely, *Vignaradiata* (mungbean) and *Phaseolusmungo* (black gram) were used in the study. At final land preparation of brown manuring crops, fertilizer N, P, K and S at the rate of 10, 20, 30, and 15 kg ha<sup>-1</sup>, respectively were applied in the form of urea, triple super phosphate, muriate of potash and gypsum, respectively. Seeds of mungbean (var. BARI mung-6) and blackgram (var. BARI mash-3) were sown on 29 March, 2009 and 6 April 2010. Seed rate for mungbean (*Vignaradiata*), and blackgram (*Phaseolusmungo*) were 35 and 40 kg ha<sup>-1</sup>, respectively. The seedlings of transplanted aman rice (var. BRRI dhan39) were raised in wet nursery-bed. Sprouted rice seeds were sown on 27 June, 2009 and 25 June 2010 in a well-prepared nursery-bed. At final land preparation, the experimental plots were fertilized with P, K, S and Zn at the rate of 18, 40, 12 and 2 kg ha<sup>-1</sup>, respectively in the form of triple super phosphate, muriate of potash, gypsum and zinc sulphate. Different doses of nitrogen viz., 0, 40, 80, 120 kg N ha<sup>-1</sup> were applied in the plots in the form of urea in three equivalent elemental rate as per treatment specification at 20, 35 and 50 days after transplanting (DAT). Twenty five-days old healthy seedlings were uprooted carefully from the seed bed and were transplanted at the rate of three seedlings hill<sup>-1</sup> in the unit plots on 22 July, 2009 and 20 July 2010 with a spacing of 20 cm ×



15 cm. T.aman rice was harvested on 31 October, 2009 and 26 October 2010. After harvesting of T. Aman rice, the plots were prepared for wheat crop. The land was fertilized with 26-50-20-05-1 kg ha<sup>-1</sup> of P, K, S, Zn and B in the form of triple super phosphate, muriate of potash, gypsum, zinc sulphate and boric acid respectively as basal dose. Urea was applied according to treatment specification. Two-third urea was applied as basal and one third urea at 21 DAS. Then small furrows were made at 20 cm apart and the seeds of wheat (var. Shatabdi) were sown in the furrows manually. The seed rate was 120 kg ha<sup>-1</sup> and the seeds were covered by soil. The sowing was done 18 November 2009 and 25 November 2010. The test variety was Shatabdi. Three times of irrigations were applied at 21, 55 and 70 DAS. Two times weeding were done before irrigation at 21 and 55 DAS. Intercultural operations were done to ensure normal growth of the crop. The crop was harvested when they attained full maturity. The crop was harvested on 24 March, 2010 and 28 March 2011. Crop of all the unit plots did not mature at the same time due to variation of nitrogen level. The crop receiving lower dose of N fertilizer matured 5-7 days earlier than the crop which received higher doses of N. Data on yield and yield contributing characters of mungbean, black gram, T.aman rice and wheat were recorded. Observations were made on yield components from 10 randomly selected plants per plot. All the data were statistically analyzed following the F-test and the mean comparisons were made by DMRT at 5% level. (Gomez, K.A. and A.A. Gomez. 1984) Meanwhile in the case of mungbean and black gram, pair T-test was followed for analysis.

## Results and Discussion

### 1. Brown manuring crops

All the plant characters of two brown manuring crops varied significantly except number of plants m<sup>-2</sup> (Table 1).

The plant height was higher in blackgram (75.72 cm) than mungbean (64.66 cm). Similarly number of branches plant<sup>-1</sup> (3.17) and number of pods plant<sup>-1</sup> (84.40) were significantly higher in blackgram as compared to mungbean. Contrary higher seed number pod<sup>-1</sup> (10.70) and 1000-seed weight (53.11 g) were obtained in mungbean than blackgram. Variation of above characters might be due to genetic control.

**Table 1** Yield components of brown manuring crops during 2010-2011

Treatment	No. of plant m <sup>-2</sup>	Plant height (cm)	No. of branch plant <sup>-1</sup>	No. of pod plant <sup>-1</sup>	Seed pod <sup>-1</sup>	1000-seed weight (g)
Mungbean	36.53	64.66	1.52	60.52	10.70	53.11
Blackgram	35.24	75.72	3.17	84.40	5.07	43.83
T-test	NS	*	**	**	**	**

\*\* Significant at 1% level of probability

\* Significant at 5% level of probability

Both seed and Stover yield were found significant. Higher seed yield was found in mungbean (1.35 and 1.27 t ha<sup>-1</sup>) in both the year than blackgram. Although number of pod plant<sup>-1</sup> was higher in blackgram the seeds number pod<sup>-1</sup> and 1000-seed weight were found higher in mungbean and contributed to higher seed yield (Table 2). Again higher Stover yield was obtained in blackgram for the both years. This result is supported by Ladha J.K. et al. (1988). They reported that cowpea, blackgram and mungbean are potential grain legumes for rice-wheat systems, but only blackgram is tolerant to wet soils. Blackgram has high N-fixation capacity with fast growth to accumulate large biomass, be easy to incorporate into soil, and decompose rapidly.



**Table 2** Grain and Stover yield of brown manuring crops during 2009-2010 and 2010-2011

Treatment	2010-2011		2009-2010	
	Seed yield (t ha <sup>-1</sup> )	Stover yield (t ha <sup>-1</sup> )	Seed yield (t ha <sup>-1</sup> )	Stover yield (t ha <sup>-1</sup> )
Mungbean	1.27	2.19	1.35	2.27
Blackgram	0.94	3.14	1.05	3.25
T-test	**	**	**	**

\*\* Significant at 1% level of probability

## 2. T.aman (Low Land) rice

### 2.1 Effect of brown manure on T. aman rice

Number of effective tillers hill<sup>-1</sup>, number of grains panicle<sup>-1</sup> and grain yield were significantly influenced by the incorporation of brown manure. Weight of thousand grains was not significantly affected by brown manures (Table 3). In the year 2010-2011, it was observed that all brown manures produced similar number of effective tillers hill<sup>-1</sup>, which was higher than that of seasonal fallow plots. The highest number of grains panicle<sup>-1</sup> (116) was produced by blackgram residue followed

by mungbean (108) and lowest on in seasonal fallow (100). This might be due to sufficient amount of nitrogen and other nutrients added by the decomposition of Green Manuring (GM) crops. These results are in agreement with the findings of Pramanik (2006) who reported that incorporation of legume residues in the soil gave higher grains panicle<sup>-1</sup> in T. aman rice.

In 2010-2011, the highest straw yield (5.23 t ha<sup>-1</sup>) was observed when blackgram residue was incorporated in the soil and almost similar results were exhibited by mungbean. The lowest straw yield (4.67 t ha<sup>-1</sup>) was produced in the seasonal fallow (control) plots. The highest grain yield (4.37 t ha<sup>-1</sup>) was observed when blackgram was incorporated in the soil. Almost similar performance was noticeable in mungbean. This was due mainly to the improvement of yield components resulted from soil incorporation of green manures. The lowest grain yield (3.52 t ha<sup>-1</sup>) was produced in seasonal fallow (control) plots. Almost similar results were obtained in 2009-2010. These results are in agreement with the findings of Pramanik (2006).

**Table 3** Yield and yield contributing characters of transplanted Aman rice as affected by brown manures

Treatment	2010-2011						2009-2010	
	Plant height (cm)	Effective tiller hill <sup>-1</sup> (No.)	Grains panicle <sup>-1</sup> (No.)	1000-grain wt (g)	Grain yield (t ha <sup>-1</sup> )	Straw yield (t ha <sup>-1</sup> )	Grain yield (t ha <sup>-1</sup> )	Straw yield (t ha <sup>-1</sup> )
Mungbean	89.91	8.30a	108b	22.16	4.19a (19.09%)	5.156a	4.36a (17.52%)	5.08
Blackgram	98.41	8.54a	116a	22.21	4.32a (22.72%)	5.237a	4.55a (22.64%)	5.12
S. fallow	94.22	7.25b	100c	21.86	3.52b	4.673b	3.71b	5.04
Level of significance	NS	0.05	0.05	NS	0.05	0.05	0.05	NS
CV (%)	15.74	9.37	10.38	6.61	7.65	10.21	5.51	6.77



## 2.2 Effect of nitrogen on T. aman rice

Number of effective tillers hill<sup>-1</sup>, number of grains panicle<sup>-1</sup>, straw yield and grain yield of transplant Aman rice were significantly influenced by the nitrogen level (Table 4). All the crop characters were found better with the increasing rate of nitrogen. In 2010-2011, maximum number of effective tillers hill<sup>-1</sup> (8.66),

grains panicle<sup>-1</sup> (113), grain yield (4.63 t ha<sup>-1</sup>) and straw yield (5.94 t ha<sup>-1</sup>) were obtained when the crop was fertilized with 120 kg N ha<sup>-1</sup> which was statistically identical to 80 kg N ha<sup>-1</sup> followed by 40 kg N ha<sup>-1</sup>. Similar results were reported in rice by Sarkaret *et al.* (2004), Pramanik *et al.* (2004).

**Table 4** Yield and yield contributing characters of transplanted aman rice as affected by nitrogen levels

Treatment	2010-2011						2009-10	
	Plant height (cm)	Effective tiller hill <sup>-1</sup> (No.)	Grains panicle <sup>-1</sup> (No.)	1000-grain wt (g)	Grain yield (t ha <sup>-1</sup> )	Straw yield (t ha <sup>-1</sup> )	Grain yield (t ha <sup>-1</sup> )	Straw yield (t ha <sup>-1</sup> )
N <sub>0</sub>	84.77c	6.93a	96c	21.66	3.04c	4.138c	3.35c	4.16d
N <sub>40</sub>	94.08b	8.05ab	106b	22.14	3.93b (29.27%)	5.134b	3.98b (18.80%)	4.77c
N <sub>80</sub>	98.05ab	8.39ab	112a	22.25	4.45a (46.38%)	5.36ab	4.59a (37.01%)	5.55b
N <sub>120</sub>	99.80a	8.66a	113a	22.17	4.63a (52.30%)	5.94a	4.71a (40.59%)	5.84a
Level of significance	0.05	0.05	0.05	NS	0.05	0.05	0.05	0.05
CV (%)	15.74	9.37	10.38	6.61	7.65	10.21	5.51	6.77

## 2.3 Combined effect of brown manure and nitrogen on T. aman rice

Number of effective tillers hill<sup>-1</sup>, number grains panicle<sup>-1</sup>, grain yield and straw yield of transplant aman rice were significantly influenced by the combined effect of brown manure and nitrogen level (Table 5). Increasing trends of yield attributes were obtained with higher levels of nitrogen in all treatment combinations of the aforementioned parameters. Blackgram combination with 80 and 120 kg N ha<sup>-1</sup> produced statistically higher and similar grain yield which was at par with mungbean.

The lowest grain yield was observed in fallow (control) plots without nitrogen application. From the study, it was observed that blackgram and mungbean showed better performance in terms of grain yield. The variation of grain yield might be due to variation of amount of fresh biomass added during incorporation. The brown manuring crops with application of nitrogen fertilizer always produced higher grain yield compared to crops not fertilized with nitrogen. Brown manure alone can substantially increase grain yield. As 80 and 120 kg N ha<sup>-1</sup> in combination with brown manures behaved



**Table 5** Yield and yield contributing characters of T.aman rice as affected by the combined effect of brown manures and nitrogen levels

Treatment		2010-2011						2009-2010	
		Plant height (cm)	Effective tiller hill <sup>-1</sup> (No.)	Grains panicle <sup>-1</sup> (No.)	1000 grain wt (g)	Grain yield (t ha <sup>-1</sup> )	Straw yield (t ha <sup>-1</sup> )	Grain yield (t ha <sup>-1</sup> )	Straw yield (t ha <sup>-1</sup> )
Mungbean	N <sub>0</sub>	82.51	7.02e	98c	21.51	3.28d	4.21de	3.84e	4.12ef
	N <sub>40</sub>	94.38	8.58bc	107b	22.43	4.26bc (29%)	5.23abcd	4.22cd (9.8%)	4.45e
	N <sub>80</sub>	98.88	8.77ab	113ab	22.31	4.57a (39%)	5.62abc	4.61ab (20%)	5.41b
	N <sub>120</sub>	101.12	8.88a	114a	22.52	4.66a (42.07%)	5.89ab	4.79a (24%)	6.05a
Black gram	N <sub>0</sub>	90.57	7.83d	109b	22.40	3.58cd	4.23cde	3.52f	4.41e
	N <sub>40</sub>	99.83	8.65bc	111b	22.29	4.27b (19%)	5.59abc	4.14d (17.61%)	4.95cd
	N <sub>80</sub>	102.3	8.73ab	118a	21.78	4.70a (31.28%)	5.49abc	4.68a (32.95%)	5.34bc
	N <sub>120</sub>	100.93	8.89a	117a	23.60	4.75a (32%)	6.35a	4.86a (38%)	5.77ab
S.fallow	N <sub>0</sub>	81.25	5.94f	80d	21.06	2.26e	3.57e	2.48g	3.96f
	N <sub>40</sub>	88.04	6.93e	99c	21.70	3.28d (45%)	4.58cde	3.56f (43.54%)	4.91d
	N <sub>80</sub>	92.98	7.69d	106bc	22.07	4.08c (80%)	4.97bcd	4.30bcd (73.38%)	5.91a
	N <sub>120</sub>	97.35	8.30c	108b	22.22	4.48ab (98%)	5.57abc	4.50bc (81.45%)	5.69ab
Level of significance		0.05	0.05	0.05	NS	0.05	0.05	0.05	0.05
CV (%)		15.74	9.37	10.38	6.61	7.65	10.21	5.51	6.77

in the similar manner in respect of grain yield, therefore 40 kg N ha<sup>-1</sup> may be reduce to transplant aman rice. The seasonal fallow plots fertilized with 120 kg N ha<sup>-1</sup> were same as 80 kg N ha<sup>-1</sup> in combination with manures in respect of grain yield. Therefore, 40 kg N ha<sup>-1</sup> can be saved when incorporating a legume crop in what-fallow-T.aman rice cropping pattern.

### 3. Wheat crop

#### 3.1 Effect of brown manure on wheat

No effect (Table 6) of brown manuring was observed in yield and yield attributes of wheat crop. There was no significant different between residual effect and yield and yield contributing cahacters of wheat. It might be due to rapid break down of organic matter obtained from brown manuring crops due to high temperature, low PH, high humidity, erratic rainfall etc. These results are in agreement with the findings of Sharma *et al.* (1995).



**Table 6** Yield and yield contributing characters of wheat as affected by residual effect of brown manure

Treatment	2010-2011						2009-2010	
	Tiller Plant -1	Effective tiller plant-1 (No.)	Grain spike-1 (No.)	1000- grain wt (g)	Grain yield (t ha-1)	Straw yield (t ha-1)	Grain yield (t ha-1)	Straw yield (t ha-1)
Mungbean	3.15b	2.98b	33.31	39.86	2.86	4.19	3.27	4.27
Blackgram	3.24a	3.07a	34.72	40.17	2.97	4.32	3.32	4.39
S.fallow	3.11c	2.96c	33.21	39.35	2.83	4.06	3.21	4.16
Level of significance	0.05	0.05	NS	NS	NS	NS	NS	NS
CV (%)	7.34	8.57	0.03584	4.60	5.93	11.33	4.37	3.47

### Conclusion

From the above discussion, it was observed that mungbean showed better performance among the brown manures in terms of seed yield but blackgram was better in respect biomass yield. However, incorporation of mungbean or blackgram between wheat and wet season rice can reduce N-fertilizer use for rice crop. It is also important for improving soil fertility. Hence, it is advocated to use on legume crops in the pattern.

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