Bangladesh Agron. J. 2022, 25(2): 67-72

GRAIN, YIELD AND QUALITY OF TRANSPLANT AMAN RICE AND SOIL NUTRIENTS STATUS WITH APPLICATION OF FERTILIZERS AND GREEN MANURES

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(**Received**: 27 August 2022, **Accepted**: 06 January 2023)

Keywords: *Mimosa*, dhaincha, green manure, grain yield, grain quality, soil nutrient status

Abstract

A field experiment was conducted at Sher-e-Bangla Agricultural University, Dhaka during 2014 on transplant aman rice var. BR11 (Mukta) under different levels of chemical fertilizers and green manures to evaluate its grain yield, grain quality and soil fertility status with incorporation of green manures. The experiment was carried out in a split- plot design with three replications. The level of fertilizers (0, 100, 75, 50% of recommended dose, RFD) was placed in main -plot and levels of green manures management (0, 5 and 10 t ha^{-1} each *Mimosa invisa* (Lajjaboti) and *Sesbania* spp. (Dhaincha) in sub-plot. Recommended dose of fertilizers of 83N, 21P, 37K, 11S and 1.5 Zn kg ha^{-1}, were applied in the form of urea, triple super phosphate (TSP), muriate of potash (MoP), gypsum and zinc sulfate, respectively. Sixty-day old *Mimosa invisa* and *Sesbania* spp. were *in - vitro* incorporated before aman transplantation. Combined application of 75% RFD along with *Mimosa invisa* @ 10 t ha^{-1} was proved to be the best management in producing higher grain yield (7.25 t ha^{-1}) and that was at par with treatment 50% RFD plus *Mimosa invisa* @ 10 t ha^{-1}. Quality of grain was increased markedly in respect of amylose, carbohydrate, and protein as well. Furthermore, the treatment improved soil nutrient status in respect of organic matter, nitrogen, sulfur and Zn over no incorporations of green manures. So, addition of green manure like *Mimosa invisa* could cut fertilizer cost by 25-50%.

Introduction

In Bangladesh rice covering 11.53 million hectares (BBS, 2011) where transplant Aman rice occupied 55.3 % of total rice area (BBS, 2018). Continuous rice cultivation could be a threat for soil health concern. Sulphur and zinc unavailability is resultant effect of continuous cultivation of aus, aman and boro (Biswas and Naher, 2019). In addition, imbalance use of fertilizers, limited or no use of crop residues or green manure into the soil thus triggered down the soil nutrient status of Bangladesh. Recently, Mg, B and Mo are also reported to be limiting in many areas (Rahman *et al.,* 2021). On the other hand, imbalance use of chemical fertilizers is further detrimental on the availability of soil nutrients for expression of crop production potentiality. It was notified that sustainable crops production cannot be maintained by using either alone chemical fertilizers or organic manure (Moe *et al.*, 2017). So, use of green manure/organic manure along with inorganic fertilizers is mostly scientific in improving soil fertility followed by sustainable crop production from integrated crop management (ICM) point of view. Dhaincha

(*Sesbania* spp.) is well known plant for conventional soil improving management in Bangladesh (Sarwar *et al.,* 2017). *Mimosa invisa* (Lajjaboti) is an emerging green manuring legume weed is being evaluated for its potentiality towards improving of soil health and quality crop yield indeed over dhaincha (Mishra *et al.*, 2011).

In Bangladesh, study on the performance of *Mimosa* as a green manure is lacking or little in practice. So, the potentiality of this novel green manure is to be tested in Bangladesh crop fields. Hence, the study of influence of *Mimosa invisa* and *Sesbania* spp. *as green manure* along with different fertilizers levels for improving T. aman rice grain yield in general and soil improvement in particular.

Materials and Methods

An experiment was conducted at Sher-e-Bangla Agricultural University during 2014 aman season (July – November) to evaluate the effect of green manures on transplant aman under different levels of fertilizers. The test crop was rice var. BR11 (Mukta). The experiment was carried out in a split- plot design with three replications. The level of fertilizers (0, 100, 75, 50% of recommended dose, RFD) was placed in main -plot and levels of green manures management (0, 5 and 10 t ha^{-1} each *Mimosa invisa* and *Sesbania* spp. in sub-plot. The treatment comprised of fertilizer levels (4); F_0 = No fertilizers (control), F_1 = Recommended dose (N = 83 kg ha^{-1}, P = 21 kg ha^{-1}, K = 37 kg ha^{-1}, S = 11 kg ha^{-1}, Zn = 1.5 kg ha^{-1}), F_2 = 75% of the recommended dose, F_3 = 50% recommended dose in main plot. Green manures had 5 levels viz. G_0 = No green manure (control), G_1 = *Mimosa invisa* at 5 t ha^{-1}, G_2 = *Mimosa invisa* at 10 t ha^{-1}, G_3 = *Sesbania* spp. at 5 t ha^{-1}, G_4 = *Sesbania* spp. at 10 t ha^{-1} were considered in sub plot. Sixty-day old *Mimosa invisa* and *Sesbania* spp. were *in - vitro* incorporated before aman transplantation. The data on grain yield, grain quality and soil health components were recorded. Grain quality analysis was done at Grain Quality and Nutrition Division, laboratory of BRRI, Gazipur-1701 following National Institute of Nutrition, NIN (1976). Soil health quality was determined following protocol of Jackson (1962), Page *et al.* (1982), Olsen *et al.* (1954) and Black (1965). The data collected were analyzed statistically using MSTAT- C software and mean differences of treatments were adjudged with Least Significant Difference (LSD) test (Gomez and Gomez, 1984).

Results and Discussion

Combined effect of fertilizer and green manure levels on grain yield of rice

Results revealed that grain yield was varied from 3.20 to 7.25 t ha^{-1} as observed with combination effect of different levels of fertilizer and green manure. The yield advantage due to F_2G_2 was 126.57% over control. This treatment had significantly higher grain yield (7.25 t ha^{-1}) but followed by F_3G_2 (6.60 t ha^{-1}), F_1G_1 (6.57 t ha^{-1}), F_2G_4 (6.21 t ha^{-1}) and F_3G_3 (6.18 t ha^{-1}). The control plot gave the lowest yield (3.20 t ha^{-1}) (Table 1). The maximum yield was attributed due to increased effective tillers $plant^{-1}$, panicle length, grains $panicle^{-1}$ and 1000-grain weight. This might be due to balanced availability of nutrients from the fertilizers and green manures combination. The combined effect of fertilizers and green manures was found positive for increasing different yield contributing traits and yield as reflected in different reports opined by rice scientists (Islam *et al.*, 2015; Abedin *et al.*, 1999; Apostol, 1989; Hoque, 1999).

Combined effect of fertilizer and green manure levels on biochemical parameters of rice grain

Significantly variations in grain quality parameters were obtained with different combined treatments (Table 2). The grain moisture, amylose, protein and carbohydrate content ranged

between 9.20 - 10.70, 23.00 - 27.10, 6.50 - 8.80 and 71.30 - 82.10 % in different treatments. Carbohydrate and protein constituted about 88% of the total grain weight.

Table 1. Combined effect of different levels of fertilizers and green manures on grain yield of transplant aman rice

Treatment combinations	Grain yield (t ha^{-1})	Yield advantage over control (%)
F_0G_0	3.20 h	-
F_0G_1	4.56 fg	42.50
F_0G_2	4.88 e-g	52.50
F_0G_3	4.32 g	35.00
F_0G_4	4.90 e-g	53.12
F_1G_0	5.20 d-g	62.50
F_1G_1	6.57 a-c	105.31
F_1G_2	6.12 b-d	91.25
F_1G_3	5.86 b-e	83.13
F_1G_4	5.50 c-f	71.90
F_2G_0	4.73 fg	47.81
F_2G_1	5.96 b-e	86.25
F_2G_2	7.25 a	126.57
F_2G_3	5.54 b-f	73.13
F_2G_4	6.21 a-d	94.06
F_3G_0	4.71 fg	47.19
F_3G_1	5.95 b-e	86.00
F_3G_2	6.60 ab	106.25
F_3G_3	6.18 a-d	93.13
F_3G_4	5.31 d-g	65.93
$LSD_{(0.05)}$	1.09	-
CV (%)	12.00	-

F_0 = No fertilizers (control)
F_1 = Recommended dose
F_2 = 75% of the recommended dose
F_3 = 50% of the recommended dose

G_0 = No green manures (control)
G_1 = *Mimosa invisa* at 5 t ha^{-1}
G_2 = *Mimosa invisa* at 10 t ha^{-1}
G_3 = *Sesbania* spp. at 5 t ha^{-1}
G_4 = *Sesbania* spp. at 10 t ha^{-1}

Treatments F_3G_2 and F_2G_4 had similar moisture content value (10.70%) which was maximum from F_1G_4 (9.20%). Amylose content elevated maximum (27.10%) in F_3G_3 and that was minimum in F_2G_0 (23.00%). Protein content was the highest (8.80%) in F_2G_2 whereas minimum in F_0G_0 (6.50%). Carbohydrate was determined greater (82.10%) in F_3G_4 and lower (71.30%) in F_0G_0. Likewise, grain yield was marked that reduced fertilizer rate (50-75%) along with either *mimosa* or *sesbania* application at 5 or 10 t ha^{-1}, increases all the grain quality parameters. Protein and carbohydrate content was minimum when plant did not get any fertilizer and green manure. The results are in corroborated with findings of Pramanik (2006) when he was concerned in rice grain quality with green manure application.

Soil health status with or without green manures application

Table 3 showed that incorporation of green manure into soil increased levels of organic matter (0.94 to 1.48%), total nitrogen (0.047 to 0.074%), available sulphur (3.4 to 3.73 ppm) and available zinc (5.63 to 9.13 ppm). This soil quality was improved due to the addition of higher amount of organic matter from green manure into soil. Rahman *et al.* (2013) and Sarwar *et al.* (2017) determined improvement of organic matter and total nitrogen content status in soil after incorporation of green manure which is in corroboration with the present findings. The increased level of sulphur indicates that green manures released sufficient sulfur due to its

decomposition in the soil. Similar results were confirmed by Sanchez (1976) whereas decreased trend was evident in case of soil pH (6.30 to 6.10), available phosphorus (27.93 to 23.93 ppm) and exchangeable potassium (0.20 to 0.13 meq/100g soil).

Table 2. Combined effect of different levels of fertilizers and green manures on grain quality of transplant aman rice

Treatment combinations	Moisture (%)	Amylose (%)	Protein (%)	Carbohydrate (%)
F_0G_0	10.10 de	23.50 k	6.50 h	71.30 h
F_0G_1	10.30 cd	26.10 bc	8.10 def	80.05 fg
F_0G_2	10.50 abc	26.00 c	8.30 bcd	80.10 fg
F_0G_3	10.50 abc	26.40 b	7.80 f	80.60 de
F_0G_4	9.90 ef	23.90 ij	7.90 ef	81.10 bc
F_1G_0	9.70 fg	25.50 d	8.50 abc	80.70 cde
F_1G_1	9.70 fg	23.60 jk	8.30 bcd	80.90 cd
F_1G_2	9.90 ef	24.80 fg	8.60 ab	80.40 ef
F_1G_3	10.40 bc	25.30 de	8.40 bcd	80.10 fg
F_1G_4	9.20 h	23.10 l	8.20 cde	81.50 b
F_2G_0	10.30 cd	23.00 l	8.50 abc	80.10 fg
F_2G_1	10.00 e	24.70 g	8.40 bcd	80.50 def
F_2G_2	9.60 g	26.10 bc	8.80 a	80.80 cde
F_2G_3	9.60 g	24.90 fg	8.50 abc	80.80 cde
F_2G_4	10.70 a	25.10 ef	8.50 abc	79.70 g
F_3G_0	10.10 de	23.80 ijk	7.90 ef	80.90 cd
F_3G_1	10.10 de	24.30 h	8.20 cde	80.60 de
F_3G_2	10.70 a	24.00 hi	8.30 bcd	79.90 g
F_3G_3	10.60 ab	27.10 a	8.20 cde	80.10 fg
F_3G_4	9.90 ef	24.90 fg	6.90 g	82.10 a
$LSD_{(0.05)}$	0.25	0.39	0.30	0.46
CV (%)	1.49	0.94	2.22	0.35

F_0 = No fertilizers (control)
F_1 = Recommended dose
F_2 = 75% of the recommended dose
F_3 = 50% of the recommended dose

G_0 = No green manures (control)
G_1 = *Mimosa invisa* at 5 t ha^{-1}
G_2 = *Mimosa invisa* at 10 t ha^{-1}
G_3 = *Sesbania* spp. at 5 t ha^{-1}
G_3 = *Sesbania* spp. at 10 t ha^{-1}

Salahin *et al.* (2013) opined that incorporation of green manure increases organic acid which ultimately decreases soil pH. Georgantas and Grigoropoulou (2006) observed that pH value less than 6 created a chemical bond between aluminum (Al) and phosphate (known as phosphorus fixation), thus availability of phosphorus may be reduced on soil testing but it is good for use of this nutrient by next crop. Sahu and Nayak (1971) obtained a slight decline of soil K after green manure addition.

Table 3. Chemical properties of soil as before and after incorporation of green manures

Chemical properties of soil	Pre-planting (unincorporated soil)	Post-harvest (after incorporation)
pH	6.30	6.10
Organic matter (%)	0.94	1.48
Total nitrogen (%)	0.047	0.074
Available phosphorus (ppm)	27.93	23.93
Exchangeable potassium (meq/100g soil)	0.20	0.13
Available sulphur (ppm)	3.40	3.73
Available zinc (ppm)	5.63	9.13

Source: Soil resource development institute (SRDI), Khamarbari, Dhaka

Conclusion

It could be suggested that incorporation of green manure either *Mimosa invisa* or *Sesbania* spp. into the soil has a positive influence in increasing grain yield, grain quality of transplanted aman rice and soil health status as well. The 75% recommended dose of fertilizers along with *Mimosa invisa* @ 10 t ha^{-1} produced the highest grain yield (7.25t/ha) and at par with 50% recommended dose of fertilizers plus *Mimosa invisa* @ 10 t ha^{-1}. So, application of novel green manure like *Mimosa invisa* in T. aman cultivation could reduce fertilizer cost by 25-50%.

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