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INTEGRATED EFFECTS OF NITROGEN, PHOSPHORUS AND CO-DIGESTED BIOSLURRY ON GROWTH AND YIELD OF *ZEA MAYS* L.

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Abstract

Effects of co-digested bioslurry (CBS) with cattle urine in combination with chemical fertilizer (N and P) on growth and yield of hybrid maize (900M) was evaluated. Treatments with four replications were T_1: Control (without CBS, N and P), T_2 : 100 kg N + 100 kg P/ha, T_3 : 2 ton CBS +100 kg N + 80 kg P/ha, T_4 : 4 ton CBS + 75 kg N + 60 kg P/ha, T_5 : 6 ton CBS + 50 kg N + 40 kg P/ha, T_6 : 8 ton CBS + 25 kg N + 20 kg P/ha and T_7 : 10 ton CBS/ha. RCBD was followed. Combined analysis of variance on maize yield showed no significant difference in the treatments of T_4,T_5 and T_6 but differed with other treatment combinations ($p < 0.05$). Though, BCR and NBCR indicated significant difference between the treatments highest BCR (2.10) was found in T_2 and lowest (0.40) in T_1. Again, significant variation was observed in the treatments on the yield and yield contributing characters. Experiment revealed that T_4 was the most profitable treatment combination in boosting up a hybrid maize yield in the northern region of Bangladesh.

Introduction

Maize (*Zea mays* L.) is the third most important cereal crop next to rice and wheat in Bangladesh and an important cereal in the global agricultural economy. It is the most important cereal crop having wide distribution and varied uses as food, feed and fodder. In the case of commercial farming of high value crops in traditional maize growing regions and high crop competition in limited arable land caused rapid increasing of maize areas in Bangladesh for the last two decades. It is now becoming an important cereal crop for its high productivity and diversity. The agro-climatic condition of Bangladesh is favorable for its cultivation round the year (Alom *et al.* 2010). However, improving maize production is considered to be one of the most important strategies for food security of ever increasing population of Bangladesh.

A good soil should have at least 2.5% organic matter, but in Bangladesh, most soils have less than 1.5%, and some soils have even less than 1% organic matter (BARC 2012). Soil fertility problem has been identified as one of the major factors hindering maize productivity in Bangladesh. Many of the regional soils are deficient in nitrogen, phosphorus, potassium and organic matter. Nitrogen is an integral component for plant physiological processes. It's amount in soil also affects the utilization of potassium, phosphorus and other mineral nutrients in plant. The optimum amount of these nutrients in soil cannot be utilized if N deficiency exists (Brady and Weil 2012). Nitrogen fertilization plays a significant role in improving soil fertility and increasing crop productivity (Habtegebrial *et al.* 2007). Nitrogen fertilization results in increased grain yield (43 - 68%) and biomass (25 - 42%) in maize (Ogola *et al.* 2002). Supplying these nutrients from chemical fertilizers has got certain limitations and inherent problems (Debelle *et al.* 2001). But there is positive interaction between the organic manures and urea as nitrogen source (Yang *et al.* 2007). Studies have shown the superior effect of integrated nutrient supply over sole use of inorganic or organic source in terms of balanced nutrient supply, improved soil fertility and crop yield (Khan *et al.* 2008). Synergistic effects of N with organic fertilizers (residue or FYM) accumulate

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more soil total N (Huang *et al.* 2007).The sole effects of FYM result in increased yield of maize (Anatoliy *et al.* 2007), more organic matter (44%) in soil, improved porosity (25%) and water holding capacity 16 times (Gangwar *et al.* 2006). Biogas slurry is a by-product obtains from the biogas plant after the digestion of dung or other biomass for generation of methane rich gas. It supplies essential nutrients, enhance water holding capacity, soil aeration, accelerates root growth and inhibit weed seed germination. Furthermore, it is of great significance from the stand point of public hygiene, pollution control and environmental protection. Biogas slurry proved to be of high quality organic manure compared to the FYM, digested sludge tends to have more nutrients. In addition, the digested slurry has traces of some important micronutrients i.e. zinc, boron, copper, iron *etc.*, which are necessary for growth and development of crops (Hukkeri *et al.* 1977). Use of the slurry inhibits disease and increase yields (Liu *et al.* 2008). High N and P levels reduce in soil pH towards increased acidity (Ibeawuchi *et al.* 2007). Application of digested biogas slurry increases the crop yield and quality. It also helps in reduction of dependence on mineral fertilizer (Krishna 2001). Furthermore, improper chemical fertilizer management (under or over doses) found as crucial for soil health, but through enhancing community participation towards accumulating and anaerobic digestion of organic wastes into organic manure may be one of the top listed recommendations for conserving soil health. Nevertheless, bio-slurry contains quick release nitrogen, phosphate and potassium (NPK) for an initial response of the plant helpful for environmentally friendly production. Integration of organic with inorganic fertilizers improves the physiological system of the crop, provides adequate growth regulating substances and modifies soil physico-chemical characteristics and results in augmented crop yield. The present study was therefore conducted to determine yield and other agronomic parameters of a hybrid maize cultivar under different doses of co-digested bio-slurry (CBS) with cattle urine and inorganic fertilizers.

Materials and Methods

The experiment was conducted at the Demonstration Farm of Rural Development Academy (RDA), Sherpur, Bogra-AEZ 4 (Northern region of Bangladesh) 200 km away from capital city Dhaka, during two consecutive Rabi seasons of 2013-14 and 2014-15 to find out a suitable fertilizer dose for a hybrid maize (900M) cultivation. This region is under 'Barind Tract'. Barind is a comparatively high, undulating region, with reddish and yellowish clay soils (Bazlar *et al.* 2014). Before conducting the experiment, soil samples were collected at a depth of 0 - 15 cm for laboratory analysis (Table 1).

The pH of the soil was 5.94. The organic carbon, available nitrogen, phosphorus and potassium were 1.31%, 0.086%, 14.69 (µg/g soil) and 0.16 (meq/100 g soil), respectively. The four important nutrients *viz.* Ca, Mg, and B, Zn were 1.96, 0.82 (meq/100 g soil) and 0.32, 1.05 (µg/g soil), respectively (Table 1). It may be mentioned that the soil of the selected site was deficient in organic matter and NPK with other micro-nutrients essential for maize cultivation. Rural Development Academy (RDA), Bogra has started rearing dairy cattle on two storied cattle shed system keeping milch and dry cows as on ground floor (1st layer) and calves (first floor) as on the 2nd layer using rubber mat for both layers to provide comfort as well as for scoping the availability of comprehensive waste collection to be used as input materials of biogas plant. Following application of a mixture of cattle urine, cowdung and flash water with feed residual produced by 130 cattle heads connected to the under ground pipeline for discharging to biogas plant for anaerobic digestion for at least 40 days to get biogas and nutrients rich co-digested bio-slurry automatically with gravitation flow ready for fertilization (Sarkar *et al.* 2013). With this system about 70 - 80% waste materials transferred automatically and the rest amount was transferred manually to biogas digester (Table 2).

Table 1. Physico-chemical characteristics of the soil before sowing maize in the study area.

Characteristics	Value
pH (1 : 2.5 W/V H_2O)	5.94
Organic C (%)[a]	1.31
Available N (%)[b]	0.086
Available P (µg/g soil) [c]	14.69
Available K (meq/100g soil) [c]	0.16
Available B (µg/g soil) [d]	0.32
Available Ca (meq/100g soil) [e]	1.96
Available Mg (meq/100g soil) [e]	0.82
Available S (µg/g soil) [e]	15.54
Available Zn (µg/g soil) [e]	1.05
Moisture (%)	2.54
Available Mn (mg/kg soil) [e]	19.24
Available Fe (mg/kg soil) [e]	6.29
Water holding capacity (%)	37

[a]Wet oxidation method (Walkley and Black 1934), [b]Kjeldahl's distillation method (Jackson 1973), [c]Troug's extraction reagent (Jackson 1973), [d]Hot water method (Berger and Truog 1939), [e]DTPA extracting solution (Anderson and Ingram 1996).

Table 2. Chemical composition of co-digested and non-codigested bioslurry (CBS).

Parameters	Bio-slurry		Level of significance
	Co-digested	Non-codigested	
pH	6.81 ± 0.06	8.62 ± 0.19	**
Moisture (%)	14.04 ± 0.39	36.20 ± 4.55	**
OC (%)	21.96 ± 0.25	4.54 ± 0.61	**
N "	1.93 ± 0.54	0.54 ± 0.07	**
C:N	11.50 ± 1.28	8.40 ± 0.51	**
P (%)	1.48 ± 0.25	0.05 ± 0.01	**
K "	2.64 ± 0.36	0.054 ± 0.005	**
S "	0.44 ± 0.15	0.078 ± 0.005	NS
Zn "	0.012 ± 0.001	0.0116 ± 0.0004	NS
Cu "	5.37 ± 1.16	5.38 ± 0.22	NS
As (ppm)	15.52 ± 0.67	15.53 ± 0.36	NS
Cr "	10.92 ± 1.06	3.66 ± 0.35	**
Cd "	0.20 ± 0.05	3.61 ± 0.22	**
Pb "	4.41 ± 0.98	5.46 ± 0.29	NS
Hg "	0.008 ± 0.003	12.02 ± 0.46	*
Ni "	9.62 ± 4.75	28.40 ± 1.45	*

*Significant at $p < 0.05$, **Significant at $p < 0.01$, NS = Non-significant.

Table 2 shows the average concentration of NPK was found significantly ($p < 0.01$) higher in co-digested compare to that of non-codigested bioslurry and their corresponding values were 1.93, 1.48, 2.64 and 0.54, 0.05, 0.054%, respectively. Again, the average concentration of pH ($p < 0.01$), Hg, Ni ($p < 0.05$) were found significantly lower in co-digested compared to that of non-codigested bioslurry and the corresponding values were 6.81, 0.008, 9.62 ppm and 8.62, 12.02, 28.40 ppm, respectively. Due to addition of cattle urine, including collection and preparation through anaerobic digestion system significant variation was found in codigested bio-slurry. Standard methods were followed to determine the above parameters (Table 2). The weather conditions during the growing season of this study in 2014 and 2015 are as shown in Fig. 1A, B.

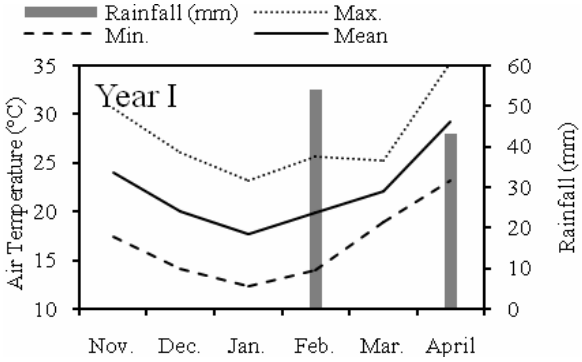

Fig. 1A. Weather data during (2013 - 2014).

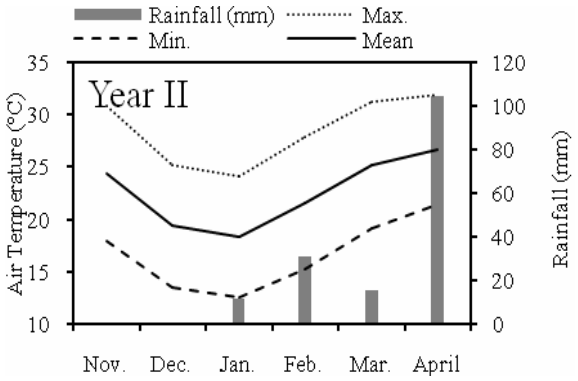

Fig. 1B. Weather data during (2014 - 2015).

The data of Fig. 1A, B show that the average minimum and maximum temperature at Bogra Weather Station were 17.7 and 29.2°C, respectively during 2013 -2014 (Fig. 1A). The average minimum-maximum temperature was recorded as 18.4 - 26.6°C during 2014 - 2015 (Fig. 1B). This range of positive temperature is suitable for maize production (Stephanie 2008). Again, regarding average rainfall it was recorded as 48.5 and 40.75 mm during 2014 - 2015 (Year I and year II), respectively. During experimental period optimum water supply was ensured through irrigation regardless of rainfall. The study was carried out during both the seasons of 2014 and 2015 under similar experimental conditions.

Hybrid maize variety (900M) was used as a test crop. Co-digested bioslurry (CBS) was used alone or in combination with inorganic fertilizers. Treatments with four replications were T_1: Control (without CBS, N and P), T_2: 100 kg N + 100 kg P/ha, T_3: 2 ton CBS + 100 kg N + 80 kg P/ha, T_4: 4 ton CBS + 75 kg N + 60 kg P/ha, T_5: 6 ton CBS + 50 kg N + 40 kg P/ha, T_6: 8 ton CBS + 25 kg N + 20 kg P/ha and T_7: 10 ton CBS/ha. Treatments were arranged in a RCBD at the RDA demonstration farm at Sherpur of Bogra district during 2013-14 and 2014-15 cropping seasons. The experimental field was prepared by using local plough according to farmers' conventional farming practices. The field was ploughed four times each year during the experimental seasons. A plot size of 4 m length by 4.5 m width with six rows per plot was used. Spacing was 0.75 m and 0.25 m between rows and plants, respectively. Sowing was done on 13th November in 2013 and 2014 at the seed rate of 25 kg/ha, respectively. Enriched CBS was prepared by adding cattle urine through anaerobic digestion method in130m^3 biogas plant from cattle manure subjected to complete microbial fermentation well ahead of sowing date. Sowing was completed on the same day for both the seasons. Then after, all necessary cultural practices were employed to raise a successful maize crop. An area of 5.65 m^2, corresponding to 32 plants in the central four rows, was harvested immediately after physiological maturity for grain yield. During harvests, border plants at the ends of each row were excluded to avoid border effects. Grain moisture percentage was estimated using a Dickey-John multi grain moisture tester. Grain yield (GY t/ha) was calculated using shelled grain and adjusted to12.5% moisture (Mosisa *et al.* 2007). Financial analysis of the treatments was done by benefit cost ratio method. That is the total return of maize from a unit area divided by the total cost of production. All collected data were analyzed statistically using SPSS 16.0 version and the mean separation was adjudged by DMRT (Gomez and Gomez 1984).

Results and Discussion

The results showed that the application of different levels of codigested bio-slurry (CBS) significantly improved the growth and yield of hybrid maize. The evaluated performance of the maize during the 2014 and 2015 growing seasons was not statistically significant in all the growth traits. The calculated t-test values for comparisons of all growth traits data between the two seasons were largely less than the tabulated value of 2.45 (5 % prob. level at 6 df). Interpretation of growth traits presented in the form of bar graph (Fig. 3.) The mean highest time of emergence was recorded 7 days in the case of T_1, T_6 and T_7. All other treatments took 6 days to emergence. The emergence time for all treatments was found insignificantly similar. The mean longest and shortest times appearing to six leaves were recorded 32 and 30 days in the case of T_1, T_2 and T_4, T_7, respectively. In the case of tassel emergence mean longest and shortest time were found 84 and 81 days for T_1 and T_4, T_5, T_7, respectively. All other treatments took 82 days for tassel emergence. The range of mean data to tassel flowering and bud emergence was found 85-88 days and 87-91 days respectively. The mean shortest and longest time for maturity was recorded 151 and 155 days in the case of T_4, T_5, T_7 and T_1 (Control). All other treatments took 152 days to reach maturity. The graph provides growth characteristics of maize days after sowing (DAS) *viz.* emergence, six leaves, tassel emergence, flowering, bud emergence and maturity time for all the treatment groups were found insignificant. Variation of temperature and soil quality might have created insignificant difference from one treatment to another treatment group (Fig. 2).

During the life cycle of the plant there are several key identifiable stages at which the plant's requirements must be met to ensure high yields (NSW 2009). The effect of CBS (codigested bioslurry with cattle urine) on progression of the key growth stages and the basic parts of the maize plant development stated here as emergence from seed to four leaves, six leaves, tassel emergence, and cob emergence stages. The highest and lowest plant height recorded at four leaves

stage was 31 and 27 cm in T_1, T_2, T_3 and T_7. At six leaves stage the highest height of plant found 75 cm in T_1, T_2 and lowest 68 cm in T_7 treatment. The same trend observed at tassel emergence stage with 179 cm as longest for T_1, T_2 and 169 cm as lowest for T_7 group. At the cob emergence or final stage of plant height was found 185 cm in the case of T_1 and the lowest as 172 cm for T_7 group. For other groups it was 184, 183, 182, 181 and 180 cm in T_2, T_3, T_4, and T_5 treatments, respectively (Table 3). That height of plant remained static from cob emergence to reach up to maturity stage accordingly.

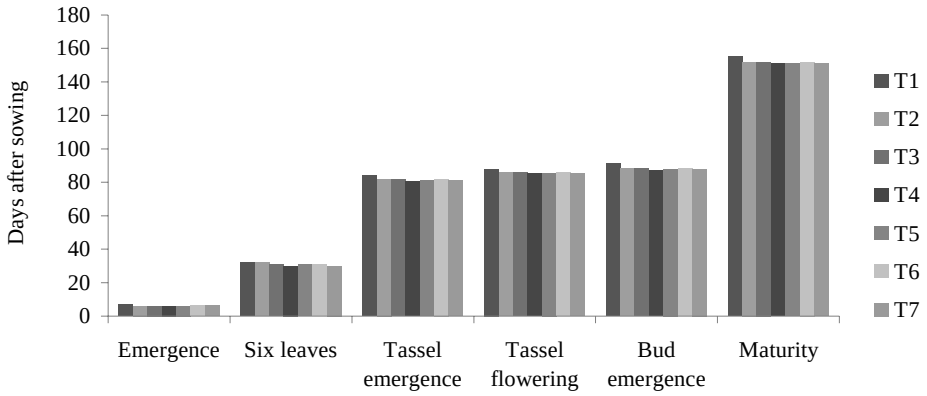

Fig. 2. Days after sowing (DAS) respond to growth of maize in soil of Sherpur, Bogra.

Table 3. Effect of nitrogen, phosphorus and bioslurry on plant height of maize grown in soil at Sherpur, Bogra during 2014-2015.

Treatment	Plant height (cm)			
	Four leaves	Six leaves	Tassel emergence	Cob emergence
T_1	31^{a} ±0.82	75^{a} ±0.82	179^{a} ±0.81	185^{a} ±0.81
T_2	31^{a} ±0.82	75^{a} ±1.15	179^{a} ±0.81	184^{ab} ±1.82
T_3	31^{a} ±0.82	74^{a} ±0.82	178^{a} ±0.81	183^{abc} ±0.81
T_4	30^{a} ±0.82	74^{a} ±0.82	178^{a} ±1.15	182^{bcd} ±0.81
T_5	30^{a} ±0.82	74^{a} ±1.15	177^{a} ±0.81	181^{cd} ±0.81
T_6	30a ±1.41	71^{b} ±0.82	177^{a} ±0.81	180^{d} ±0.81
T_7	27^{b} ±0.82	68^{c} ±0.82	169^{b} ±0.81	172^{e} ±0.81
CV%	3.08	1.26	0.49	0.56
LSD at 5%	2.12	2.12	2.00	2.35

Data bearing different letters as superscript within the same column differ significantly at $p < 0.05$, ± = Standard error.

Collective analysis of variance on grain yield of hybrid maize (900M) over the consecutive years found no significant difference within treatment groups of T_4 (4 ton CBS+75 kg N + 60 kg P/ha), T_5 (6 ton CBS + 50 kg N + 40 kg P/ha) and T_6 (8 ton CBS + 25 kg N + 20 kg P/ha) (Table 5) and also the results conspicuously indicated that all proportions of co-digested bio-slurry (CBS) and inorganic fertilizer treatments significantly increased maize grain yield as compared to the

control treatment (Tables 4 and 5). The highest grain yield (8882.3 kg/ha) was obtained in the treatment T_4 (4 ton CBS + 75 kg N + 60 kg P/ha) and the lowest grain yield (2643.5 kg/ha) was recorded in the control (Table 4). The analysis of variance indicated significant difference among treatments T_2: 100 kg N + 100 kg P/ha, T_3: 2 ton CBS + 100 kg N + 80 kg P/ha,T_4: 4 ton CBS + 75 kg N + 60 kg P/ha, T_5: 6 ton CBS + 50 kg N + 40 kg P/ha, respectively except no significant difference found between T_6: 8 ton CBS + 25 kg N + 20 kg P/ha and T_7: 10 ton CBS/ha on grain yield of hybrid maize (Table 5). However 4 ton CBS + 75 kg N + 60 kg P/ha maize grain yield increased from 5. 3 - 8.8 ton/ha (Table 5). Combined analysis of variance on grain yield of hybrid maize (900 M) over the consecutive years found no significant difference between treatments T_2: 100 kg N + 100 kg P/ha and T_7: 10 ton CBS/ha ($p < 0.05$). But financial analysis on the basis of BCR and NBCR indicated the presence of significant difference between these two treatment combinations (Table 4). Four tons CBS/ha added with 75 kg N + 60 kg P/ha was found to be the most profitable and cost-effective treatment combination. Nevertheless, analysis of BCR and NBCR showed no significant differences among 2 ton CBS + 100 kg N + 80 kg P/ha; 6 ton CBS + 50 kg N + 40 kg P/ha; 8 ton CBS + 25 kg N + 20 kg P/ha and 10 ton CBS/ha treatment combinations whose net benefit cost ratios were 1.57, 0.51, 0.50, 0.49, respectively (Table 4). The

Table 4. Financial analysis on the use of CBS and chemical fertilizers on growth and yield of maize grown in soil at Sherpur, Bogra during 2014-2015 (values in BD Taka).

Cost of items	Treatment						
	T_1	T_2	T_3	T_4	T_5	T_6	T_7
Land preparation	5187	5187	5187	5187	5187	5187	5187
Seed 900M	6500	6500	6500	6500	6500	6500	6500
Planting	2400	2400	2400	2400	2400	2400	2400
Bio-slurry (CBS)	0	0	10000	20000	30000	40000	50000
Urea	0	1800	1800	1350	900	450	0
DAP	0	2300	1840	1380	920	460	0
MoP	0	1920	1920	1920	1920	1920	1920
Gypsum	400	400	400	400	400	400	400
Borax	320	320	320	320	320	320	320
Zinc sulphate	240	240	240	240	240	240	240
Fertilizer application	1200	2000	2400	3000	2800	2800	2800
Pesticides	2400	2400	2400	2400	2400	2400	2400
Weeding	6000	6000	5000	4000	3400	3400	3400
Irrigation	3952	3952	3952	3952	3952	3952	3952
Harvesting	4800	4800	4800	4800	4800	4800	4800
Miscellaneous	2400	2400	400	400	400	400	400
Yield (kg/ha)	2643.5	6954.5	6707.5	8882.3	5297.5	5957.0	6661.3
Total returns	50226.5	132135.5	127442.5	168763.7	100652.5	113183	126564.7
Total cost	35799.0	42619.0	49559.0	58249.0	66539.0	75629.0	84719.0
Net benefit	14427.5	89516.5	77883.5	110514.7	34113.5	37554.0	41845.7
BCR(PVB/I)	1.40^{NS}	3.10^{**}	2.57^{**}	2.90^{*}	1.51^{***}	1.50^{***}	1.49^{***}
NBCR (BCR-1)	0.40	2.10	1.57	1.90	0.51	0.50	0.49

*Significant at the 5% level, **Significant at the 1% level, ***Significant at the 0.1% level, NS = Not significant, T_1: Control (without CBS, N and P), T_2: 100 kg N + 100 kg P/ha, T_3: 2 ton CBS + 100 kg N + 80 kg P/ha, T_4: 4 ton CBS + 75 kg N + 60 kg P/ha, T_5: 6 ton CBS + 50 kg N + 40 kg P/ha, T_6: 8 ton CBS + 25 kg N + 20 kg P/ha and T_7 : 10 ton CBS/ha.

highest BCR (2.10) was found on treatment of 100 kg N + 100 kg P/ha on single basis and the lowest assessment of BCR (0.40) was recorded on the control plots (Table 4). It is to be mentioned here that, low soil organic matter content is one of the burning issues of low productivity, and may be considered as one of the most somber threats to the sustainability of crop growing especially in the northern region of Bangladesh. Balance fertilization using both CBS and chemical fertilizers is important for safe guarding of soil organic matter (OM) content and long term soil productivity. Bangladesh Agricultural Research Council (2012) reported that most soils in Bangladesh have less than 1.0% organic matter and decreasing in trends must be well thought-out as alarming for crop cultivation. Hence, utilization of CBS needs to be considered as a customary way of returning organic matter and to conserve the soil health in an environmentally sustainable manner. Consequently farmers from the northern region of Bangladesh can select the treatment combination which would best fit to capture maximum advantages for the production of hybrid maize (900M). In this study it is evident that yield advantage did not elucidate financial benefit. For that reason, it is necessary to undertake economic analysis at farm level profitability like the benefit cost ratio for commercial entrepreneurship; this finding is almost similar to Zelalem Bekeko 2014. Four treatment options are suggested for practicing commercially in the northern region of Bangladesh. Growth and yield characters of hybrid maize cultivated in northern region of Bangladesh during 2014-15, a significant variation was observed among the treatments on the yield and yield contributing characters of maize production (Tables 3 and 5).

Table 5. Effect of nitrogen, phosphorus and co-digested bioslurry on growth and yield of maize grown in soil at Sherpur, Bogra during 2014-2015.

Treatments	Cob length (cm)	No. of grain/cob	1000 grains wt. (g)	Stover yield (t/ha)	Grain yield (t/ha)
T_1	$18.0^{ab} \pm 0.41$	$402.0^{g} \pm 0.71$	$248.0^{e} \pm 0.41$	$5.7^{f} \pm 0.0$	$2.6^{e} \pm 0.05$
T_2	$19.3^{ab} \pm 0.25$	$488.8^{b} \pm 0.48$	$325.5^{b} \pm 0.29$	$10.6^{b} \pm 0.0$	$7.1^{b} \pm 0.22$
T_3	$19.5^{ab} \pm 0.65$	$472.3^{d} \pm 0.48$	$321.0^{c} \pm 0.41$	$10.5^{c} \pm 0.0$	$6.7^{bc} \pm 0.22$
T_4	$20.3^{a} \pm 0.25$	$494.0^{a} \pm 0.41$	$334.0^{a} \pm 0.41$	$13.3^{a} \pm 0.0$	$8.8^{a} \pm 0.32$
T_5	$19.3^{ab} \pm 0.25$	$463.5^{f} \pm 0.29$	$313.0^{d} \pm 0.41$	$10.0^{e} \pm 0.01$	$5.3^{d} \pm 0.14$
T_6	$19.5^{ab} \pm 0.29$	$470.0^{e} \pm 0.41$	$321.0^{c} \pm 0.41$	$10.2^{d} \pm 0.0$	$6.0^{cd} \pm 0.18$
T_7	$19.0^{b} \pm 0.41$	$478.3^{c} \pm 0.25$	$319.8^{c} \pm 0.25$	$11.5^{c} \pm 0.01$	$6.0^{cd} \pm 0.18$
CV%	3.97	0.20	0.24	0.32	6.28
LSD at 5%	1.75	2.08	1.71	0.23	0.88

Data bearing different letters as superscripts within the same column differ significantly at $p < 0.05$, ± = Standard error.

The highest plant height was found in T_1 (185 cm) and differ with all other treatment groups but it was statistically similar for T_3, T_5, T_6 and T_7. The highest cob length (20.3 cm) was recorded for the treatment T_4 which differed statistically but similar to all other groups except T_7. The highest 1000 grain weight (334 g) was noted from the treatment T_4 and was statistically superior with all other treatments. The highest stover yield was also recorded with the treatment T_4, whichwas statistically different from all the treatment groups (Table 5). Similar findings were also reported by Sarker *et al.* 2014. Grain yield per hectare was found highest in T_4 (8882.3 kg) and lowest in T_1 (2643.5 kg). Statistical analysis showed insignificant for all treatments groups except control (T_1).

In brief enriched co-digested bioslurry (CBS) with cattle urine in combination with less amount of chemical fertilizers can be used for hybrid maize production particularly at the AEZ-4 of northern region of Bangladesh in order to get maximum grain yield of hybrid maize (900M)

and paramount crop production conserving soil organic matter (OM) for future generation. Also, it is recommended that utilization of 4 ton CBS/ha incorporated with 75 kg of N and 60 kg of P/ha was the most suitable and profitable treatment combination for boosting up hybrid maize (900M) grain yield over the years in an environmentally sustainable way.

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