ISSN 0258-7122 (Print), 2408-8293 (Online)
Bangladesh J. Agril. Res. 42(3): 467-474, September 2017

EFFECT OF BIOSLURRY ON TRANSPLANTED AUS RICE UNDER RAINFED CONDITION IN SYLHET

M. R. SHAHEB[1] AND M. I. NAZRUL[2]

Abstract

An experiment was conducted in farmer's field with the aim to evaluate the effect of integrated use of bioslurry and inorganic fertilizer on the agroeconomic performance of transplanted aus rice (t. aus) (cv. BRRIdhan42) in AEZ 20. The trial was laid out in a randomized complete block design with three replications. There were three treatments *viz*., T_1: soil test based inorganic fertilizer dose for high yield goal (HYG), T_2: cowdung (CD) slurry @ 5 t ha^{-1} with integrated plant nutrition system (IPNS) basis inorganic fertilizer dose for HYG and T_3: Farmer's practice (average of 20 farmers fertilizer dose). The highest mean grain yield (3.93 t ha^{-1}) of t. aus rice was obtained from the treatment T_2 followed by T_1 (3.46 t ha^{-1}). Gross return, gross margin and benefit cost ratio were also observed higher in T_2. Therefore, fertilizer package NPKSZn @ 56-4-20-9-1 kg ha^{-1} + cow dung slurry @ 5 t ha^{-1} in IPNS approach might be helpful for getting higher grain yield of t. aus rice and maintaining sustainable soil health as well.

Keywords: Bioslurry, IPNS, transplanted aus rice, benefit cost ratio, soil health.

Introduction

The fertility status of Bangladesh soils is gradually declining and becoming a critical issue for sustainable crop production. Most of the soils are depleted and decline in crop yields is observed everywhere if proper fertility management is not made (Islam, 2006). A good soil should have at least 2.0% organic matter (OM), but in Bangladesh most of the soils have less than 1.5% OM and some soils have even less than 1% OM (FRG, 2012). Proper sol fertility management is, therefore, one of the prime importances in an endeavor to increase crop productivity and food security.

Bio-slurry produced from biogas plant is rich in nutrients and can be used successfully for economic crop production. It is an important type of organic manure that is applied in the form of semi-liquid or compost. It contains considerable amount of plant nutrients compared to cowdung, poultry manure or even compost that improves the soil fertility. It has no toxic or harmful effects on plants. The nutrient quality of bioslurry is higher than that of compost manure and chemical fertilizer. Because of the minimal loss of nitrogen in slurry, it is more effective as fertilizer than composted cattle dung (Islam, 2006; BCAS, 2009). Joshi *et al*. (1994) reported that use of bio-slurry along with inorganic fertilizers may be a good option for increasing soil fertility. The preliminary

[1&2]Senior Scientific Officer, On-Farm Research Division, Bangladesh Agricultural Research Institute (BARI), Sylhet-3100, Bangladesh.

experimental results also indicated that the yield of crops and vegetables could be increased from 10 to 30 percent through the application of slurry (CMS/FAO, 1996). Bonten *et al*. (2014) asserted that nutrients in bio-slurry, especially nitrogen, are more readily available than in manure, leading to a larger short term fertilization effect. Batsai *et al.* (1979) and Shaheb and Nazrul (2011) observed that chemical fertilizer along with bioslurry produced the highest cabbage yield. Although animal waste causes environmental pollution (Paik, 1999) when applied to land without appropriate controls and management (Balsari *et al*., 2005), the agronomic utilization of slurry represents the best solution for their reuse specially as a potential source of soil nutrients for smallholder rural farmers. However, the utilization of bio-slurry along with inorganic fertilizers may be a good option for increasing crop productivity and soil fertility. The maintenance of organic matter, soil fertility and sustainable crop production are some alarming issues for the farmers and agricultural scientists. Research work on the bioslurry is lacking in acidic soil of Sylhet, Bangladesh. Therefore, the present study was undertaken to evaluate the efficiency of bio-slurry on the performance of t. aus rice under rainfed condition in AEZ 20.

Materials and Method

The experiment was conducted at farmer's field in multilocation testing site, Moulavibazar (AEZ 20) during the two consecutive years of 2011 and 2012 under rainfed condition in AEZ 20. The experiment was laid out in a randomized complete block design with three replications. Three fertilizer treatments *viz*., T_1: soil test based inorganic fertilizer dose for high yield goal (HYG), T_2: cowdung (CD) slurry @ 5 t ha^{-1} with IPNS basis inorganic fertilizer dose for HYG and T_3: Farmer's practice (average of 20 farmers fertilizer dose applied in transplanted aus rice) were used in the trial. The initial soil nutrient status of the experimental soil is presented in Table-1. Treatment-wise nutrient elements were calculated based on the initial soil nutrient status with the help of FRG (2005) and described in Table 2. The unit plot size was 6m × 5m. Rice variety BRRIdhan42 of transplanted aus (t. aus) was used in the trial. Entire amounts of cow dung slurry as per treatment were applied 4 days before final land preparation. The whole amount of phosphorus (P), potassium (K), sulphur (S), boron (B) and ⅓ of nitrogen (N) were applied during final land preparation. The rest of N was top dressed at 21 and 45 days after transplanting of aus rice. Twenty seven day old aus rice seedlings were transplanted on 08-10 June 2011. Plant protection measures and other intercultural operations were done as and when necessary. The crop was harvested on 15 and 17 August in 2011 and 2012, respectively. Five years average monthly maximum and minimum temperatures and monthly total rainfall data have been presented in Fig. 1. Data on yield attributes *viz*., plant height, plants per m^2, effective tillers per plant and 1000 grain weight were recorded in time. Individual plot-wise data on grain and straw yields were recorded and converted into t ha^{-1}. Harvest index and biological yield were calculated by the following formula (Equ. 1 and 2). The collected data were analyzed statistically following the ANOVA technique with the help of MSTAT-C software. The mean differences among the treatment means were adjudged by Least Significant Difference (LSD) test (Gomez and Gomez, 1984).

$$\text{Harvest Index (\%)} = \frac{\text{Grain Yield}}{\text{Biological Yield}} \times 100 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

$$\text{Biological Yield} = \text{Grain Yield} + \text{Straw Yield} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(2)$$

Table 1. Initial soil (0-15cm depth) nutrient status of the experimental field

Nutrients	N (%)	P (µg/g soil)	K (m.eq /100g soil)	S (µg/g soil)	Zn (µg/g soil)	B (µg/g soil)	OM (%)	p^H
Value	0.08	9.55	0.12	7.53	1.04	0.48	1.85	5.10
Critical limit	0.12	7.0	0.12	10.0	0.6	0.2	-	-
Interpretation	Very low	Low	Low	Low	Medium	Optimum	Medium	Acidic

Table 2. Treatment-wise nutrient elements for transplanted aus rice

Treatments	N-P-K-S-Zn (kg ha^{-1}) + Cowdung Slurry (CDS)
T_1: soil test based inorganic fertilizer dose for high yield goal (HYG)	78-11-45-9-1 + 0
T_2: cowdung slurry @ 5 t ha^{-1} + IPNS basis inorganic fertilizer dose for HYG	56-4-20-9-1 + CDS @5 t ha^{-1}
T_3: Farmer's practice (average of 20 farmers fertilizer dose)	80-20-25-0-0 + 0

Results and Discussion

Five years average monthly maximum and minimum temperatures and monthly total rainfall data have been presented in Fig. 1. It was observed that the highest amount of average monthly rainfall in Sylhet was recorded in June followed by August, July and May, whereas the lowest amount of rainfall occurred in January followed by December and February. Rainfall increased gradually from the month of January to June and then decreased. However, the annual monthly total rainfall was 3720 mm during the period 2007-12. Average maximum and minimum temperatures were 31.32 and 14.71^{0}C, respectively. Two years research results on the yield attributes and yield of t. aus rice (cv. BRRI dhan42) are presented in Tables 3-5. Results revealed that yield attributes and yield of t. aus rice were significantly influenced by different nutrient packages except plants per m^2 in 2011. The details discussion is furnished below.

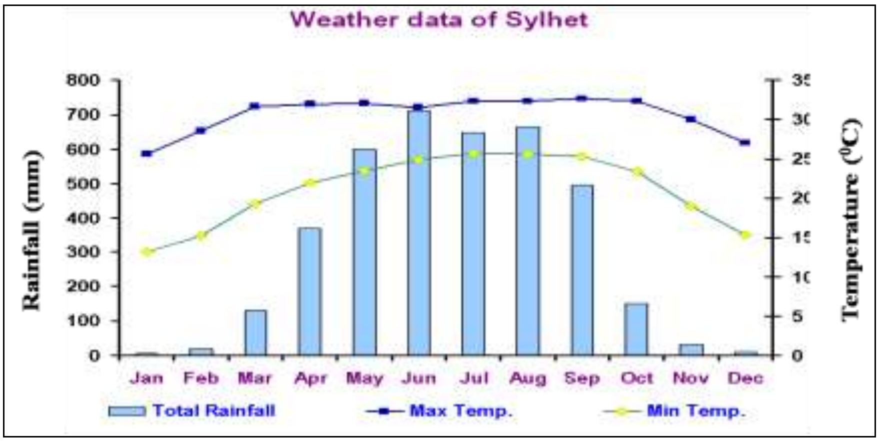

Fig. 1. Monthly average total rainfall, maximum and minimum air temperatures in Sylhet during the period 2007-2013.

Yield attributes of transplanted aus rice

Treatment having CD slurry @5 t ha^{-1} along with IPNS based inorganic fertilizer gave the longest plant heights of t. aus rice (87.17 and 89cm) compared to that of only inorganic fertilizers in both the years of 2011 and 2012 (Table 3). The shortest plants (83.93 and 86.27 cm) were obtained from farmer's practice (T_3) treatment in both the years, respectively. Like plant height, the highest number of plants per m^2 (243.40) was obtained from T_2 treatment (CD slurry @ 5 t ha^{-1} with IPNS based inorganic fertilizer) which was close to T_1 treatment in 2011. The highest number of effective tillers per plant (14.10 and 13.30) was obtained from T_2 treatment (CD slurry @ 5 t ha^{-1} with IPNS based inorganic fertilizer) but the lowest tillers per plant (10.93 and 10.67) was obtained in T_3 treatment in both the years, respectively. On the contrary, the highest 1000 grain weights (25.15 and 24.88g) were recorded in CD slurry @ 5 t ha^{-1} with IPNS based inorganic fertilizer and the lowest 1000 grain weights (23.32 and 23.78g) were recorded in farmer's practice (T_3) in 2011 and 2012, respectively (Table 3).

Table 3. Yield attributes and yield of transplanted aus rice in AEZ 20 during 2011 and 2012

Treatments*	Plant height (cm)		Plants m^{-2}		Effective tillers $plant^{-1}$ (nos.)		1000 grain weight (g)	
	2011	2012	2011	2012	2011	2012	2011	2012
T_1	84.77	86.33	239.20	239.20	11.85	11.08	23.77	23.98
T_2	87.17	89.00	245.60	243.40	14.10	13.30	25.15	24.88
T_3	83.93	86.27	159.80	236.50	10.93	10.67	23.32	23.78
LSD(0.05)	1.77	2.23	NS	6.28	1.54	1.08	1.55	0.61
CV(%)	0.92	1.13	35.45	1.16	5.54	4.08	2.84	1.12

*T_1: soil test based inorganic fertilizer dose for high yield goal (HYG), T_2: cowdung slurry @5 t ha^{-1} + IPNS based inorganic fertilizer dose for HYG and T_3: Farmer's practice (average of 20 farmers fertilizer dose).

Table 3. Continued.

Treatments*	Grain yield ($t\ ha^{-1}$)			Straw yield ($t\ ha^{-1}$)			Biological yield ($t\ ha^{-1}$)	Harvest Index (%)
	2011	2012	Mean	2011	2012	Mean		
T_1	3.57	3.35b	3.46	4.87	4.08	4.48	7.94	43.60
T_2	4.14	3.71a	3.93	4.43	3.89	4.16	8.09	48.55
T_3	3.39	3.16b	3.28	4.17	4.35	4.26	7.54	43.46
LSD(0.05)	0.28	0.28	0.28	0.37	0.29	0.33	-	-
CV(%)	3.36	3.61	3.49	3.32	3.18	3.25	-	-

*T_1: soil test based inorganic fertilizer dose for high yield goal (HYG), T_2: cowdung slurry @5 t ha^{-1} + IPNS based inorganic fertilizer dose for HYG and T_3: Farmer's practice (average of 20 farmers fertilizer dose).

Biological yield and harvest index of transplanted aus rice

Grain and straw yields of t. aus rice (cv. BRRI dhan42) was influenced significantly by different fertilizer treatments (Table 4). In 2011, the highest grain yield (4.14 t ha^{-1}) was recorded in CD slurry @5 t ha^{-1} along with IPNS based inorganic fertilizer, while the lowest grain yield (3.39 t ha^{-1}) was obtained from farmer's practice. In 2012, the highest grain yield (3.71 t ha^{-1}) was recorded in T_2 (CD slurry @5 t ha^{-1} along with IPNS based inorganic fertilizer), which was followed by T_1 (inorganic fertilizers for HYG) (3.35 t ha^{-1}). The lowest grain yield was recorded in farmer's practice (3.16 t ha^{-1}). From the result, it was evident that cowdung bio-slurry has a great potentiality in increasing t. aus rice production. The highest straw yields (4.87 and 4.35 t ha^{-1}) were recorded in T_1 and T_3 treatments, respectively in both the years. It might be due to the accumulation of more dry matter in T_3. From the mean grain yield of two years, it was also found that treatment T_2 provided the highest grain yield (3.93 t ha^{-1}). The highest mean biological yield of t. aus rice (8.09 t ha^{-1}) was achieved from the same treatment (T_2). However, yield increase due to application of CD slurry @5 t ha^{-1} along with IPNS based inorganic fertilizer (T_2) was 113 and 120% compared to soil test based inorganic fertilizer (T_1) and farmer's practice (T_3), respectively. Similarly, the highest harvest index (48.55) of t. aus rice was recorded in T_3 treatment. Gnanamani and Kasturi Bai (1992) reported that the yield of rice grain showed a 23 percent increase when soil was amended with biodigest slurry compared to SF (containing N, K and P). Similar results were also observed by Bharde (2003). A combination of biogas slurry @ 12.5 t ha^{-1} and 100% NPK had pronounced effect on enhanced growth and yield attributes and yield of rice (Gurung, 1997). The result is also in conformity with the findings of Shaheb and Nazrul (2011) who reported that inorganic fertilizer along with cowdung slurry 5 t ha^{-1} in IPNS approach produced the highest yield of cabbage. Higher crop yield due to application of bio-slurry were also reported by Manna and Hazra (1996) and Galli and Lalitpur (2001). Biogas slurry increases agricultural production because of its high content of plant nutrients, growth hormones and enzymes (CMS/FAO, 1996). Garfi *et al.* (2011) asserted that the potato yield was increased by 27.5 percent with bioslurry compared to the control. Warnars (2012) alluded that bio-slurry increased crop revenues with an average of 25 percent. Thus, it might be summed up that bioslurry has profound effect to increase the production of t. aus rice.

Table 4. Cost and benefit analysis of t. aus rice as influenced by bio-slurry in AEZ 20 during 2011 and 2012

Treatments*	Gross return (Tk. ha^{-1})	Total variable cost (Tk. ha^{-1})	Gross margin (Tk. ha^{-1})	BCR
1	2	3	4 (2-3)	5 (2÷3)
T_1	78150.00	39716.00	38434.00	1.97
T_2	86820.00	42882.00	43938.00	2.02
T_3	74020.00	38676.00	35344.00	1.91

*T_1: soil test based inorganic fertilizer dose for high yield goal (HYG), T_2: cowdung slurry @5 t ha^{-1} + IPNS based inorganic fertilizer dose for HYG and T_3: Farmer's practice (average of 20 farmers fertilizer dose).

N. B. Price of inputs and outputs ((Tk. kg^{-1})*):*

Price of input (Tk. kg^{-1})	Price of output (Tk. kg^{-1})
Rice seed-35.00	Rice grain-20.00
Cowdung slurry-1.00	Rice straw-2.00
Urea-12.00	
TSP-22.00	
MOP-15.00	
Gypsum-10.00	
Zinc Sulphate-130.00	

Economic analysis

The cost and return analysis of different fertilizer treatments are presented in Table 5. The highest gross return (Tk.86820 ha^{-1}), net return (Tk.43938 ha^{-1}) and benefit cost ratio (2.02) were obtained in IPNS basis inorganic fertilizer application with 5 t ha^{-1} cow dung slurry for HYG. Gross return, gross margin and benefit cost ratio were the lowest with farmer's practice. Profitable production of cabbage and cauliflower was found with poultry manure slurry @ 3 t ha^{-1} or CD slurry @ 5 t ha^{-1} with IPNS basis inorganic fertilization in Grey Terrace Soil (AEZ-28) of Joydebpur (BARI, 2008). The results of this study are also in conformity with the findings of Shaheb and Nazrul (2011) who reported that inorganic fertilizer applied with bioslurry in an IPNS approach gave higher yield as well as economic return of cabbage. Gnanamani and Kasturi Bai (1992) asserted that the combined application of mineral fertilizer with slurry performed better than the separate application of either mineral fertilizer or slurry in their experimentation.

Table 5. Post harvest (0-15cm depth) nutrient status of the bioslurry applied experimental soil (mean of two years).

Nutrients	N (%)	P (µg/g soil)	K (m.eq /100g soil)	S (µg/g soil)	Zn (µg/g soil)	B (µg/g soil)	OM (%)	p^H
Value	0.11	10.50	0.10	9.19	1.20	0.47	2.1	5.30
Critical limit	0.12	7.0	0.12	10.0	0.6	0.2	-	-
Interpretation	Low	Low	Low	Low	Medium	Optimum	Medium	Acidic

Post harvest nutrient status of the soil

Post harvest nutrient status of the experimental field at 0-15cm depth of the soil was described in Table 6. Results revealed that soil nutrient status in bioslurry treated plots were increased compared to initial nutrient status of the soil. Soil pH was also slightly increased in the bioslurry treated plots compared to others. It might be due to application of bioslurry. The results are in agreement with the findings of Joshi *et al.* (1994) who reported that use of bio-slurry along with inorganic fertilizers may increase fertility of the soil. Islam (2006) also asserted that integrated plant nutrition system (IPNS) that combines the use of organic (bioslurry) and chemical fertilizers play a vital role in restoring fertility as well as organic matter status of the soils.

Conclusion

From the results, it can be concluded that application of CD slurry@ 5 t ha^{-1} with IPNS based inorganic fertilizer is better than other two treatments to obtain higher yield and economic return of transplanted aus rice. Cost benefit analysis also confirmed that the same treatment provided the highest gross return, net return and BCR. Soil nutrient status after harvest of t. aus rice also slightly increased due to application of bioslurry with inorganic fertilizers in the soil. Thus, it is recommended that farmers of AEZ 20 should apply cowdung slurry with IPNS basis inorganic fertilizer dose in their field for getting higher economic return and better soil health.

References

Balsari, P., G. Airoldi and F. Gioelli. 2005. Improved recycling of livestock slurries on maize by means of a modular tanker and spreader. *Bioresource Techno1*. **96**(2):229-234.

BARI. 2008. Project report on “Bio-slurry management and its effect on soil fertility and crop production”. Soil Science Division & On-Farm Research Division, Bangladesh Agricultural Research Institute, Gazipur 1701, Bangladesh. p.41.

Batsai, S. T., A. A. Polyakev and R. F. Nedbal. 1979. Effect of organic and mineral fertilizers on the yield and quality of irrigated late and white cabbage in the steppe region of the Crimea. *Hort. Abst*. **49** (11): 730.

BCAS. 2009. Biogas User Survey 2008 under National Domestic Biogas and Manure Program (Final report). IDCOL, Dhaka.

Bharde, N. M., Y. S. Shivay and S. Singh. 2003. Effect of bioslurry and neem oil-treated urea sources in rice (*Oryza sativa*)-wheat (*Triticum aestivum*) cropping system, *Indian J. Agron.* **48** (2): 73-75.

Bonten, L. T. C., K. B. Zwart., R. P. J. J. Rietra1., R. Postma and M. J. G. de Haas. 2014. Bio-slurry as fertilizer. Is bio-slurry from household digesters a better fertilizer than manure? A literature review. Alterra report 2519. Alterra Wageningen UR, Wageningen. pp 50. www.wageningenur.nl/en/alterra (Last accessed on 20 December 2014).

CMS/FAO. 1996. Biogas Technology: A Training Manual For Extension. Published by FAO, Rome, Italy.

FRG. 2005. Fertilizer Recommendation Guide, Bangladesh Agricultural Research Council (BARC), Farmgate, Dhaka. Pp. 64, 238-243.

FRG. 2012. Fertilizer Recommendation Guide, Bangladesh Agricultural Research Council (BARC), Farmgate, Dhaka. P. 58.

Galli, K. and P. Lalitpur, 2001. Response to bio-slurry application on maize and cabbage in Lalitpur District, Nepal. Final Report. October 2001. GPO Box 1309, Kathmandu, Nepal. Pp. 63.

Garfi, M., P. Gelman., J. Comas., W. Carrasco., I. Ferrer. 2011. Agricultural reuse of the digestate from low-cost tubular digesters in rural Andean communities. *Waste Management,* doi:10.1016/j.wasman.2011.08.007.

Gnanamani, A. and R. Kasturi Bai. 1992. Influence of biodigested slurry on rice-gram cultivation. *Bioresource Technol.* **41**(3):217–221.

Gomez, K.A and A.A. Gomez. 1984. Statistical Procedures for Agricultural Research. 2nd edn. John Wiley and Sons. New York. Pp. 207-215.

Gurung, J. B. 1997. Review of Literature on Effects of Slurry Use on Crop production. FINAL REPORT submitted to The Biogas Support Program Post Box 1966 Kathmandu, Nepal, Pp. 109.

Islam, M.S. 2006. Use of bioslurry as organic fertilizer in Bangladesh agriculture. Paper presented in the International Workshop, Bangkok, Thailand, 27-28 September 2006.

Joshi, J. R., J. F. Moncrief, J. B. Swan and G. L. Malzer. 1994. *Soil Till. Res.* **31**: 225.

Manna, M. C and J. N. Hazra. 1996. Comparative performance of cowdung slurry, microbial inoculum and inorganic fertilizers on Maize. *J. Indian Soc. Soil Sci.* **44** : 526-528.

Paik, I. K. 1999. Strategies to reduce environmental pollution from animal manure: Nutritional management option. *Asian-Aust. J. Anim. Sci.* **12**:657-666.

Shaheb, M. R. and M. I. Nazrul. 2011. Performance of cabbage under IPNS with cowdung bio-slurry in estern surma-kushiyara floodplain. *Bangladesh Agron. J.* **14** (1&2): 23-26.

Warnars, P. 2012. From biomass to biogas: present day status & future requirements. Master Thesis, International Development Studies. Utrecht University. P. 64.