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Biomass Yield and Chemical Composition of Maize (*Zea mays*) Fodder Using Compost as Fertilizer

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ABSTRACT: The experiment was carried out by using compost on maize fodder production. Maize fodder was cultivated at 4 levels of compost viz. 0, 5, 10, and 12 ton/ha in a Randomized Block Design having three replications in each treatment. The unit plot size of each replication was 4m x 2.5m. The fodder plant height, circumference of stem were measured every fortnightly. The fodder was harvested at the pre-flowering stage at 77 days after sowing (DAS). The average yield, number of leaves, and leaf area of green forage was recorded. The proximate composition of fodder for each treatment was determined. The result showed that height of the plant significantly increased with increasing doses of compost. Result showed that the fodder plant height and circumference of stem were significantly ($p<0.01$) influenced by the increasing rate of compost DAS. The highest total DM yield of fodder for the use of compost at T_3 treatment was found 22.23 (g/100g). The crude protein content of maize fodder by the effect of compost in different levels of doses were 11.43, 10.94, 9.78, and 9.05 (g/100gDM) in response to 0, 5, 10, and 12 ton/ha respectively. Number of leaves of fodder plant was not significant but leaf area was significant ($p<0.01$) among the treatment groups. The highest green biomass yields of maize fodder was 35.89 ton/ha at T_2 treatment. Organic matter content (g/100g DM) of maize fodder was higher in T_2 treatment groups. The ash content (g/100g DM) of maize fodder was higher in T_2 group which was not significant with the treatment T_3. The EE and CF contents (g/100g DM) of maize fodder were not significant with the treatment groups. The finding says that maize fodder harvested at 77 DAS through application of 10 ton compost/ha was better for the production of biomass yield and nutritive value.

Keywords: Biomass, Maize fodder, Compost, Bio-fertilizer.

INTRODUCTION

Bangladesh has an area of 1,47,570 sq. km. with net cultivable land of 1.20 million hectares. Eighty four percent of cultivable land is using for the production of rice and only 0.05% land are contributed for the production of forage and rest for other crops (BBS, 2008). But unplanned cultivation of land causing the reduction of soil fertility enhanced using the chemical fertilizer, which leads imbalance of soil nutrient for plant growth. So, bio-fertilizer is needed to keep the soil healthy. The compost is recognized a good quality bio-fertilizer, with a total production of about 225 million tons and 9.3 million tons from other animals and poultry per year (BBS, 2008). The addition of organic matter via compost might be useful to conserve soil fertility by increasing organic matter, which is decomposed slowly but steadily. It contains nitrogen (1.89%), phosphorus (0.80%), Potassium (0.88) and other micro minerals those help to maintaining fertility of the soil and hold the suitable pH of the soil for better fodder production.

Livestock plays an important role in our total GDP. But 90% of our rural families are involved in backyard farming system. Tareque (1992) reported that more than a 90% of the feeds consumed by the 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 ruminant's diet consists of low quality roughage i.e. rice straw and moreover, the amount available is far less than the requirement (Jackson, 1981). As a result, our animals are left under fed and maintained poorly. For this reason, fodder production should be increased in other techniques may be adopted.

At present 0.736 million hectares of cultivable land are laying fallow for more than one year and 8.697 million hectares are unavailable for cultivation. About 84% of the total cultivable land is used for cereal and only 0.05% for fodder production and the rest for other crops (BBS, 2008). In Bangladesh, farmers generally do not grow any crop extensively as fodder because they do not have enough land to do so. As a result, fodder shortage is aggravating day by day and recently it has emerged out as an acute problem for raising livestock. Besides, no pasture land in our country used as temporary pasture. In the recent, pastures have now been turned into crop field due to the production of irrigation facilities. Growing of fodder crops with existing cropping system may be an appropriate to technology to meet the fodder shortage of Bangladesh (Mamun *et al.,* 1994). Maize grown commercially in central and northern Europe, North America and South America and used primarily in animal feeding. Maize has higher protein content than most wheat (Scott 1982).

Excessive and imbalanced use of chemical fertilizers has adversely affected the soil causing decrease in organic carbon reduction in microbial flora of soil, increasing of nitrogen fertilizer is contaminating water bodies thus affecting fish fauna and causing health hazards of human beings and animals. To overcome the deficit nutrient supply and the adverse effects of chemical fertilizer, it is suggested that the use of organic fertilizers will help to proper use of waste as well increase the soil fertility and to release nutrients to fodder for sustainable production in an eco-friendly pollution free environment. Compost is a potential source of soil nutrients for smallholder rural farmers. Among fodder only the maize has been drawing attention is an ideal fodder crop due to its quick growing nature, high yielding ability, palatability for livestock, and nutrient contents. But due to cumulative looseness of soil fertility in relation to organic matter content is important to add bio-fertilizer in the soil for better production of maize fodder is an important element for better yield compost might be a good solution (Ranjan,1980). The production of maize fodder, with the compost and then feeding this fodder to the animals, the human can get organic meat, milk etc. There is a available information on growth, 'biomass yield, nutrient content, chemical composition, and energy content of maize fodder as affected by different doses of compost (Rubio *et al.,* 1996; Uddin, 2002).

MATERIALS AND METHODS

The experiment was conducted in two stages- the first stage was the production of maize fodder and second stage was chemical analysis of the produced fodder. The climate of the experimental site was moderate rainfall and medium temperature during the experimental period from December, March. The maximum and minimum temperature was in the range of 32.60 to 26.30°C and 23.44 to 20.04°C respectively. The relative humidity during the period ranged from 85.40 to 76.54 % and average rainfall was recorded to 201mm.

The soil of the experimental site was silt loam texture and contained 0.14% nitrogen, 0.12% Phosphorus,0.41 % potassium and 0.11 % sulphur. The land was flat, moderate drained and above flood levels. Soil sample was subjected to chemical analysis for the determination of nitrogen, phosphorus, potassium and sulphur.

The land was ploughed and cross ploughed four times with tractor followed by laddering to obtain the desirable tilts. The corners of the land were spaded and visible larger clots were broken into small pieces. 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 the each plot was 10 m² (4m x 2.5m).

Experimental Design and Treatments

The experiment was conducted in a Randomized Block Design (RBD) comprised four (4) levels of treatments viz: 0(T_o), 5(T_1), 10(T_2), and 12(T_3) ton compost/ha. Each treatment was replicated into three times and they were randomly distributed into twelve plots.

Table1: The layout of the experiment is shown in tabular form

T_0R_1	T_0R_2	T_0T_3
T_1R_1	T_1R_2	T_1T_3
T_2R_1	T_2R_2	T_2T_3
T_3R_1	T_3R_2	T_3T_3

T_o= Without Compost, T_1= 5 ton compost/ha, T_2= 10 ton compost/ha, T_3= 12 ton compost/ha

Towards the final stage of land preparation, Compost was applied as organic fertilizer at the rate of 0, 5, 10, 12 ton/ha. Finally, experimental plots were prepared and leveled. Amounts of compost were calculated from the availability of N in the dung and standard nitrogen requirements for maize cultivation.

Chemical Analysis of Compost, Soil, and Fodder Plant Samples

Sample of Compost, and fodder plant samples were subjected to chemical analysis for the determination of nitrogen, phosphorus, potassium and sulphur.

Table 2: The percent of nitrogen (N), phosphorus (P), potassium (K), and sulphur (S)

Sample Compost		N%	P%	K%	S%
		1.89	0.80	0.88	0.082
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

Sowing of Seed

Seeds of Maize were sown on December by line sowing method. In this method, seeds were sown in rows behind a plough maintaining a row spacing of 20cm and seed spacing of 15cm and depthless was 5-6cm. Alight spading was done for better soil covering of seed.

Gap Filling

The seedlings of the fodder emerged out within 5-6 days after sowing. The germination rate was 85%. Necessary gap filling was done at 30 days after sowing.

Weeding of the Plots

Weeding and irrigation were done once at 35 days after sowing during the experimental period.

Plants Height Measurement

Plants height was measured at 15 days interval. Three plants were randomly selected from each plot and full lengths of the plant were recorded by a measuring tape. Plant height was measured in cm from the base of the plant to the tip of the plant.

Circumference of Maize Fodder Measurement

Three plants were randomly selected from each plot and the circumferences of the plants were measured by the measuring tape in every 15 days.

Plant Leaves Area Measurement

The leaf area was measured at 15 days interval. Three fodder plants were randomly selected in each plot. The length of the leaf was measured from base to tip of leaves. Then width also was measured in three places of a leaf (base, middle, and tip of the leaves). To measure the area of the leaf, the average value of width was multiplied with its own length of the leaf. It was expressed in cm^2

Number of Leaves/plant

Before cutting the fodder plant, the numbers of leaves were counted randomly from three plants in each plot.

Harvesting of the Fodder

Maize fodders of all the plots were harvested at 77 days after sowing (about 10% flowering stage). Immediately after harvesting, biomass yield of the Maize fodder was recorded by weighing balance. All the fodders were weighed and average forage production under different levels of Compost was expressed in ton/ha.

Collection and Preparation of Fodder Sample

The plants were harvested above the ground level and immediately collected from the plot. The plant of the fodder individual plot was collected and tagged separately. At the same time freshly collected representative plants from each plot were chopped into small pieces and a portion was subjected to oven dry at 105˚C for the determination of dry matter (DM) content.

Dried samples were ground in a grinding machine (CYCLO'1'EC 1993 -sample mill Tecator, Sweden) at the size of 1.0 mm for chemical analysis. The ground samples were bottled covered with polythene paper and kept in desiccators.

Chemical Analysis

Chemical composition of dried samples for dry matter (DM), organic matter (OM) and nitrogen (N) were estimated according to the methods of AOAC (2007). Crude Fiber and Ether Extract were estimated by the methods of Faichney and White (1983).

Dry Matter (DM)

Dry matter was determined from well mixed representative samples of different Treatments. The samples were weighed and dried in an oven at a temperature of 105°C for 1 days to get the constant weight was attained.

Organic Matter (OM)

After determination of dry matter (DM), the sample was taken for determination of OM by ashing one gram of sample in a muffle furnace at 550°C for 5 hours. The weight of the ash was deducted from the DM for estimation of OM.

Nitrogen and Crude Protein

Nitrogen content of all the samples was determined by Kjeldhal digestion of a 1g sample with concentrated sulphuric acid(H_2SO_4) and 1g mixed catalyst, distilled into 2% boric acid solution titrated with 0.1N HCL. Crude protein was estimated by multiplying N content by 6.25.

Crude Fiber

2 gm of dried sample was weighted and was made acid free and alkali free with the help of 1.25% H_2SO_4 solution (125 ml) and of 1.25% NaOH solution (125 ml). The washed residue was transferred into previously weighted empty crucible and was placed into an oven regulated at 105°C for 24 hours or up to constant weight. The dried sample was weighted and ignited with muffle furnace at 600°C degree centigrade for 5 hours. The loss of weight due to ignition was crude fiber of the sample. The formula is mentioned below:

$$CF = \frac{\text{Loss of weight in ignition}}{\text{Weight of sample}} \times 100$$

Ether Extract

Ether extract was determined by sox-let apparatus using diethyl ether. . Accurately weighed sample 2 gm was taken in pre-weighed thimbles and were dipped in pre-weighed aluminum cups with 180 ml diethyl ether. First boiling then rising and finally extraction was done at 40-45°C which took about 7-8 hours. After extraction the aluminum cups were taken out and dried in oven for 30 minutes at 100°C. The cup containing Ether extract was cooled in desiccators and weighed the calculated value for lipid content was obtained as percent of the sample.

The formula is mentioned below:

$$\%\ EE = \frac{\text{Weight of Ether}}{\text{Weight of Sample}} \times 100$$

RESULTS

Effect of Compost on Yield Characteristics and Biomass Yield of Maize Fodder

Height of Maize Fodder

From the Table it can be seen that application of compost resulted in significantly ($p<0.01$) higher plant height than that obtained in control group having no Compost at 15 days after sowing. Among the treatment groups the treatment T_3 (12 ton compost/ha) gave the highest plant height at 15, 30, 45, 60 days of plant growth but the treatment T_2 groups (10 ton compost/ha) gave the highest plant height at 77 days of plant growth. The effect of T_3 on plant height was significantly ($p<0.01$) higher than that of T_o, T_1, and T_2 at 15, 30, 45, 60 days after sowing. At 77 days of fodder growth, the treatment groups T_2 (10 ton compost/ha) was significantly ($p<0.01$) higher than that of T_o, T_1, and T_3.

Table 3: Effect of compost on plant height of Maize fodder at different days after sowing

Treatments	15 days	30 days	45 days	60 days	77 days
T_o	16.03	24.13	44.75	75.77	131.30
T_1	17.83	25.11	56.22	96.34	150.14
T_2	17.46	27.04	63.32	104.42	160.27
T_3	19.33	28.23	64.60	120.51	159.10
SEM	0.444	0.048	3.827	7.300	0.972
Levels of significance	**	**	**	**	**

** = Significant at 1% level of probability.

The effect of treatment T_3 on plant height was significantly ($p<0.01$) higher than that of T_o (control group), T_1 (5 ton compost/ha), T_2 (10 ton compost/ha) at 15, 30, 45, 60 days of fodder growth. At 77 days after sowing the fodder height was also significantly ($p<0.01$) higher in the treatment of T_2

Circumference of Stem

At 15, 60, 77 days after sowing, the effect of T_3 on the circumference of stem of maize fodder was higher than that of T_o, T_1, and T_2 at 0.01% of significant. But T_o, T_1, T_2 and T_3 was non-significant at 77 days and T_o, T_1, T_2, and T_3 was significant at 15, 30, 45, 60 days. Circumference of stem showed that T_1, is higher than T_o, T_2 and T_3 at 30 days but no significant ($p<0.01$) effect than T_2. At 45 days of fodder growth, treatment T_2 gave the highest circumference (4.48 cm) of stem of maize fodder and the effect of T_2 treatment was significantly ($p<0.01$) higher than that of T_1. At 60 days of stem circumference T_3 is gave the highest result than T_o, T_1, and T_2.

Table 4: Effect of compost on circumference of maize fodder stem (cm/stem)

Treatments	15 days	30 days	45 days	60 days	77 days
T_o	2.22	3.72	4.40	6.62	8.45
T_1	2.52	3.96	4.14	6.81	7.20
T_2	2.44	3.92	4.48	6.75	8.63
T_3	2.80	3.80	4.29	7.04	8.78
SEM	0.002	0.001	0.001	0.007	1.382
Levels of significance	**	**	**	**	NS

** = Significant at l% level of probability, NS means non-significance.

Number of Leaves per Plant

From the Table 5, it is revealed that the number of leaves per days of plant of maize fodder ranged from 11.22 to 14.00 at harvesting period on (77 number of leaves of sowing) Application of compost did not show significant effect on number of leaves of fodder.

Area (cm^2) per Leaf

Area per leaf is higher (474.70 cm^2) with the treatment of T_3. The treatment effect T_3 is significant ($p<0.01$) than that T_o, T_1, and T_2.

Table 5: Effect of compost on number of leaves, area of leaves and biomass yield of Maize fodder

Treatment	Parameters		
	No. of leaves	Area cm^2	Biomass yield (MT/ha)
T_o	11.22	409.56	27.13
T_1	11.44	430.68	33.03
T_2	12.22	450.72	35.89
T_3	14.00	474.70	30.12
SEM	0.047	9.375	0.620
Levels of significance	**	**	**

** = Significant at 1% level of probability.

Biomass Yield:

It is revealed from the Table 5 that the highest biomass yield of maize fodder is in the treatment group of T_1 and T_2. The effect of T_1 (5 ton compost/ha), T_2 (10 ton compost/ha) is non-significant regarding the biomass yield but that these two group are significant than T_0 (control group) and T_3 (12 ton compost/ha).

Effect of Compost on Chemical Composition of Maize Fodder

Chemical composition (DM% basis) of maize fodder cultivated under four levels of compost is shown on Table 5.

Dry Matter (DM)

It is shown from the Table 5 that the dry mater (DM) ranged from 21.04 to 22.23%. Application of compost did not show significant effect on dry matter yield.

Organic Matter (OM)

The organic matter (OM) content is higher in the fodder of T_2 treatment. The treatment effect is not significant between T_1 and T_3 treatment. T_2 treatment effect is higher (93.03%) than the T_o, T_1, and T_3 (91.83%, 90.97% and 90.97% respectively).

Ash

It is revealed from the Table 5 that the highest ash content of maize fodder is in T_2 treatment group (9.90%). The effect treatment of T_2 on ash content was significantly ($p<0.01$) higher than that of T_o (7.08%) and T_1 (8.10 %) but non significantly higher than that of T_3 (9.67%).

Crude Protein (CP)

Effect of compost on CP content of maize fodder is shown Table 5. CP content is higher (11.43 %) in T_o (control group) treatment group and the effect of T_o on the CP content of maize fodder was significantly ($p<0.01$) higher than that of others (T_1, T_2, and T_3).

Table 6: Effect of compost on chemical composition of Maize fodder

Treatment	D M %	OM%	CP %	CF %	EE %	As %
T_o	21.48	91.83	11.43	35.25	2.15	7.08
T_1	21.04	90.97	10.94	35.06	2.29	8.10
T_2	21.56	93.03	9.78	35.79	2.72	9.90
T_3	22.23	90.97	9.06	34.32	2.99	9.67
SEM	0.375	0.169	0.172	0.071	0.00 4	0.17 0
Levels of significance	NS	**	**	**	**	**

** = Significant at 1% level of probability, NS = Non significant.

Crude Fiber

It is observed from the Table 5 that the CF ranged from 34.32 to 35.80%. Application of compost showed significant effect on CF content. The highest value of CF is in T_2 (35.79 %) and lowest value is in T_3 (34.32%).

Ether Extract

From the Table 5 it is shown that the value of ether extract of maize fodder is higher in the treatment of T_3 (2.99%). Application of compost in the treatments showed significant effect on EE content.

DISCUSSION

Fodder Height

Fodder height is positively correlated with the fodder yield. The increasing of compost increase the fodder height as well as the fodder yields. Reddy *et al.,* (1987) found 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 the plant height was increased by providing the increasing level of compost (N source). Fodder height of the present experiment was higher at 60 days than to Hammam (1995). There are some factors responsible for the fodder plant height such as genetic constituent of fodder, soil fertility, climatic condition, day length, light intensity etc. Among them genetic factor 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, steam weight, stem diameter, leaf weight, leaf diameter etc.

Biomass Yield

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. This experiment is similar to Kumar *et al.* (2001), Shahjalal *et al.* (1996), Khan *et al.* (1996) and Rajput and Singh (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 maristematic activity and also increase in the photosynthetic surface and hence more production and accumulation of photosynthetic (Verma, 1989).

Number of Leaves and Leaf Area

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 is observed that the Compost did not affect the increasing number of leaves. Because the leaf number is the genetic factor which does not affect the fertilizer. Fertilizer only can affect the area of the leaves. Rezende *et al.,* (1994) concluded that number of leaves increased with increasing N rate. The number of leaves slowly and gradually declined with the advancement of plant age. Temperature and moisture of the soil are two important parameters affecting the number of leaves produced by the maize plants and the increase in temperature from 15 to 24°C almost doubled the initiation of leaves. For leaf area N increasing levels did not also affect that is same with the experiment which is conducted with

Ganga safed 2 varieties by Singh *et al.,* (1996).

Chemical Composition of the Fodder

Chemical composition, alone, as measured by the proximate and elemental analysis system, is an inadequate indicator of nutritive value. This measurement takes no account of either the form of availability of nutrients, and at best, may provide information on potential nutrient content. The content of DM % found in the experiments different to the experiment of others. Particularly, Sarker (2000) in zamboo fodder, Khan *et al,* (1996) in oat fodder, Shajalal *et al,* (1996) in oat and maize fodder and Sarker and Khan(1996) in maize fodder. It may be varied with species, stage of maturity of fodder, soil topography, season, temperature, climate condition, nutrients etc. The content of DM % found in the experiment is similar to the report of other sources particularly Islam *et al.* (1997), Khan *et al.* (2002) but differ to the report of Ranjhan (1980). The total ash content of fodder was gradually increased with increasing level in the compost doses. It differs to the report of Pieper *et al.* (1974) and Sarker (2000). It may be varied because of ash, silica and individual mineral in soils. From my result, it appears that compost level up to 12 kg decreases the CP % than other treatments. Sarker (2000) also found same in zamboo fodder, Singh *et al,* (1974) in bajra, Lawrence (1970) in wheat grass and maize fodder. Stage of maturity influences the nutrient content of fodder. Crude protein and soluble carbohydrate are higher in young fodder and indigestible crude fiber increase as the plant matures. Nutritive values decline with the advancing stage of maturity of fodder. Temperature, moisture, soil, season etc. also affect the nutrients.

The content of CF % found in the experiment is similar to the report of Sarma and Singh (1988). The causes of variation are due to soil compost, season, topography etc. The EE% of the fodder is similar to Sarma and Singh (1988). It may be varied because of stage of maturity of fodder.

CONCLUSION

The study showed that the plant height significantly increased with increasing doses of compost. Results were showed that the fodder plant height was significantly influenced by the increasing rate of compost at 15, 30, 45, 60, and 77 days. Fodder plant height varied significantly ($p<0.01$) among the treatments of compost. Circumference of stem of maize fodder also increased with increasing level of compost. But the best result was found from the treatment group of T3. The number of leaves of fodder at different level of treatment group of compost was not affected. The averagely maximum number of leaves was 14.000 at T3 group and lowest was 11.22 at control group. Area of leaves of maize fodder was not affected the increasing level of compost. The maximum area of leaf (474.70 cm^2) was found at the treatment T_3. Biomass yield of maize fodder was not also affected with the increasing level of compost. The maximum biomass yield of maize fodder was found at the treatment group of T_2 (35.89 ton/ha) that is not significant with the treatment of T_1 (35.03 ton/ha). The average DM content (g/100g fresh sample) of maize fodder was 21.48, 21.04, 21.56, and 22.23 on treatments T_0 (control group), T_0 (5 ton compost/ha), T_2 (10 ton compost/ha), and T_3 (12 ton compost/ha) respectively. The result showed that there was no significant difference among the treatments. The average OM content (g/100g DM) of maize fodder was not increased significantly with increasing level of compost. The highest OM was at the treatment group of T_2 (93.03) and that was significant with the other treatment groups. The ash content (g/100g DM) of maize fodder was increased significantly ($p<0.01$) with increasing level of compost/ha. The highest yield of ash was observed in T_2 .The average CP content (g/100g DM) of maize fodder was 11.43, 10.94, 9.78, and 9.06 in $T_{0,}$ T_1, T_2, and T_3 respectively. There was significant ($p<0.01$) difference in CP content among the treatments. The highest CP content was recorded for treatment T_0 (control group). The average CF and EE content of maize fodder were not significantly affected due to the application of compost.

From the findings of this study, it may be concluded that maize fodder harvested at 77 days after sowing through application of 10 ton/ha compost was better for the production of biomass yield and nutrient contents, topography, seasonal effects etc.

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