Asian-Aust. J. Anim. Sci.
Vol. 21, No. 11 : 1592 - 1598
November 2008

www.ajas.info

Effect of Cattle Slurry on Growth, Biomass Yield and Chemical Composition of Maize Fodder

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ABSTRACT : An experiment was carried out to study the effect of cattle slurry on maize fodder (*Zea mays*) production. Maize fodder was produced at 4 cattle slurry levels T_0 (0 ton/ha), T_1 (10 ton/ha), T_2 (12 ton/ha) and T_3 (14 ton/ha) in a randomized block design. Agronomic characteristics, plant heights, circumference of stems, number of leaves, leaf area and dry matter yield of maize fodder were measured. Maize plant height and stem circumference were significantly ($p<0.01$) influenced by the increasing rate of cattle slurry at 15, 30, 45 and 56 days after sowing. Number of leaves of fodder plants was not significant but leaf area was significant ($p<0.05$) among the treatment groups. The highest biomass yield ($p<0.01$) of maize fodder was observed in T_2 (44.0 ton/ha). For crude protein content, a significant difference ($p<0.01$) was observed in the treatment groups and the highest value was observed in T_2 (11.99%). Organic matter content of maize fodder showed a significant difference but ash, ADF and NDF contents showed no significant differences among treatment groups. From this study it may be concluded that the application of 12 tons of cattle slurry/ha was optimal for production of biomass and nutrient content of maize fodder. (**Key Words :** Cattle Slurry, Biomass Yield, Nutrient Content, Maize Fodder)

INTRODUCTION

Maize is an important dual purpose crop that can be grown in spring and autumn seasons. Maize or corn is widely used as an excellent livestock feed as grain, green fodder or silage (Haque, 2003) and recently it is used as human food (Begum, 2003). In Bangladesh, farmers generally do not grow any crop exclusively as fodder because they have insufficient land to do so. Here cultivable land is mainly occupied by the crops which give direct benefit to farmers in terms of food and cash. At present 0.736 million hectares of cultivable land are laying fallow for more than one year and 8.697 million ha are unavailable for cultivation. About 84% of the cultivable land is used for cereal and only 0.05% for fodder production and the rest for other crops (BBS, 2005). As a result, forage-based livestock production becomes more difficult because of fodder shortage. Besides, there is no pasture land in our country and crop land is used as temporary pastures. Pasture lands have now been turned into crop fields due to the introduction of irrigation facilities. Growing of fodder crops with the existing cropping system may be an appropriate technology to meet the fodder shortage of Bangladesh (Mamun et al., 1994). Tareque (1992) reported that more than 90% of the feeds consumed by ruminants in our country are roughage. Feeding of green grass to livestock is essential for the maintenance of normal health and production. Unfortunately, about 90% of the diet of ruminants consists of low quality roughage i.e. rice straw; moreover, the amount available is far less than the requirement. As a result, our animals are left underfed and are maintained poorly.

Maize (*Zea mays*) is a highly esteemed fodder, commonly grown in the winter season. The fodder is excellent, highly nutritive and sustainable either in green or dry condition and highly responsive to nitrogen fertilizer application (Hukkeri et al., 1977). Nitrogen application directly contributes to the quantity and quality of forage production. Excessive and imbalanced use of chemical fertilizers has adversely affected the soil causing a decrease in organic carbon reduction by microbial flora of the soil, and increasing use of nitrogen fertilizer is contaminating water bodies thus affecting fish fauna and causing health hazards to human beings and animals. Use of chemical fertilizers adds to the pollution. To overcome both the

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Received March 28, 2008; Accepted August 18, 2008

deficit in nutrient supply and the adverse effects of chemical fertilizer, it is suggested that the use of organic fertilizers will assist proper use of livestock waste as well as increase soil fertility and release nutrients to fodder for sustainable production in an eco-friendly, pollution-free environment. Cattle slurry is a potential source of soil nutrients for smallholder rural farmers. This slurry is a mixture of cow-dung, urine, feed spillage and cleaning water. Animal waste causes environmental pollution when applied to land without appropriate controls and management (Balsari et al., 2005) but the agronomic utilization of slurry represents the best solution for their reuse. Animal wastes or slurry can be a valuable resource as a fertilizer but can also be a potential hazard to the environment (Paik, 1999). Fertilizer and manure applications may affect N_2O emission in several ways depending especially on the type of N source (NO_3^-, NH_4^+ or organic N) and the applied amount and composition of C substrates in easily biodegradable or recalcitrant C compounds (Dambreville at el., 2008). Slurry N differs in its overall effects on physical, chemical and biological processes and consequently on nitrification and denitrification in uncropped soil. Demand for organic food for maintaining their health is a growing concern of the people. Through production of maize fodder with cattle slurry and feeding this fodder to animals, the human population can obtain organic meat, milk etc. There was no information available on growth, biomass yield, nutrient content, chemical composition and energy content of maize fodder as affected by different doses of cattle slurry. Therefore, this study aimed to assess the suitability of cattle slurry as a N fertilizer in maize fodder cultivation by measuring the yield and chemical quality of the fodder.

MATERIALS AND METHODS

Experimental materials and procedures

The experiment was conducted in two stages; the first stage was the production of maize fodder and the second stage was laboratory analysis of the fodder. Fodder production and activities were carried out on the Sheep, Goat and Horse Farm of the Department of Animal Science, Bangladesh Agricultural University, Mymensingh from March 10 to May 16, 2007. The laboratory analysis of forage was completed in the Animal Science laboratory and Humboldt Soil Testing Laboratory of the Department of Soil Science. During the experimental period, the maximum and minimum temperature was in the range of 33 to 26°C and 23 to 20°C respectively. The relative humidity during the period ranged from 85.4 to 76.5% and average rainfall was recorded at 201 mm. The soil of the experimental site was silt loam texture and contained 0.14% nitrogen, 0.114% phosphorus, 0.411% potassium and 0.11% sulphur. The land was flat, moderately drained and above flood levels.

The land was prepared well by ploughing and cross ploughing five times with a bullock-drawn country plough followed by laddering to obtain the desirable tilts. Weeds and stables of the previous crop were removed from the soil and then the land was leveled and divided into 12 plots according to the layout of the experiment. The size of each plot was $10m^2$ (4 m×2.5 m). The experiment was conducted in a Randomized Block Design (RBD) comprised of four levels of cattle slurry at 0, 10, 12 and 14 kg per plot as treatments T_0, T_1, T_2 and T_3 respectively. Cattle slurry was obtained from the biogas plant of the Sheep, Goat and Horse Farm of BAU. Towards the final stage of land preparation, cattle slurry was applied as organic fertilizer to the designed experimental field. Finally, the experimental plots were prepared and leveled. Amounts of slurry were calculated from the availability of N in the slurry and standard nitrogen requirements for maize cultivation. Cattle slurry, soil and fodder plant samples were subjected to chemical analysis for the determination of nitrogen, phosphorus, potassium and sulphur in the Humboldt Soil Testing Laboratory of the Soil Science Department, Bangladesh Agricultural University, Mymensingh. The percentages of nitrogen (N), phosphorus (P), potassium (K), and sulphur (S) are given in Table 1.

Cultivation procedure and harvesting time of maize is different for grain production and fodder production. In the case of grain production, line to line distance is 75 cm, plant to plant distance is 25 cm and harvesting time is 90-120 days (Haque, 2003), but for fodder production line to line distance is 30 cm, plant to plant distance is 15 cm and harvesting time is 55-60 days (Motalib, 2003). Motalib (2003) also stated that the proper time of harvesting green maize plant as fodder occurs when 50% of plants are in the

Table 1. Status of nitrogen, phosphorus, potassium, and sulphur in the slurry and soil and uptake by the maize fodder (%)

Sample	N	P	K	S
Cattle slurry	0.560	0.240	1.627	0.082
Soil	0.140	0.114	0.411	0.110
Maize plant				
T_0	1.344	0.173	2.098	0.101
T_1	1.400	0.205	2.098	0.075
T_2	1.456	0.176	2.518	0.115
T_3	1.456	0.183	2.098	0.085

Table 2. Effect of cattle slurry on Maize fodder height (cm)

Days after sowing	Treatments				SEM	Level of significance
	T_0	T_1	T_2	T_3		
15	27.3^{c}	29.6^{b}	32.8^{a}	30.9^{ab}	0.62	**
30	89.9^{c}	98.1^{b}	109.0^{a}	103.5^{ab}	1.90	**
45	189.5^{c}	197.0^{b}	201.4^{a}	200.5^{ab}	0.95	**
56	242.3^{b}	244.2^{b}	258.8^{a}	251.7^{ab}	3.15	**

T_0: no slurry, T_1: 10 ton/ha, T_2: 12 ton/ha, T_3: 14 ton/ha.
Mean values with different superscripts within the same row differ significantly. ** p<0.01.

flowering state and contain 60-70% moisture. At this stage, maize plants contain sufficient nutrients and are succulent enough.

We used the seeds of the 'Barnali' variety of maize which is normally used for grain production. There is no specific variety of maize for fodder production, so this variety was selected for fodder production and for observing the efficacy of slurry nitrogen. Maize seed was sown by a line sowing method maintaining a row to row spacing of 30 cm, seed to seed spacing of 15 cm and depth of 5 cm. The seed rate was 55 kg/ha (Rahman et al., 1993). Weeding of the plot during the experimental period was done once at 20 days after sowing. The germination rate was 90%. Necessary gap filling was done after 1 week of germination. Plant height and circumferences were measured in cm at 15 day intervals. The leaf area was measured in square cm from an average length and width of a leaf (base, middle and tip of the leaves). Before cutting the fodder plant, the average number of leaves was counted randomly from each plot. Maize fodder from all the plots was harvested at 56 days after sowing when 50% of plants were in the flowering stage by manually cutting the maize plants and samples were kept for further analysis according to the objectives of the experiment. Immediately after harvesting, biomass yield of the maize fodder was recorded by weighing and average forage production under different levels of cattle slurry was expressed in metric ton/ha (MT/ha).

Analysis

A representative sample was prepared by chopping maize plants from each plot, tagged separately and kept for further analysis. Representative samples of fresh fodder were oven dried at 105°C for 24 h. Oven-dried samples were ground (CYCLOTEC 1993 sample mill Tecator, Sweden) to a size of 1.0 mm for chemical analysis. The ground samples were bottled, covered with aluminum foil and kept in desiccators. Chemical composition of oven-dried samples for dry matter (DM), organic matter (OM) and crude protein (CP) were estimated according to the methods of AOAC (2003). Neutral detergent fiber (NDF) and acid detergent fiber (ADF) were estimated by the methods of Faichney and White (1983).

Statistical analysis

The data generated from this experiment were analyzed using the MSTAT statistical computer program and differences among the treatment means were determined by the LSD value.

RESULTS AND DISCUSSION

Maize fodder height

From Table 2 it can be seen that application of cattle slurry resulted in significantly (p<0.01) higher plant height at 15 days after sowing than that obtained in the control group receiving no fertilizer. Among the treatment groups, treatment T_2 gave the largest plant height (32.84 cm) at 15 days of plant growth. The effect of T_2 on plant height was significantly (p<0.01) higher than that of T_1 and T_3 at 15 days after sowing. At 30 days of fodder growth, treatment T_2 gave the largest plant height (109.00 cm). The effect of treatment T_2 on plant height was significantly (p<0.01) higher than T_0 (control group) and $T_{1,}$ but non-significantly higher than T_3 after 30 days of fodder growth. At 45 days after sowing, treatment T_2 gave a larger plant height (201.43 cm) than T_0 and T_1. The effect of T_2 on plant height was significantly (p<0.01) higher than that of T_0 and $T_{1,}$ but non-significantly higher than that of T_3 at 45 days after sowing. At 56 days after sowing the fodder height was also significantly (p<0.01) larger on treatment T_2. The effect of T_2 on plant height was non-significantly larger than that of T_3 at 56 days after sowing. Marchiol et al. (1992) reported an increase in plant height but a decrease in total biomass and pods of soybean grown by intercropping the maize as compared to a pure stand. Fodder height is positively correlated with the fodder yield. The application of increasing amounts of cattle slurry increases the fodder height as well as the fodder yield. Reddy et al. (1987) found a positive effect of N on maize plant height. They reported that plant height increased significantly due to N application up to 80 kg/ha. The present experiment also showed that plant height was increased by providing an increasing level of cattle slurry (N source). Halima (1999) also obtained increased plant height, stem weight and leaf weight at the highest nitrogen doses (100 kg N/ha) compared to the control (0 kg N/ha) and the trend was linear. Fodder height

Table 3. Effect of cattle slurry on circumference of Maize fodder stem (cm)

Days after sowing	Treatments				SEM	Level of significance
	T_0	T_1	T_2	T_3		
15	2.83^b	2.67^c	2.94^a	2.87^{ab}	0.03	**
30	4.50^b	5.18^a	5.33^a	4.83^a	0.14	**
45	6.67^b	7.00^b	7.51^a	6.72^b	0.13	**
56	7.78^b	8.97^a	8.40^a	8.38^a	0.12	**

T_0: no slurry, T_1: 10 ton/ha, T_2: 12 ton/ha, T_3: 14 ton/ha.
Mean values with different superscripts within the same row differ significantly. ** p<0.01.

in the present experiment was 9.53% higher at 56 days compared to that reported by Hossain (2001). The mean plant height of maize sown alone was higher (227.8 cm) than all other seed combinations (Ibrahim et al., 2006). There are other factors responsible for fodder plant height such as genetic constitution of fodder, soil fertility, climatic condition, day length, light intensity etc. Among these, genetic factors and soil fertility are more important. Nitrogen fertilizer, either organic or inorganic, is always responsible for vegetative growth of the fodder plant i.e. fodder plant height, stem weight, stem diameter, leaf weight, leaf diameter etc.

Circumference of stem

Circumference of the stem of maize fodder is shown in Table 3. At 15 days after sowing, the effect of T_2 on the stem circumference of maize fodder was higher (2.94 cm) than T_0 and T_1 at 0.01% significance, but T_2 was non-significantly different to T_3. At 30 days and 56 days after sowing the treatment effect of T_1, T_2 and T_3 was non-significant. At 45 days of fodder growth, treatment T_2 gave the highest stem circumference (7.51 cm) of maize fodder and the effect of T_2 was significantly (p<0.01) higher than other treatments (T_0, T_1 and T_3). Fodder production depends on leaf number, leaf area, fodder height, circumference of stem etc. If the stem circumference is higher the production of fodder is also increased. In this study, circumference increased with increasing level of cattle slurry. This result is similar to that of Reiad et al. (1997). Nitrogen is involved with the vegetative growth as well as increasing stem circumference. The diameter of the maize stalk was reported to be strongly influenced by environmental conditions (Duncan, 1975).

Number and area of leaves

It was observed that the number of leaves per maize fodder plant ranged from 12.56 to 14.55 during the harvesting period (Table 4). The number of leaves per plant of maize and cowpea was also significantly influenced by different seed ratios of maize and cowpea (Ibrahim et al., 2006). In the case of maize, maximum number of leaves (12.18/plant) were noted when sown alone followed by the 75:25 rate (11.82). Application of cattle slurry did not show a significant effect on number of leaves of fodder but average leaf area per plant was higher (499.70 cm^2) with treatment T_1. The treatment effect (T_1) was significant (p<0.05) compared with T_0, T_2 and T_3, but there was no significant difference between treatments T_2 and T_3. The maximum number of leaves, the length, width and thickness increases the production of fodder because a large number of leaves provide the heavy weight of the fodder. From the present experiment it was observed that the cattle slurry did not increase number of leaves because leaf number is a genetic factor which is not affected by the fertilizer. Fertilizer can only affect the area of the leaves. Rezende et al. (1994) concluded that number of leaves increased with increasing N rate. The leaf number/plant in this study was 28.67% less than the findings of Chitra (2000). The number of leaves slowly and gradually declined with advancing plant age. Temperature and moisture of the soil are two important parameters affecting the number of leaves produced by maize plants (Tollenar et al., 1979) and an increase in temperature from 15 to 24°C almost doubled the initiation of leaves. Leaf area was unaffected by increasing levels of N in an experiment which was conducted with 2 varieties of Ganga safed by Singh et al. (1996).

Biomass yield

In the case of biomass yield, the highest yield of maize fodder was obtained in treatment groups T_1 and T_2. Biomass yield was not significantly different between T_1 and T_2 but these two groups were significantly higher than T_0 and T_3.

Table 4. Effect of cattle slurry on number and area of leaves and biomass yield of Maize fodder

Parameters	Treatments				SEM	Level of significance
	T_0	T_1	T_2	T_3		
No. of leaves	12.56	13.67	14.55	13.89	6.87	NS
Area (cm^2)	391.13^c	499.70^a	421.50^b	423.58^b	11.70	*
Biomass yield (MT/ha)	34.67^c	45.00^a	44.00^a	42.67^b	7.77	*

T_0: no slurry, T_1: 10 ton/ha, T_2: 12 ton/ha, T_3: 14 ton/ha.
Mean values with different superscripts within the same row differ significantly. NS: Not significant. * p<0.05.

Table 5. Effect of cattle slurry on chemical composition of Maize fodder

Nutrients (% DM basis)	Treatments				SEM	Level of significance
	T_0	T_1	T_2	T_3		
DM	19.44	19.66	19.95	20.00	0.11	NS
OM	92.65^a	90.25^b	92.17^a	90.60^b	0.35	**
CP	10.21^c	10.94^b	11.90^a	9.96^c	0.24	**
Ash	7.54^c	8.63^b	10.20^a	9.40^{ab}	0.32	**
ADF	35.37	35.19	35.21	34.11	0.25	NS
NDF	55.93	56.67	57.22	56.16	0.26	NS

T_0: no slurry, T_1: 10 ton/ha, T_2: 12 ton/ha, T_3: 14 ton/ha.
Mean values with different superscripts within the same row differ significantly. NS: Not significant; ** p<0.01.

The application of increased level of N fertilizer presumably increased the availability of soil nitrogen, which might have enhanced the meristematic growth and resulted in higher fodder yield. The present result is similar to those of Khandakar and Islam (1988), Khan et al. (1996) and Shahjalal et al. (1996). The higher green forage yield with increasing level of N might be due to its beneficial effect on cell elongation, cell division, formation of nucleotide and coenzyme in meristematic activity and also increased photosynthetic surface and hence more production and accumulation of photosynthetic compounds (Verma, 1989). Dauden and Quilez (2004) conducted an experiment on maize yield with different levels of pig slurry and observed no significant differences in plant number, plant height and biomass yield among different treatments, but a decreasing trend of grain yield was observed at the higher rate of slurry N. The nitrogen fertilizer value of slurry is thus considered similar to that of mineral fertilizer, because higher N level reduced the yield.

Chemical composition

It can be observed from Table 5 that dry matter (DM) content ranged from 19.44 to 20.00%. Application of cattle slurry did not show a significant effect on dry matter yield. The content of DM % found here was different to other reports, particularly Sarker (2000) for zamboo fodder, Khan et al. (1996) for oat fodder, Shahjalal et al. (1996) for oat and maize fodder and Khandakar and Islam (1988) for maize fodder. DM content may vary with species, stage of maturity of fodder, soil topography, season, temperature, climate condition, nutrients etc. The organic matter (OM) content was higher in the fodder of the T_0 and T_2 groups. The treatment effect was not significant between the control and T_2, but T_0 and T_2 treatment effect was higher (92.65% and 92.17%) than T_1 and T_3 (90.25% and 90.60%). The content of OM % found in this experiment is similar to the findings of Khandokar and Uddin (2002), but differs from the report of Ranjhan (1980). The CP content of maize fodder was higher (11.90%) in T_2 treatment group and was significantly (p<0.01) higher than other treatments (T_0, T_1 and T_3). From our results, it appears that cattle slurry level up to 12 kg increases the CP % more than other treatments. Beckwith et al. (2002) found increasing level of cattle slurry on cut grass increases the crude protein content. Similar results were obtained by Sarker (2000) in zamboo fodder, Singh et al. (1974) in bajra, and Shahjalal et al. (1996) in maize fodder. Crude protein and soluble carbohydrate are higher in young fodder and indigestible crude fibre increases with plant maturity. Nutritive values decline with advancing stage of maturity of fodder. Different fractions of maize plant and whole mixed fodder were analysed (Azim et al., 1989) for their chemical composition and dry matter digestibility (DMD). Highest crude protein (CP) values were found in leaves compared to the other portions. Values of DMD were higher in younger plants as compared to the matured ones. It was concluded that younger plants and the upper portion of the plants have a higher nutritive value as compared to the matured plants and lower portion of the plants. Durmus et al. (2006) cited that ensiling alfalfa with whole-crop maize improved the pH, OMD and ME values. The highest ash content of maize fodder was in group T_2 (10.20%). The effect of treatment T_2 on ash content was significantly (p<0.01) higher than that of T_0 (7.54%) & T_1 (8.63%) but non-significantly higher than that of T_3 (9.40%). The total ash content of fodder gradually increased with increasing level of the cattle slurry dose which differs from the report of Sarker (2000). Variation can occur because of ash, silica and individual minerals in soils. ADF ranged from 34.11 to 35.37% and application of cattle slurry did not show a significant effect on ADF content. The highest value of ADF was in T_0 (35.37%) and the lowest value in T_3 (34.11%). The causes of variation are due to soil composition, cattle slurry, season, topography etc. Azim et al. (1989) found that crude fiber (CF) content of various fractions of the plant ranged between 19.12 to 35.60% with maximum values in the bottom portion of the stem. Matured plants contained more CF. NDF ranged from 55.93% to 57.22%. Application of treatments showed a non-significant effect on NDF content. The highest value of NDF was in treatment T_2 (57.22%) and the lowest value in treatment T_0 (55.93%). The NDF % of the fodder was similar to that reported by Gupta et al. (1995) and may vary because of stage of maturity of fodder, topography, seasonal effect etc.

CONCLUSION

From the present study, it may be concluded that maize fodder harvested at 56 days of age through application of 12 ton/ha cattle slurry was best for the production of biomass yield and content of nutrients. Considering the importance of animal waste management and organic farming, as well as environmental pollution control, further research is warranted.

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