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Plant characteristics, growth and leaf yield of *Aloe vera* as affected by organic manure in pot culture

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Abstract
A pot experiment was conducted at Sher-e-Bangla Agricultural University, Dhaka, Bangladesh to evaluate the effect of different amount of manures on the leaf and plant characteristics as well as yield of *Aloe vera*. There were 8 different treatments viz., T_1 = 100% soil (control), T_2= 50% cowdung + 50% soil, T_3= 25% cowdung + 75% soil, T_4= 10% cowdung + 90% soil + urea, T_5= 10% cowdung + 90% soil, T_6=5% cowdung + 95% soil + urea, T_7= 5% cowdung + 95% soil, T_8=soil + urea. It was observed that the plant produced highest number of leaves and maximum leaf weight, maximum leaf breadth, total leaf area as well as length and breadth of largest leaves with application of 50% cowdung + 50% soil (T_2). Different plant characters such as weight of tiller, stem and root as well as root length was also found to be highest with T_2 treatment over control (100% soil). The growth rate of leaves also significantly affected by different manure treatments where maximum effect was noticed at early stages with all the treatment. It was revealed that urea had a little effect on plant character of *Aloe vera* over organic manure (cowdung).

***Key words*:** *Aloe vera*, cowdung, urea, leaf growth

Introduction

Aloe belongs to Liliaceae, the family of perennial tropical plants of African origin. More than 360 species are known worldwide. Species of *Aloe* which have been used as folk medicine include: Curacao Aloe (*Aloe barbadensis* or *Aloe vera*), Cape Aloe (*Aloe ferox*), and Socotra *Aloe* (*Aloe perryi*). Records of the use of *Aloe vera* as folk medicine date to antiquity with an early account from around 1500 B.C. The exudate of *Aloe vera* is used for numerous medical and cosmetic applications since ancient times (Morton, 1961). The gel of *A. vera* possesses various biological and physiological activities viz. healing ability of skin burns and cutaneous injuries; prophylactic effect against radiation leucopenia; anti-ulcer; inhibitory action against some bacteria and fungi;inflammation-inhibiting effect; inhibition of the prostaglandin synthesis by anthraquinone-type compounds; and inhibition of the AIDS virus by acemannan. Commercial exploitation of *Aloe vera* gel has been carried out for at least 50 years. Various companies in the US act as primary growers and processors of the plant and manufacture bulk supplies of the gel for domestic and export market. Many other companies are secondary processors of *A. vera* products, and cosmetics firms and chain store often buy the gel for incorporation into their own brand name products (Grindlay and Reynolds 1986). The cultivation of *A. vera* has acquired great commercial importance for medicinal products and cosmetics processing but information is scarce about agronomic management of this crop. The land of Bangladesh is very fertile as well as seasons are variable and favorable for various medicinal plants to grow.

Table 1. Leaf characteristics of *Aloe vera* plant at harvest (60 DAT)

Treatment	No. of leaves plant^{-1}	Total leaf weight plant^{-1} (g)	Single mature leaf weight (g)	Mature Leaf length (cm)	Mature Leaf breadth (cm)	Total leaf area plant^{-1} (cm^2)	Length of the Largest leaf (cm)	Breadth of the Largest leaf (cm)	Weight of the Largest leaf (g)
T_1 = 100% soil (control)	8.67 d	348.33 f	29.39 f	26.00 d	2.39 c	672.54 e	31.60 c	4.03 b	71.00 f
T_2= 50% cowdung + 50% soil	12.00 a	883.66 a	85.27 a	34.82 a	3.67 a	1346.89 a	43.30 a	5.11 a	143.33 a
T_3= 25% cowdung + 75% soil	11.67 ab	704.63 b	63.58 b	29.44 bc	3.34 ab	1196.58 b	37.93 abc	4.76 ab	116.00 b
T_4= 10% cowdung + 90% soil + urea	11.33 ab	650.50 c	56.06 c	30.56 b	3.29 ab	1189.56 b	36.50 bc	4.60 ab	94.00 c
T_5= 10% cowdung + 90% soil	10.67 bc	583.33 d	50.42 cd	29.34 bc	3.16 ab	1082.54 c	39.90 ab	4.50 ab	91.00 cd
T_6=5% cowdung + 95% soil + urea	9.33 d	421.33 e	45.35 d	26.39 d	3.08 b	756.69 d	33.40 bc	4.15 b	73.33 ef
T_7= 5% cowdung + soil	9.67 cd	382.00 f	39.53 e	26.73 d	2.87 bc	749.95 d	34.05 bc	4.13 b	64.00 f
T_8=soil + urea	8.67 d	367.00 f	43.02e	27.45 cd	2.99 b	699.55 e	34.70 bc	4.23 b	82.00 de
$LSD_{0.05}$	**1.23**	**34.11**	**6.54**	**2.55**	**0.55**	**40.88**	**6.78**	**0.78**	**10.06**
CV (%)	7.44	5.67	7.88	4.66	5.64	3.67	4.43	5.23	3.99

Aloe vera is cultivated in many places in this country but not in wide range. About 90 per cent of the plants are estimate to come from wild harvest (Dixie *et al*., 2003). In Bangladesh, Natore district is the major production area of *Aloe vera*. Cultivation of *Aloe vera* is expanding day by day in the area as it provides quick and regular income to the farmers. Farmers are not using any recommended farming practices for *Aloe vera* cultivation which resulted poor yield. Fertility management in *Aloe vera* field may be one of the strategies for boosting up the yield of *Aloe vera.* As Aloe *vera* is succulent plant and thus it is more responsive to nutrient. However, the excess doses of chemical nutrient as well as improper sources can show negative effect of quality. Organic manures are more effective in *Aloe vera* growth and yield which is comparable to chemical fertilizer (Saha *et al*., 2005). In addition organic manures enhance a good leaf quality. So, it may necessary to find out a suitable recommendation for manuring in *Aloe vera* farming. The present study was carried out to determine the effect of manuring levels on the growth and yield of *Aloe vera.*

Materials and Methods

This experiment was conducted at the Sher-e-Bangla Agricultural University, Dhaka-1207, during July-November of 2006. The climate of this area is subtropical. The soil of the experimental site was clay loam with pH of 5.47-5.63. The experiment was laid out by Randomized Completely Block Design (RCBD) with 4 replications comprising eight different treatments viz. T_1 = 100% soil (control), T_2= 50% cowdung + 50% soil, T_3= 25% cowdung + 75% soil, T_4= 10% cowdung + 90% soil + urea, T_5= 10% cowdung + 90% soil, T_6=5% cowdung + 95% soil + urea, T_7= 5% cowdung + 95% soil, T_8=soil + urea. The size of the pot used in the experiment was 12 inches in diameter and of 12 inches in height. Seedlings of around 8 weeks were collected from Kholabaria of

Table 2. Plant, tiller, stem and root characteristics of *Aloe vera* plant at harvest (60 DAT)

Treatment	Weight of plant (g)	Weight of tillers plant $^{-1}$ (g)	Total Weight of plant and tillers (g)	No. of tillers plant^{-1}	Weight of stem plant^{-1} (g)	No. of lateral root plant^{-1}	Length of tap root system (cm)
T_1 = 100% soil (control)	399.33 h	33.83 g	433.16 h	1.03 e	45.00 e	19.67 c	13.97 e
T_2= 50% cowdung + 50% soil	993.33 a	199.40 b	1193.06 a	4.00 a	109.67 a	32.67 a	16.40 de
T_3= 25% cowdung + 75% soil	766.00 b	269.33 a	1035.33 b	3.00 c	61.37 cd	33.00 a	19.65 bc
T_4= 10% cowdung + 90% soil + urea	714.33 c	114.63 d	828.96 c	3.67 ab	63.83 bc	32.00 a	23.50 a
T_5= 10% cowdung + 90% soil	645.67 d	142.73 c	788.40 d	3.67 ab	62.34 c	35.33 a	17.53 cd
T_6=5% cowdung + 95% soil + urea	465.00 ef	55.43 f	520.43 f	1.33 e	43.67 e	27.33 b	22.17 ab
T_7= 5% cowdung + soil	453.00 fg	103.33 e	557.00 e	1.25 e	71.67 b	25.33 bc	15.33 de
T_8=soil + urea	421.00 gh	59.31 f	496.48 g	2.00 d	54.0 d	24.00 bc	14.30 e
$LSD_{0.05}$	**34.21**	**8.43**	**21.23**	**0.45**	**7.87**	**4.33**	**2.99**
CV (%)	4.07	3.77	5.61	4.11	5.33	6.00	5.65

Natore District. Well decomposed cowdung was used in this experiment as per treatment. Urea was used as recommended doses of 150 kg ha^{-1}. Single seedling was planted in every opened pot. The pots were irrigated whenever necessary. Data were recorded every 15 days interval starting from 15 days after planting (DAP) for measuring leaf length and breadth. Final data were recorded at harvest to measure plant characters. Flexible tap and scale were used to measure leaf. Weighing was done by digital balance (Kaifeng Group Co., Ltd., China). The data were analysed following Analysis of Variance (ANOVA) technique and mean separations were adjusted by the Multiple Comparison test (Gomez and Gomez, 1984) using the statistical computer programme MSTAT-C v.1.2 (MSTAT-C, 1990). Means were compared by using LSD test at 5% level of significance.

Results and Discussion

Different combination of manuring significantly affected the leaf characteristics of *Aloe vera* in this experiment (Table 1). The highest number of leaf per plant was observed from T_2 (50% cowdung + 50% soil) followed by T_3 and T_4. Concerning total leaf fresh weight per plant, the data in the same table indicate that all treatments increased significantly leaf fresh weight as compared to control plant.

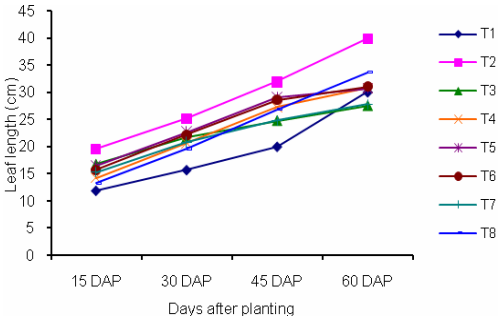

Fig 1. Leaf length of *Aloe vera* leaf type no.1 (initial length of 5 cm to 11 cm) at different days after planting.

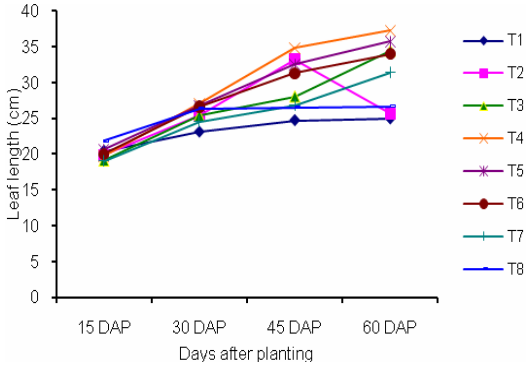

Fig 2. Leaf length of *Aloe vera* leaf type no.2 (initial length of 11 cm to 18 cm) at different days after planting

Using 50% cowdung was the most effective in increasing leaf fresh weight per plant (883.66 g). The effect of urea was not superior to the cowdung in this experiment which was supported by Saha *et al*. (2005) and Nobel *et al*. (1991). This trend of increased production due to increased application of cowdung were also observed in case of single leaf weight, leaf length and breadth, leaf area per plant, length and breadth of the largest leaf and weight of the largest leaf. The application of organic matter were increased the cell division and elongation without hampering the nutrient uptake process which provided the better results due to better nutrition. Guerrero *et al.* (2001) found that organic matter addition is a suitable technique for accelerating the natural recovery process of burned soils. In this case application of urea as recommended doses did not showed superior results than cowdung application in this experiment. Different manuring treatment also significantly affected the plant characteristics of Aloe vera in this study (Table 2). The highest weight of plant at harvest (993.33 g) was observed in the treatment where 50% cowdung was applied (T2) which was statistically superior to other treatments. The lowest plant weight (399.33 g) was observed in control plots (100% soil) where no cowdung and urea was applied (Table 2). An increased trend of plant weight was observed with the increase of cowdung amount. It was due to the beneficial effect of organic matter in soil properties and plant growth (Dexter, 1988; Tisdall and Oades, 1982; Uyanoz et al., 2002) More or less similar trend was observed in case of total plant weight along with tillers. The weight of tillers was higher in case of 50% and 25% cowdung applied treatments and the increase was not regular in other treatments. Number of tillers per plant was highest with the treatment T2 (50% cowdung + 50% soil) which were followed by T4 and T5. These results were supported by Hernández-Cruz et al. (2002). Increased number of lateral roots per plant was observed in case of the treatments where increased amount of cowdung was applied. The stem weight and root length were positively responsive with higher amount of cowdung application. These results were confirmed with Tawfik (1984) and Yepez et al. (1993).

In case of leaf type no. 1 (from base), continuous and highest growth rate of leaf was observed in the treatment where 50% cowdung was applied. The leaf length was also highest in this case (Fig. 1). This trend was also found in the treatments where comparatively more cowdung was applied. The lowest growth rate was observed in case of control treatment where no cowdung and urea was applied. The growth rate of the leaves was highest at early stages of growth which declined gradually. The growth of control treatment was lower but consistent up to 60 DAP. In that case urea has not significant effect over the organic manures. These findings were also in agreement with the results of Chatterjee *et al.* (1979) and van Schaik *et al.* (1997).

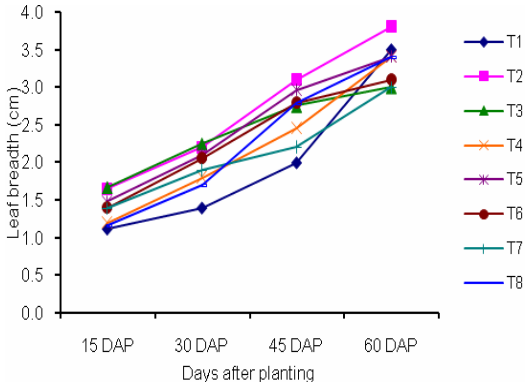

Fig 3. Leaf breadth of *Aloe vera* leaf type no.2 (initial length of 11 cm to 18 cm) at different days after planting

Higher growth trend was also observed in case of leaf type no. 2 with the treatments where 50% to 10% cowdung was applied. The growth rate in length decreased with the decrease in cowdung percentage (Fig. 2). The lowest growth rate was observed in control treatment where no manure was applied. The highest length of leaves was observed in case of the treatment where 50% and 25%

cowdung were applied. This dose of cowdung improving the *Aloe vera* plant growth by providing the essential nutrient which resulted the maximum cell growth and turgidity which influenced the leaf growth. Pichgram (1987) also observed similar results in *Aloe vera*.

Growth rate of leaf breadth type no.1 has been presented in Fig. 3. It this case the highest growth rate was observed in the treatments where higher amount of cowdung was used. The lowest growth rate was observed in case of control treatment. The highest percentage of increase in leaf breadth was observed in the early stage of growth irrespective of treatments (Fig. 3). Some irregular increase in growth rate of leaf breadth was observed in control treatment at later stage. van Schaik *et al.* (1997) observed similar results.

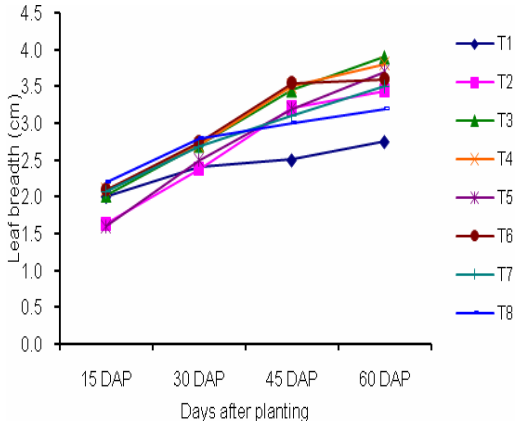

Fig 4. Leaf breadth of *Aloe vera* leaf type no.2 (initial length of 11 cm to 18 cm) at different days after planting.

In case of leaf type no. 2 growth rate of leaf breadth was higher with the treatments where higher percentage of cowdung was used (Fig. 4). The growth rate was the lowest in case of control treatment. The percentage of increased rate was highest in the early 15 days in all the treatments. This increase was gradually decreased in the later stages. The decreasing rate was highest in case of control treatment and treatments with lower doses of cowdung. It was due to the failure of *Aloe* plant to produce the cell expanse. This result was supported by Bates (1971) and Saha *et al.* (2005).

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