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GROWTH AND YIELD OF *ALOE VERA* (L.) BURM.F. AS INFLUENCED BY ORGANIC MANURES AND CHEMICAL FERTILIZERS

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Abstract

Influence of organic manures (10 ton ha^{-1}), nitrogen (50 and 100 kg ha^{-1}), phosphorus (10 and 20 kg ha^{-1}) and potassium (30 and 60 kg ha^{-1}) on the growth and yield of *Aloe vera* (L.) Burm.f. (*Aloe barbadensis* Mill.) were evaluated. Experiment was conducted in a randomized design replicated thrice with eleven treatments with NPK and without NPK fertilizers. Highest length of leaf (18 cm), highest leaf area (23.40 cm^2plant^{-1}), highest leaf area index 0.06 were observed in ACI_{10}ton ha^{-1}plus $N_{50}P_{10}K_{30}$ kg ha^{-1} treatment, highest fresh weight (78.23g$plant^{-1}$) and highest dry weight (9.58 g$plant^{-1}$) of plant biomass were observed in GTS_{10}ton ha^{-1} treatment. Highest concentration of N (2.69%) and protein content (16.84 %) in the leaf were recorded in GTS_{10} ton ha^{-1} treatment. Results revealed that the best growth performance and yield, and protein content in the leaf of *Aloe vera* was observed in GTS_{10} ton ha^{-1} treatment.

Introduction

Aloe belongs to Liliaceae, the family of perennial tropical plants of African origin. More than 360 species are known worldwide[1]. Species of Aloe which have been used as folk medicine include: Curacao aloe (*Aloe barbadensis*), Cape aloe (*Aloe ferox*) and Socotra aloe (*Aloe perryi*). The exudates of *Aloe vera* is used for numerous medical and cosmetic applications since ancient times[2]. It is well-known for the treatment of different diseases mainly skin problem as well as for many disorders like constipation, stomach disease, hair loss, kidney disease and others[3]. Products containing *Aloe vera* are used for the treatment of minor cuts and burns and to heal wounds[4]. Aloe gel possesses important biological properties *viz*. anticancer[5], antimicrobial[6], antioxidant[7], antiulcer[8], hepatoprotective[9], immunomodulatory[10] and many more medicinal activities. It is cultivated in many locations in our country but not in a wide range. About 90 per cent of the plants are estimated to come from wild harvest[11]. Cultivation of *Aloe vera* is expanding day by day as it provides quick and regular income to the farmers and grows in a variety of climates including desert, grassland and coastal lands. Farmers are not using any recommended farming practices for *Aloe vera* cultivation which results in

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yield. Fertility management in the field may be one of the strategies for boosting up the yield. 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. A large variety of organic wastes are available in the country that can be used as potential source of manure to improve soil. These are domestic wastes (non-edible vegetables, food and fruit parts, after- meal wastes etc.), farmyard wastes (cattle dung and urine, feed/fodder refuse, harvested crop residues, poultry manure etc.), agro-industrial wastes (sugarcane trash, oil cakes, bagasse, molasses, bone meal, blood meal, rice husk, brans, saw dust etc.) farm wastes (crop residues, weeds, dead animals, water hyacinth etc.) and city wastes (solid wastes and sewage sludge). There is an increasing trend in soil health degradation which can be attributed to higher crop removal due to increasing cropping intensity, nutrient leaching, minimum manure application *etc*. Chronologically N, P, K, S, Zn and B deficiencies have appeared. Government provided huge development support in fertilizers especially in nitrogen, phosphorus and potassium fertilizers[12].

Organic manures are more effective in *Aloe vera* growth and which is comparable to chemical fertilizer[13]. Organic farming is safe, inexpensive, profitable and environment friendly. The application of organic manure has been reported to increase crop yield and improve soil quality especially soil organic matter content[14]. Organic manures preserve natural resources and reduce degradation of ecosystem[15]. Harmless effects on the soil health are also an important consideration for the use of organic nutrients[16]. In Bangladesh, *Aloe vera* is traditionally grown in the natural habitats and there is no regular practice of cultivation by improved agro-techniques, particularly nutrient management. It may respond differentially under varying sources and amounts of fertilizers. Nitrogen, phosphorus, potassium, sulfur, magnesium and calcium are the macronutrient elements, which have important functions in living ecosystems. These elements are known to be essential and necessary for plants[17]. Phosphorus and potassium play an important role in yield limiting towards disease and drought conditions[18]. Phosphorus is the second most important plant nutrient after nitrogen. It is an essential macro nutrient that plays important role in all crop biochemical processes *viz.,* photosynthesis, respiration, energy storage, transfer, cell division, cell enlargement and nitrogen fixation. It is also important in seed germination, seedling establishment, root, shoot, flower and seed development [12]. Potassium is associated with the movement of water, nutrient and carbohydrate in plant tissue. It is involved with enzyme activation within the plant, which affects protein, starch and adenosine triphosphate (ATP) production. It also helps to regulate the opening and closing of the stomata, which regulates the exchange of water vapor, oxygen and carbon dioxide. If K is deficient or not supplied in adequate amounts it stunts plant growth and reduced yield[12].

The objective of the present experiment was to assess the growth and yield of *Aloe vera* under organic manures, NPK fertilizers application, and combined effects of manures and NPK fertilizers.

Materials and Methods

Soil sample collection and analysis: Soil sample (0-15 cm depth) was collected from Gojariya under Munshiganj district. After collection, the soil was processed and prepared for pot experiment. The sample was air-dried, ground and sieved through 3 mm sieve. Soil was preserved in plastic bottles and used for physicochemical analysis. Munshiganj (between 23°37′00″N and 90°33′00″E) is in agro-ecological zone of 19 within Old Meghna Estuarine Flood Plain. Soil is silty clay loam[19], had a pH of 5.64[20] cation exchange capacity (CEC)25.4cmole kg^{-1}[20], organic carbon 1.12%[21]) and total nitrogen content 0.13%[22]. Protein content of the leaf was determined by the method of Magomya *et al.*[23].

Collection of organic manures and NPK fertilizers: Four types of organic manures manufactured by different companies were collected from local market. Organic manures were ACI, GTS, Sebak and Kazi. The organic manures were properly mixed separately at the rate of 10 ton ha^{-1}.). Nitrogen (50 and 100 kg ha^{-1}) as urea, phosphorus (10 and 20 kg ha^{-1}) as triple super phosphate and potassium (30 and 60 kg ha^{-1}) as muriate of potash were applied.

Pot experiment: Pots were arranged in the net house of the Department of Soil, Water and Environment, University of Dhaka in a completely randomized design (CRD) having eleven treatments with three replications. Treatments were T_1: Control (-OM & -NPK), T_2: $Kazi_{10}$ ton ha^{-1}, T_3: GTS_{10}ton ha^{-1}, T_4: $Sebak_{10}$ton ha^{-1}, T_5:ACI_{10}ton ha^{-1}, T_6: $N_{100}P_{20}K_{60}$ kg ha^{-1} (100% NPK), T_7:$N_{50}P_{10}K_{30}$ kg ha^{-1} (50% NPK), T_8: $Kazi_{10}$ton ha^{-1} + $N_{50}P_{10}K_{30}$ kg ha^{-1}, T_9:GTS_{10} ton ha^{-1} + $N_{50}P_{10}K_{30}$ kg ha^{-1}, T_{10}: $Sebak_{10}$ton ha^{-1} + $N_{50}P_{10}K_{30}$ kg ha^{-1} and T_{11}: ACI_{10} ton ha^{-1} + $N_{50}P_{10}K_{30}$ kg ha^{-1}. Five kilograms of soil were taken per pot (height 22 cm and diameter 26 cm). Three weeks old seedlings of *Aloe vera* (L.) Burm.f. were collected from nursery and one was transplanted per pot. The length of leaf, number of leaf (with the help of a Taley counter), leaf area (length x width) and leaf area index (leaf area divided by ground area) were measured at 20 days interval up to harvest (120 days). Length of leaf was measured from the surface of the soil to the tip of the leaf. Intercultural practices *i.e.* weeding, watering, pesticide *etc.* were applied as per when needed.

Plant growth and harvesting: Plants were harvested as root, leaf and stem washed with tap water and finally with distilled water, wrapped with soft tissue paper after 120 days of transplanting of seedlings. Immediately after the harvest, fresh weight of leaf, stem and root were recorded and then air-dried in the room temperature and oven dried at 65°C. Dry weight of the plant samples were taken and stored in the polythene bags. Protein content was calculated by multiplying the N concentration of leaf with a factor

6.25.[23] Analysis of variance was done with the help of Microsoft Excel 2007 program and the mean differences among treatments were evaluated by LSD test at 5% level.

Results and Discussion

Assessment of growth: Growth of plant was measured in terms of length of leaf (Table 1), number of leaf (Table 2), leaf area (Table 3), leaf area index (Table 4) and biomass yield of leaf and root (Table 5).

Table 1. Effects of organic manures and NPK fertilizers on the length of leaf (cm) of *Aloe vera*.

Treatments	Days after transplanting					
	20d	40d	60d	80d	100d	120d
Control (-OM & -NPK)	11.00	11.67	12.16	12.67	12.83	13.33
$Kazi_{10}$ ton ha^{-1}	8.66	9.83	11.33	12.17	12.33	13.17
GTS_{10} ton ha^{-1}	11.16	12.00	14.00	15.50	15.83	16.50
$Sebak_{10}$ ton ha^{-1}	11.50	12.16	13.10	13.50	14.16	14.67
ACI_{10} ton ha^{-1}	9.00	10.00	10.50	11.33	11.83	14.50
$N_{100}P_{20}K_{60}$kg ha^{-1} (100% NPK)	8.50	10.00	10.50	11.33	11.85	12.67
$N_{50}P_{10}K_{30}$ kg ha^{-1} (50% NPK)	9.66	11.16	12.83	13.50	13.73	14.50
$Kazi_{10}$ ton ha^{-1} + $N_{50}P_{10}K_{30}$ kg ha^{-1}	10.66	11.16	11.83	12.50	13.00	13.83
GTS_{10} ton ha^{-1} + $N_{50}P_{10}K_{30}$ kg ha^{-1}	11.00	12.17	12.33	12.67	13.33	13.50
$Sebak_{10}$ ton ha^{-1} + $N_{50}P_{10}K_{30}$ kg ha^{-1}	10.50	11.17	12.76	12.83	13.03	14.67
ACI_{10} ton ha^{-1} + $N_{50}P_{10}K_{30}$ kg ha^{-1}	11.66	12.83	14.00	15.83	16.99	18.00
LSD at 5%	0.78	0.64	0.72	0.84	NS	0.577

Leaf length: Application of organic manures and NPK fertilizers had a significant effect on leaf length of *Aloe vera*. Length of leaf was increased over time and reached their maximum values at harvest. The values of leaf length at harvest were 13.33, 13.17, 16.50, 14.67, 14.50, 12.67, 14.50, 13.83, 13.50, 14.67, and 18.00. Length of leaf increased with the dose of treatments and varied significantly ($P \leq 0.5$) (Table 1). Highest length of leaf (18 cm) was observed in GTS organic manure after 120 days of growth. The lowest length was observed in $Kazi_{10}$ ton ha^{-1} organic manure treatment.

Leaf number: Leaf number differed with time, although after 60 days, GTS showed the highest number of leaves7.33 leaves/plant (Table 2). It was also observed that control treatment had the lowest production of leaves. Leaf number increased gradually through 20,40,60,80,100,120 days. After 120 days of sowing there is no significant difference between control and Sebak. Highest value of leaf number after 120 days was recorded in

the GTS_{10} ton ha^{-1} organic manure; the lowest value was observed in the $N_{100}P_{20}K_{60}$kgha^{-1} (100% NPK). The number of leaves in the treatment increased up to 120 days interval (Table 2). The increase in the number of leaves and yield was due to increased solubilization effect and availability of nutrients by the addition of organic manures relatively results in better development of more leaves [24].

Table 2. Effects of different organic manures and NPK fertilizers on the leaf number of *Aloe vera*.

Treatments	Days after transplanting					
	20d	40d	60d	80d	100d	120d
Control (-OM & -NPK)	5.33	5.33	5.67	5.67	5.99	6.33
$Kazi_{10}$ ton ha^{-1}	3.33	4.33	5.67	5.99	6.33	7.67
GTS_{10} ton ha^{-1}	4.67	5.67	6.00	7.33	7.67	8.33
$Sebak_{10}$ ton ha^{-1}	5.00	5.33	5.67	5.99	6.33	6.33
ACI_{10} ton ha^{-1}	5.67	5.00	6.67	6.99	7.33	7.67
$N_{100}P_{20}K_{60}$ kg ha^{-1} (100% NPK)	5.00	4.67	5.67	4.99	5.33	5.67
$N_{50}P_{10}K_{30}$ kg ha^{-1} (50% NPK)	5.00	5.33	7.00	6.33	6.67	6.67
$Kazi_{10}$ ton ha^{-1} + $N_{50}P_{10}K_{30}$ kg ha^{-1}	5.00	5.00	6.33	6.67	6.99	7.67
GTS_{10} ton ha^{-1} + $N_{50}P_{10}K_{30}$ kg ha^{-1}	5.00	5.00	5.67	6.33	6.67	7.00
$Sebak_{10}$ ton ha^{-1} + $N_{50}P_{10}K_{30}$ kg ha^{-1}	4.67	5.67	7.33	6.67	7.33	7.33
ACI_{10} ton ha^{-1} + $N_{50}P_{10}K_{30}$ kg ha^{-1}	6.33	6.00	7.67	7.00	7.67	7.67
LSD at 5%	0.36	0.68	0.69	0.17	0.34	0.29

Table 3. Effects of different organic manures and NPK fertilizers on the leaf area (cm^2plant^{-1}) of *Aloe vera*.

Treatments	Days after transplanting					
	20d	40d	60d	80d	100d	120d
Control (-OM & -NPK)	8.47	9.34	10.09	11.40	11.93	13.33
$Kazi_{10}$ ton ha^{-1}	7.79	9.54	12.46	13.79	14.30	15.28
GTS_{10} ton ha^{-1}	8.93	10.80	13.06	16.02	16.78	17.60
$Sebak_{10}$ ton ha^{-1}	9.20	10.09	11.39	13.05	14.16	15.11
ACI_{10} ton ha^{-1}	6.30	7.30	8.05	9.82	10.50	10.65
$N_{100}P_{20}K_{60}$ kg ha^{-1} (100% NPK)	5.95	7.30	8.40	10.99	11.85	13.05
$N_{50}P_{10}K_{30}$ kg ha^{-1} (50% NPK)	7.44	8.93	10.65	13.50	13.73	14.94
$Kazi_{10}$ ton ha^{-1} + $N_{50}P_{10}K_{30}$ kg ha^{-1}	8.21	8.93	9.82	12.08	13.00	14.24
GTS_{10} ton ha^{-1} + $N_{50}P_{10}K_{30}$ kg ha^{-1}	9.13	10.59	11.09	12.25	13.33	13.91
$Sebak_{10}$ ton ha^{-1} + $N_{50}P_{10}K_{30}$ kg ha^{-1}	8.09	8.94	10.99	12.40	13.03	15.11
ACI_{10} ton ha^{-1} + $N_{50}P_{10}K_{30}$ kg ha^{-1}	11.66	13.21	14.84	20.05	20.39	23.40
LSD at 5%	NS	NS	NS	NS	NS	NS

Leaf area: The results of leaf area measurement were obtained in table 3. The maximum leaf area was 23.40 cm^2 obtained in ACI_{10} ton ha^{-1} + $N_{50}P_{10}K_{30}$ kg ha^{-1}. Leaf area increased continuously up to 120 days of growth consideration of length and width. Lowest value of length area was observed in N_{100} K_{20} P_{60}kg $ha^{-1}$is lower even than the control value due to the combination of this treatment took much more time to release nutrients than other treatments.

Table 4. Effects of different organic manures and NPK fertilizers on the leaf area index of *Aloe vera*.

Treatments	Days after transplanting					
	20d	40d	60d	80d	100d	120d
Control (-OM & -NPK)	0.02	0.02	0.02	0.02	0.03	0.03
$Kazi_{10}$ ton ha^{-1}	0.02	0.02	0.03	0.03	0.03	0.04
GTS_{10} ton ha^{-1}	0.02	0.02	0.03	0.04	0.04	0.04
$Sebak_{10}$ ton ha^{-1}	0.02	0.02	0.02	0.03	0.03	0.03
ACI_{10} ton ha^{-1}	0.01	0.01	0.02	0.02	0.02	0.02
$N_{100}P_{20}K_{60}$ kg ha^{-1} (100% NPK)	0.01	0.01	0.02	0.02	0.03	0.03
$N_{50}P_{10}K_{30}$ kg ha^{-1} (50% NPK)	0.01	0.02	0.02	0.03	0.03	0.03
$Kazi_{10}$ ton ha^{-1} + $N_{50}P_{10}K_{30}$ kg ha^{-1}	0.02	0.02	0.02	0.03	0.03	0.03
GTS_{10} ton ha^{-1} + $N_{50}P_{10}K_{30}$ kg ha^{-1}	0.02	0.02	0.02	0.03	0.03	0.03
$Sebak_{10}$ ton ha^{-1} + $N_{50}P_{10}K_{30}$ kg ha^{-1}	0.02	0.02	0.02	0.03	0.03	0.03
ACI_{10} ton ha^{-1} + $N_{50}P_{10}K_{30}$ kg ha^{-1}	0.03	0.03	0.03	0.05	0.05	0.06
LSD at 5%	0.28	0.41	0.44	NS	0.49	0.57

Leaf area index: The maximum leaf area index was 0.06 determined in the ACI_{10} ton ha^{-1} + $N_{50}P_{10}K_{30}$ kg ha^{-1} (Table 4). The lowest value of leaf area index was 0.02 recorded in the ACI organic manure. Leaf area index was determined from the value of leaf area and value of soil area. Leaf area index defined as leaf area per unit surface of soil and characterizes plant canopies.

Fresh and dry weight: Fresh weight of root and leaf are shown in Table 5. The maximum fresh and dry weight of a plant were observed 78.23 and 9.58 g $plant^{-1}$ in GTS_{10} ton ha^{-1}. Prabha *et al*.[25] reported that the plant weight and growth were increased due to absorption of mineral nutrients such as nitrogen and plant growth regulators. The lowest total fresh weight and lowest total dry weight value were recorded in $Sebak_{10}$ ton ha^{-1}which were 25.89 and 5.96 g $plant^{-1}$, respectively. The highest value of the fresh weight of leaf 73.63 g $plant^{-1}$ and dry weight of leaf 8.20 g $plant^{-1}$ were recorded in GTS_{10} ton ha^{-1}. Results did not vary significantly ($p < 0.05$).

Table 5. Effects of different organic manures and NPK fertilizers on the fresh and dry weight of *Aloe vera*.

Treatments	Fresh weight (g plant^{-1})			Dry weight (g plant^{-1})		
	Root	Leaf	Total	Root	Leaf	Total
Control (-OM & -NPK)	2.70	24.11	26.81	1.00	5.05	6.05
$Kazi_{10}$ ton ha^{-1}	4.20	61.67	65.87	1.26	7.55	8.81
GTS_{10} ton ha^{-1}	4.60	73.63	78.23	1.38	8.20	9.58
$Sebak_{10}$ ton ha^{-1}	2.54	23.35	25.89	0.95	5.01	5.96
ACI_{10} ton ha^{-1}	3.55	41.57	45.12	1.12	5.65	6.77
$N_{100}P_{20}K_{60}$ kg ha^{-1} (100% NPK)	2.80	30.22	33.02	1.02	5.17	6.19
$N_{50}P_{10}K_{30}$ kg ha^{-1} (50% NPK)	4.05	58.96	63.01	1.20	7.00	8.20
$Kazi_{10}$ ton ha^{-1} + $N_{50}P_{10}K_{30}$ kg ha^{-1}	4.00	51.42	55.41	1.18	6.10	7.28
GTS_{10} ton ha^{-1} + $N_{50}P_{10}K_{30}$ kg ha^{-1}	3.30	34.23	37.53	1.06	5.23	6.29
$Sebak_{10}$ ton ha^{-1} + $N_{50}P_{10}K_{30}$ kg ha^{-1}	3.70	45.67	49.37	1.10	5.80	6.90
ACI_{10} ton ha^{-1} + $N_{50}P_{10}K_{30}$ kg ha^{-1}	4.35	65.19	69.54	1.28	7.80	9.08
LSD at 5%	NS	NS	-	NS	NS	-

Protein content in leaf: The highest protein content (16.84 %) was found in GTS_{10} ton ha^{-1}and the lowest content (6.18 %) was found in$Sebak_{10}$ ton ha^{-1} treatment .Results varied significantly ($p < 0.05$). Nitrogen is the most imperative element for proper growth and development of plants which significantly increases the yield and its quality by playing vital role in biochemical and physiological functions of plant[26]. Brady and Weil[27] concluded that the organic manures contain a passive fraction of 60 to 90 per cent which is very slowly available to plants. Akon *et al*.[28] observed that height, leaf area, and fresh and dry weights of leaf of *Gynura procunbens* varied significantly ($p < 0.05$) under seven types of manures. Magomya *et al*.[23] collected ten different plant samples from wild and farmland of Nizeria *viz*. *Hibiscus cannabinus*, *Haematostaphis barteri*, *Sesamum indicum*, *Balanites aegyptiaca*, *Cassia tora*, *Celtis integrifolia*, *Anona senegalensiss*, *Ceiba petandra*, *Ficus ingens* and *Solanum melongena* the protein of which ranged from 2.63 to 18.59%.

Residual value: Post -harvest soil analysis demonstrated that all of values of organic matter were higher than initial value due to the application of different manures. In GTS_{10} ton ha^{-1} treated soil showed highest concentration of organic carbon (2.80%). All of the values of organic carbon content were higher than control treatment.SRDI estimated that about 0.76 mha of arable land across the country was under very low organic matter content and 2.88 mha was under low organic matter content in 2010, which is 7.94 and 30.00% of total arable lands. About 55.57, 5.28 and 1.21% of arable lands were under medium, high and very high level of organic matter contents[12].

Table 6. Effects of organic manures and NPK fertilizers on the concentration of Nitrogen and protein content in the leaf of *Aloe vera.*

Treatments	Conc. of Nitrogen (%)	Protein (%)
Control (-OM & -NPK)	1.78	11.13
$Kazi_{10}$ ton ha^{-1}	1.48	9.28
GTS_{10} ton ha^{-1}	2.69	16.84
$Sebak_{10}$ ton ha^{-1}	.99	6.18
ACI_{10} ton ha^{-1}	1.68	10.51
$N_{100}P_{20}K_{60}$ kg ha^{-1} (100% NPK)	1.63	10.20
$N_{50}P_{10}K_{30}$ kg ha^{-1} (50% NPK)	1.73	10.86
$Kazi_{10}$ ton ha^{-1} + $N_{50}P_{10}K_{30}$ kg ha^{-1}	1.70	10.63
GTS_{10} ton ha^{-1} + $N_{50}P_{10}K_{30}$ kg ha^{-1}	2.54	15.90
$Sebak_{10}$ ton ha^{-1} + $N_{50}P_{10}K_{30}$ kg ha^{-1}	1.79	11.21
ACI_{10} ton ha^{-1} + $N_{50}P_{10}K_{30}$ kg ha^{-1}	1.48	9.28
LSD at 5%	0.022	**0.**196

Table 7. Organic carbon, organic matter, concentration of nitrogen and carbon nitrogen ratio of the post-harvest soils.

Treatments	Organic carbon (%)	Organic matter (%)	Nitrogen (%)	C-N ratio
Control (-OM & -NPK)	1.12	1.93	0.13	8.61
$Kazi_{10}$ ton ha^{-1}	1.44	2.48	0.16	9.00
GTS_{10} ton ha^{-1}	2.80	4.82	0.34	8.24
$Sebak_{10}$ ton ha^{-1}	1.21	2.08	0.14	8.64
ACI_{10} ton ha^{-1}	1.70	2.92	0.18	9.44
$N_{100}P_{20}K_{60}$ kg ha^{-1} (100% NPK)	1.58	2.72	0.22	7.18
$N_{50}P_{10}K_{30}$ kg ha^{-1} (50% NPK)	1.71	2.94	0.19	9.00
$Kazi_{10}$ ton ha^{-1} + $N_{50}P_{10}K_{30}$ kg ha^{-1}	1.68	2.89	0.19	8.84
GTS_{10} ton ha^{-1} + $N_{50}P_{10}K_{30}$ kg ha^{-1}	2.41	4.15	0.33	7.30
$Sebak_{10}$ ton ha^{-1} + $N_{50}P_{10}K_{30}$ kg ha^{-1}	1.72	.96	0.21	8.19
ACI_{10} ton ha^{-1} + $N_{50}P_{10}K_{30}$ kg ha^{-1}	1.44	2.48	0.16	9.00

Traditional farming system and indiscriminate use of fertilizers and pesticides are degrading the soil and killing microorganisms and this ultimately reduces soil respiration and soil fertility and has a direct influence on food production[29]. Results

demonstrated that the highest growth and yield and protein content in the leaf of *Aloe vera* was observed in GTS_{10} ton ha^{-1} organic manure treatment. Research on the properties of *Aloe* which are medicinally important, still needs to be explored [30].

References

1. Hassunzzaman M, KU Ahmed, KM Khalequzzaman, AMM Shamsuzzaman and K Nahar 2008. Plant characteristics, growth and leaf yield of *Aloe vera* L. as affected by organic manure in pot culture. Aust. J. Crop Sci. **2**(3): 158-163.
2. Mortan JF 1961. Folk uses and commercial exploitation of *Aloe* leaf pulp. Econ. Bot. **15**: 311-319.
3. Lee SK 2006. Overview of aloe study. In: Park YI and SK Lee (eds.). *New Perspectives of Aloe.* Springer, Boston, MA, USA. p. 19-62.
4. Barandozi FN, ST Enferadi and MR Naghavi 2011. Effects of fertilizer on morphological traits in *Aloe vera*. J. Med. Plants Res. **5**(18): 4537-4541.
5. Naveena, BK Bharath and S Selva 2011. Antitumor activity of *Aloe vera* against Ehrlich Ascitis Carcinoma (EAC) in Swiss albino mice. Intl. J. Pharma Bio Sciences **2**: 400-409.
6. Bashir A, B Saeed, YM Talat and N Jehan 2011. Comparative study of antimicrobial activities of Aloe vera extracts and antibiotics against isolates from skin infections. African J. Biotechnol. **10**: 3835-3840.
7. Miladi S and M Damak 2008. In vitro antioxidant activities of *Aloe vera* leaf skin extracts. Journal de la Société Chimique de Tunisie **10**: 101-109.
8. Borra SK, RK Lagisetty and GR Mallela 2011. Anti-ulcer effect of *Aloe vera* in non-steroidal anti-inflammatory drug induced peptic ulcers in rats. African J. Pharmacy and Pharmacology **5**(16): 1867-1871.
9. Chandan BK, AK Saxena, S Shukla, N Sharma, DK Gupta, KA Suri, J Suri, M Bhadauria and B Singh 2007. Hepatoprotective potential of aloe barbadensis Mill. against carbon tetrachloride induced hepatotoxicity. J. Ethnopharmacol. **111**: 560-566.
10. Atul NC, KC Santhosh, C Bhattacharjee, DK Subal and K Kannan 2011. Studies on immunomodulatory activity of *Aloe vera* (Linn). Intl. J. Applied Biol. Pharmaceutical Technol. **2**: 19-22.
11. Dixie GH, MJ Hossain and SA Imran 2003. Medicinal plant marketing in Bangladesh. A publication by Intercooperation and South Asia Enterprise Development Facility. p. 8-22.
12. Hasan MN, MA Bari and MR Lutfar 2020. Soil Fertility Trends in Bangladesh 2010 to 2020. Strengthening of Soil Research and Research Facilities (SRSRF) Project. Soil Resource Development Institute(SRDI), Ministry of Agriculture, Dhaka, Bangladesh. pp. 84.
13. Saha R, S Palit, BC Ghosh and BN Mittra 2005. Performance of *Aloe vera* as influenced by organic and inorganic sources of fertilizer supplied through fertigation. ActaHort. **676**: 171-175.
14. Garg RN, H Pathak, DK Das and RK Tomar 2005.Use of fly ash and bio slurry for improving wheat yields and physical properties of soil. Environ. Monitoring Assess. **107**: 1-9.
15. Mader P, A Fliessbach, D Dubois, L Gunst, P Fried and U Niggli 2002. Soil fertility and biodiversity in organic farming. Science **296**: 1694-1697.

16. Patel VB, SK Singh, R Asrey and YK Sharma 2005. Response of organic manures and bio fertilizer on the growth, fruit yield and quality of mango cv. Amrapali under high density orcharding. Karnataka J. Hort. **1**(3): 51-56.
17. Yaronskay EB, ER Gritskevich, NL Trukhanovets and NG Averina 2007. Effect of macro-nutrient elements on early stages of chlorophyll biosynthesis in streptomycin- treated barley seedlings. Russian J. Plant Physiol. **54**: 388-395.
18. Fagerial NK, Slaton AB and Baligar VC 2003. Nutrient management for improving lowland rice productivity and sustainability. Advances in Agron. **80**: 63-152.
19. Bouyoucos GJ 1962. Hydrometer method improved for making particle size analysis of soils. Agron. J. **54**: 461-465.
20. Jackson ML 1965. *Soil chemical analysis*. Prentice -Hall Inc., New York, USA. pp. 498
21. Walkley A and IA Black 1934. An examination of the Degtijareff method for determining soil organic matter and a proposed modification of the chromic acid titration method. Soil Sci. **37**: 29-38.
22. Marr IL and MS Cresser 1983. The lithosphere. In: *Environmental Chemical Analysis.* Blackie and Son Ltd. UK. p. 155-182.
23. Magomya AM, D Kubmarawa, JA Ndahi and GG Yebpella 2014. Determination of plant proteins via the Kjeldahl method and amino acid analysis: A comparative study. Intl. J. Scientific Technol. Res. **3**(4): 68-72.
24. Tovihoudji GP, CP Djogbenou, PBI Akponikpe, E Kpadonou, CE Agbanga and DG Dagbenonbakin 2015. Response of Jute Mallow (*Corchorus olitorius* L.) to organic manure and inorganic fertilizer on a ferruginous soil in North Eastern Benin. J. Applied Bio. Sci. **92:** 8610-8619.
25. Prabha ML, I Jayraaj, R Jayraaj and DS Rao 2007. Effects of vermicompost on growth parameters of selected vegetable and medicinal plants. Asian J. Microbial Biotechnol. Environ. Sci. **9**: 321-326.
26. Leghari SJ, NA Wahocho, GM Laghari, GM Bhabhan, KH Talpur, TA Bhutto, SA Wahocho and AA Lashari 2016. Role of nitrogen for plant growth and development: A review. Advanced Environmental Biol. **10**(9): 209-218.
27. Brady NC and RR Weil 2002. The Nature and Properties of Soils. 13th edn., Pearson Education (Singapore) Pte. Ltd. Singapore. pp. 960.
28. Akon MOS, DK Datta, T Biswas, K Nakamura and MK Rahman 2018. Influence of organic manures on the growth of diabetes preventive medicinal plant Gynura, *Gynura procumbens*. J. Biodivers. Conserv. Bioresour. Manag. **4**(2): 61-66.
29. Evanylo G and R McGuinn 2009. Agricultural management practices and soil quality: Measuring assessing and comparing laboratory and field test kit indicators of soil quality attributes. Virginia cooperative extension, Virginia, USA.
30. Badar Z, S Khan, K Ali, SG Musharraf and MI Choudhary 2013. *In vitro* and biotransformational studies of *Aloe barbadensis* Mill. Pakistan J. Bot. **46**(2): 679-685.

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