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BIO-SLURRY INFLUENCES THE YIELD AND PROFITABILITY OF RADISH

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Abstract

Bio-slurry is a renewable source based organic fertilizer that can improve the nutrient status of soil. An on-farm verification trial of bio-slurry was carried out at farming system research and development site, Jalalpur, Sylhet during *rabi* season of 2011-12. The aim of the study was to verify the effect of integrated use of bio-slurry along with inorganic fertilization on the performance of radish in agroecological zone (AEZ) 20. The trial was replicated thrice with three treatments viz. T_1: soil test basis (STB) inorganic fertilizer dose for high yield goal (HYG), T_2: cowdung (CD) bio-slurry @ 5 t ha^{-1} along with IPNS basis inorganic fertilizer dose for HYG and T_3: farmers' practice i.e. average of 20 farmers' fertilizer dose. Results revealed that the highest root yield of radish (45.60 t ha^{-1}) was recorded from T_2 treatment that was closely followed by T_1 treatment (42.60 t ha^{-1}). Increment of radish yield in T_2 was 107 and 111% compared to T_1 and T_3 treatments, respectively. Highest gross return (Tk 3,64,800 ha^{-1}), gross margin (Tk 3,05,550 ha^{-1}) and benefit cost ratio (6.16) were also obtained from the same treatment (T_2). But, post harvest chemical analysis of soil indicated that there were no significant changes in soil pH, OM and other nutrients due to application of bio-slurry. However, as bioslurry based crop revenue is more profitable than others and therefore nutrient package N-P-K-S-Zn-B @ 67-44-99-25-2-2 kg ha^{-1}, respectively + CD bio-slurry @ 5 t ha^{-1} might help provide higher yield of radish as well as sustainable crop management in AEZ 20.

Keywords: Bio-slurry, IPNS, yield of radish, crop revenue

Introduction

Bangladesh has a wide range of environmental conditions and this diversity occurs in all agro-ecological regions (AEZ) of the country. Soil fertility status of AEZs is gradually diminishing and this is now a big concern of the scientists and policy makers. Over and prolonged uses of chemical fertilizers in soil are two of the vital reasons behind it. 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). Bio-slurry produced from biogas plant can be a potential source of OM. It contains considerably higher amount of plant nutrients than cowdung (CD), poultry manure (PM) or even compost that improves the soil fertility and crop production. So, application of bio-slurry along with inorganic fertilizers may be a good option for increasing soil health while sustaining higher yield of crops. Positive effect of integrated use of bio-slurry along with inorganic fertilizers was found in some tested crops in different sites in Bangladesh (Anon, 2008). The nutrient quality of bio-slurry is higher and loss of nitrogen is lesser than that of compost, manure and chemical fertilizer (Islam, 2006). Joshi *et al.* (1994) reported that use of bio-slurry along with inorganic fertilizers could help increasing soil fertility. Nutrients in bio-slurry, especially nitrogen, are more readily available than in manure, leading to a larger short term fertilization effect (Bonten *et al.* 2014). A number of studies were also revealed that bio-slurry increased crop revenues and represented a potential source of soil nutrients for smallholder rural farmers (Batsai *et al.* 1979; Balsari *et al.* 2005; Holm-Niesen *et al.* 2009; Shaheb and Nazrul, 2011 and Warnars, 2012).

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Radish is an edible root vegetable, rich in ascorbic acid, folic acid, and potassium, good source of vitamin B_6, riboflavin, magnesium, copper, and calcium (htts://en.wikipedia.org) and is grown all over the world. Shahabaz (2011) showed that under equal nitrogen conditions, bio-slurry treatment on radish can increase the quality of the crop and soil. The maintenance of organic matter, soil fertility as well as sustainable crop production etc. are some alarming issues for the farmers and agricultural scientists. Soil fertility and productivity status in Sylhet region, especially in AEZ 20, are not satisfactory due to low OM in soil, imbalanced use of inorganic fertilizer, less use of organic manure and so on. The soils in these areas are generally heavy, clay loams to clays and the top soil quickly becomes dry and hard after the harvest of transplanted *aman* rice. However, rainfall prevails here till late October and in some cases to early November that offers the opportunity for the production of short duration crops like radish, potato, others vegetables etc. On the other hand, many biogas plants have already been functioned in different areas in Sylhet, Moulvibazar and Sunamgonj. As bio-slurry contains substantial plant nutrients, application of this organic manure in soil might help for sustainability of crop production and soil health management. Research findings on the verification effect of bio-slurry on radish as a deep rooted crop under farmers' condition is lacking in acidic soil of Sylhet environment (AEZ 20). Hence, the present study was undertaken to evaluate the efficiency of integrated use of bio-slurry along with inorganic fertilizers on the performance of radish and soil nutrient status in AEZ 20.

Materials and Methods

An on-farm verification trail of bio-slurry on the performance of radish was carried out at FSRD (farming system research and development) site, Jalalpur, South Surma, Sylhet in AEZ-20 of Bangladesh during the *rabi* season of 2011-12. The trial was replicated thrice with three treatments viz. T_1: soil test basis (STB) inorganic fertilizer dose for high yield goal (HYG), T_2: cowdung (CD) bio-slurry @ 5 t ha^{-1} along with integrated plant nutrient system (IPNS) basis inorganic fertilizer dose for HYG and T_3: farmers' practice i.e. average of 20 farmers' fertilizer dose. Dominant variety Tasakisan (BARI Mula-1) was selected by the cooperator farmers and used in the trail. The unit plot size was $30m^2$ (5m × 6m). Seeds of radish were sown on 22 November. The initial soil nutrient status of the experimental plots was presented in Table 1. Nutrient packages for each treatment were calculated based on the BARC (2005) and were presented in Table 2. Fertilizers were applied as per the treatment specification of the trial and these were T_1: N-P-K-S-Zn-B @ 89-51-124-25-2-2 kg ha^{-1}, respectively; T_2: CD bio-slurry @ 5 t ha^{-1} + N-P-K-S-Zn-B @ 67-44-99-25-2-2 kg ha^{-1}, respectively (IPNS basis) and T_3: N-P-K-S-Zn-B @ 100-80-70-0-0-0 kg ha^{-1}, respectively. Monthly mean maximum and minimum temperatures and total rainfall data were presented in Fig. 1. Intercultural operations viz. weeding, irrigation and spraying of insecticides were done as and when required in order to support normal establishment, growth and development of the crop. The crop was harvested at full maturity and it was ranged from 45 to 60 days after sowing (DAS) of seed. Data on plant height, individual root weight, root length and diameter of radish were recorded from the ten randomly selected plants of each treatment. Plot wise data on root yield of radish was recorded and converted into per hectare of yield. Soil samples of each treatment after harvest of radish were also collected and subjected to chemical analysis at Regional Laboratory of SRDI, Sylhet. Data were then statistically analyzed following MSTATC software and mean separation were accomplished by DMRT as per Gomez and Gomez (1984).

Table 1. Initial soil nutrient status of the experimental field

Items	pH	OM (%)	N (%)	P (µgg^{-1} soil)	K (m.eq 100g^{-1} soil)	S (µgg^{-1} soil)	Zn (µgg^{-1} soil)	Mg (meq. 100g^{-1} soil)	B (µgg^{-1} soil)
Value	4.5	1.95	0.11	3.00	0.08	7.00	0.70	0.49	0.12
Interpretation	Very strongly acidic	Medium	Low	Very low	Very Low	Very low	Low	Low	Very Low

Results and Discussion

Weather data

Average maximum and minimum temperatures and total rainfall in Sylhet for the years 2010-2012 are presented in Fig. 1. According to the figure, the highest amount of average monthly total rainfall 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. The average monthly total rainfall was 3720 mm and the average maximum and minimum temperatures were 31.32 and 14.71^0C,

respectively. However, weather data revealed that radish was received very small amount of precipitation over the growing period that may not have significant effect on the growth and yield. Nonetheless, lower temperatures might have favoured to produce higher yield of radish.

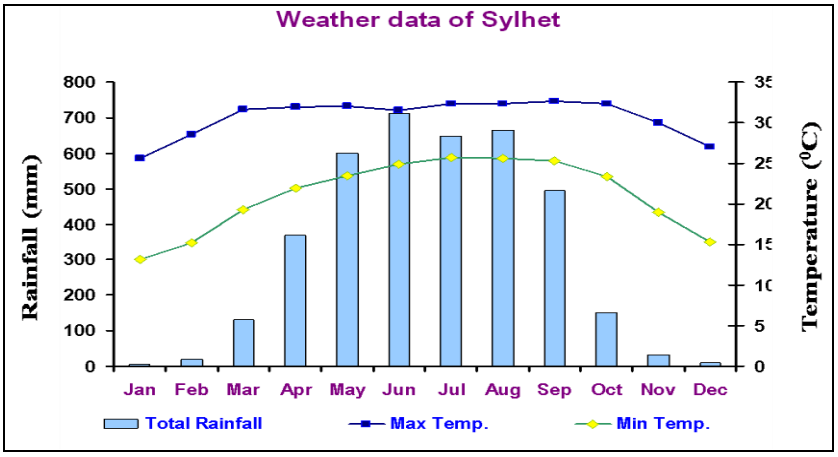

Fig. 1. Monthly total rainfall, mean maximum and minimum temperatures in Sylhet (2010-2012)

Effect of bio-slurry on the yield attributes and root yield of radish

Results revealed that the root yield and yield attributes of radish except root diameter were significantly influenced by different nutrient packages (Fig. 2 and Table 3). Application of STB inorganic fertilizers produced the longest plant height of radish compared to other treatments. Highest plant height (57.97 cm) was obtained from STB inorganic fertilizer (T_1) which was followed by CD bio-slurry @ 5 t ha^{-1} along with IPNS basis inorganic fertilizer dose for HYG treatment (T_2) (55.17 cm). Lowest plant height (53.70 cm) was obtained from farmers' practices (T_3) treatment. But, the highest individual root weight of radish (1060 g) was recorded from T_2 treatment (CD bio-slurry @ 5 t ha^{-1} along with IPNS basis inorganic fertilizer dose for HYG), which was close to T_1 treatment (960 g). The lowest individual weight $plant^{-1}$ was gained in T_3 treatment (830 g). Like individual weight, the highest root length of radish (24.20 cm) was recorded in CD bio-slurry @ 5 t ha^{-1} along with IPNS basis inorganic fertilizer dose for HYG treatment (T_2). Similarly the lowest root length of radish (22.33 cm) was obtained from farmers' practices treatment (T_3).

Table 2. Treatment-wise nutrient packages for radish (var. Tasakisan) production

Treatments	**N-P-K-S-Zn-B (kg ha^{-1})**
T_1: STB inorganic fertilizer dose for HYG	89-51-124-25-2-2
T_2: IPNS basis inorganic fertilizer + cowdung slurry @ 5 t ha^{-1} for HYG	67-44-99-25-2-2+ 5 t ha^{-1} cow dung slurry
T_3: Farmers practice (average of 20 farmers fertilizer dose)	100-80-70-0-0-0

Table 3. Effect of CD bio-slurry on the yield attributes of radish in AEZ 20

Treatments*	**Plant height (cm)**	**Individual root weight (kg)**	**Root length (cm)**	**Root diameter (cm)**
T_1	57.97a	960b	22.90b	19.27
T_2	55.17b	1060a	24.20a	19.82
T_3	53.70b	830c	22.33c	17.50
LSD (0.05)	1.95	97.07	0.24	NS
CV (%)	1.54	4.51	0.46	6.81

**Here, T_1: Inorganic basis fertilizer dose for HYG, T_2: CD bio-slurry @ 5 t ha^{-1} + IPNS basis inorganic fertilizer dose for HYG and T_3: Farmers practice fertilizers dose (Average of 20 farmers).*

Moreover, Fig. 2 shows that the highest root yield of radish (45.60 t ha^{-1}) was observed in CD bio-slurry @ 5 t ha^{-1} along with IPNS basis inorganic fertilizer dose for HYG treatment (T_2) that was closely followed by STB inorganic fertilizer treatment (42.60 t ha^{-1}) (T_1). However, the lowest root yield (41.13 t ha^{-1}) was obtained from farmers'

practice (T_3). From this result, it might be evident that cowdung slurry has a great potentiality in increasing root yield of radish. Result showed that the increment percentage in the yield of radish were noticeable and these were 7 and 11 percent more in CD bio-slurry @ 5 t ha^{-1} along with IPNS basis inorganic fertilizer dose for HYG (T_2) treatment compared to STB inorganic fertilizer (T_1) and farmers' practices treatments (T_3). Regression co-efficient study also revealed that association between different nutrient management and root yield (r^2= 0.104) showed highly significant positive correlation (Fig. 2). Higher accumulation of dry matter leading to higher individual root weight might have significant contribution to attain higher yield of radish in T_2 treatment. The findings of the present study are in conformity with that of Jayakumar *et al.* (1993) and Manna and Hazra (1996) who reported that bio-slurry has a positive effect to increment of crop yield. Increased radish yield obtained in the study also confirmed the results as reported by Warnars and Oppenoorth (2014). Furthermore the results are also similar to that of Shaheb and Nazrul (2011) who reported that CD slurry @ 5 t ha^{-1} along with IPNS basis inorganic fertilizers produced the highest yield of cabbage in AEZ 20. Similar results were also reported by Bharde (2003) and Garfi *et al.* (2011). In addition, the role of bio-slurry to sustainable increase of crop revenue was also remarked by CMS/FAO (1996) and Galli and Lalitpur (2001).

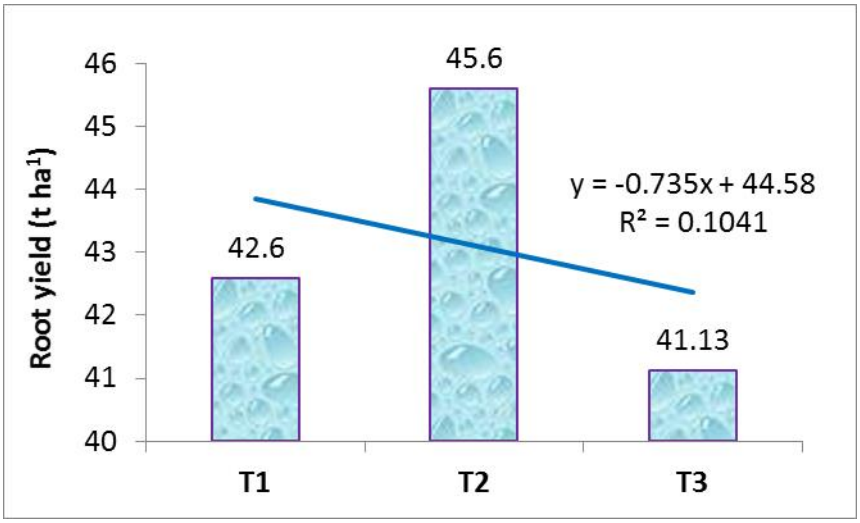

Fig. 2. Effect of integrated use of bioslurry on the root yield of Radish

Effect of bioslurry on nutrients status of soil

The post-harvest chemical analysis of soil, as presented in Table 4, revealed that there were no significant change in soil pH and OM in three treatments viz. application of STB inorganic fertilizer (T_1), CD bio-slurry @ 5 t ha^{-1} along with IPNS basis inorganic fertilizer (T_2) and fertilizer dose of farmers' practices (T_3). The differences here did not play any significant role in the nutrient availability to plants, as the difference was negligible. These units of soil pH are regarded as very strongly acidic (FRG, 2012). The residue of the phosphorus (P) and potassium (K) fertilizer were evident. Slightly higher amount of available P and K were observed where bio-slurry with inorganic fertilizers was applied. Both the available P and K content in the soil after crop harvest showed no definite trend. Organic matter content of the soil was found almost similar in all the treatments as their differences were not so significant. However, long term study is needed to harness the effect of bio-slurry on the physical and chemical properties of soil, which might help to reach concrete findings in this respect.

Table 4. Post-harvest soil nutrient status of the experimental field

Treatment*	pH	OM (%)	N (%)	P (µgg^{-1} soil)	K (m.eq 100g^{-1} soil)	S (µgg^{-1} soil)	Zn (µgg^{-1} soil)	Mg (meq. 100g^{-1} soil)	B (µgg^{-1} soil)
Initial status	4.50	1.95	0.11	3.00	0.08	7.00	0.70	0.49	0.12
T_1	4.50	1.93	0.10	3.12	0.09	7.20	0.73	0.50	0.14
T_2	4.52	1.98	0.11	3.25	0.88	7.23	0.71	0.49	0.13

T_3	4.48	1.94	0.11	3.25	0.078	7.00	0.68	0.48	0.10

**Here, T_1: Inorganic basis fertilizer dose for HYG, T_2: CD bio-slurry @ 5 t ha^{-1} + IPNS basis inorganic fertilizer dose for HYG and T_3: Farmers practice fertilizers dose (Average of 20 farmers).*

Table 5. Economic analysis of the effect of bio-slurry application on radish (var. Tasakisan) in AEZ 20

Treatment*	Gross Return (Tk ha^{-1})	TVC** (Tk ha^{-1})	Gross margin (Tk ha^{-1})	BCR On TVC
1	2	3	4 (2-3)	5 (2÷3)
T_1	340800	58520	282280	5.82
T_2	364800	59250	305550	6.16
T_3	329040	58205	270835	5.65

**Here, T_1: Inorganic basis fertilizer dose for HYG, T_2: CD bio-slurry @ 5 t ha^{-1} + IPNS basis inorganic fertilizer dose for HYG and T_3: Farmers practice fertilizers dose (Average of 20 farmers).*
******* Total Variable Cost = TVC*
***N. B. Price of inputs and outputs (**(Tk kg^{-1}**):** Urea-12, TSP-22, MoP-15, Gypsum-10, Zinc sulphate-130, CD slurry-1, Radish seed-500, Radish-6.*

Economic profitability of radish cultivation

Economic analysis of different fertilizer treatments is presented in Table 5. The highest gross return (Tk 3,64,800 ha^{-1}), gross margin (Tk 3,05,550 ha^{-1}) and benefit cost ratio (6.16) were obtained from the treatment T_2 (CD bio-slurry @ 5 t ha^{-1} along with IPNS basis inorganic fertilizer for HYG). Again, the lower gross return, gross margin and benefit cost ratio were observed from farmers' practice (T_3). Financially profitable production of cabbage and cauliflower were found from PM slurry @ 3 t ha^{-1} or CD slurry @ 5 t ha^{-1} with IPNS basis inorganic fertilizer in Grey Terrace Soil (AEZ-28) of Joydebpur (BARI, 2008). The results are also in conformity with the findings of Shaheb and Nazrul (2011).

Bio-slurry is a renewable energy source organic byproduct produced from biogas plant. It contains considerable amount of plant nutrients and can improve the soil fertility. However, the finding of the present study revealed that the highest root yield of radish (45.60 t ha^{-1}) was obtained from CD slurry @ 5 t ha^{-1} along with IPNS basis inorganic fertilizer for HYG. Increment of radish yield due to application of CD bio-slurry @ 5 t ha^{-1} with IPNS basis inorganic fertilizer was 7 and 11% more than that of STB inorganic fertilizer and farmers followed fertilizers treatments. Furthermore, based on economic analysis, the highest gross return (Tk 3,64,800 ha^{-1}), gross margin (Tk 3,05,550 ha^{-1}) and benefit cost ratio (6.16) were also obtained from the same treatment (T_2). It might be clear to state that bio-slurry based crop revenue is more profitable than that of chemical fertilizer based crop production of radish. On the contrary, post-harvest chemical analysis of soil indicated that there were no significant changes in soil pH, OM and nutrients status observed in all experimental plots. However, farmers were found to be highly impressed to receive higher yield of radish with CD slurry and they would continue to apply bio-slurry in their field for sustainable crop production. In conclusion, it might be recommended that nutrient package N-P-K-S-Zn-B @ 67-44-99-25-2-2 kg ha^{-1}, respectively + cow dung slurry 5 t ha^{-1} (i.e. CD slurry @ 5 t ha^{-1} along with IPNS basis inorganic fertilizer) might help provide higher yield of radish as well as sustainable crop and soil management in AEZ 20.

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