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Implication of Cow Urine and Biochar-Based Fertilizer on Bitter Gourd Production in Sack Garden

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ABSTRACT:- An experiment on cow urine and biochar based fertilizer application on bitter gourd production in sack garden was carried out to find out the optimal does of the said fertilizers for better production. Two experiments were conducted in two subsequent seasons from October 2019 to February 2020 at the Germplasm Center, Patuakhali Science and Technology University. Five treatments combination were laid viz. T_1= Control (2 kg compost plant per plant), $T_{2=}$ 2 kg compost + 1 L cow urine +0.5 kg bc, T_3= 0.5 kg bc + NPK (40 g urea + 16 g TSP + 30 g MoP), T_4= NPK (40 g urea + 16 g TSP + 30 g MoP), and T_5= Compost 2 kg + 0.5 kg bc + NPK (40 g urea + 16 g TSP + 30 g MoP). Among the different doses of cow urine and biochar combination T_5 treatment ensured the maximum germination (78.33%) at 5-7 Days After Sowing (DAS) and the longest plant (178.4 cm) and the maximum number of leaves (56.63) at (45 DAS, respectively). The longest leaves (10.90 cm and 11.97 cm) at 30 and 60 DAS were found in the plant fertilized with T_5. Maximum number of fruits (5.87) at 100 DAS where the biggest fruits (25.55 cm × 12.34 cm) and the heaviest fruits (211.23 g) were harvested from the plants fertilized with T_5 treatment. Based on the performance of the experiment 1, a 2nd trial was made in the subsequent growing season with 50% dose of previously considered treatments- T_2, T_3, and T_5 in same sack bag. This was done to assess the residual effects of different growing media and the treatments were named RT_1, RT_2 and RT_3. Growth and yield of bitter gourd also varied significantly in the residual treatments (RT_2, RT_3 and RT_5). Longest plant at 45 DAS (162.81 cm) were found in RT_5. Maximum number of fruits at 90 DAS (5.57), at 100 DAS the biggest fruits having length and width (24.22 cm × 16.55 cm) and the heaviest fruit (209.55 g) were harvested from RT_5 treatment. The results revealed that cow urine and biochar-based growing media in sack gardening could be utilized by 50% reduction of nutrient with same output.

Key words: Bitter gourd, Biochar, Cow urine, Sack culture and Fertilizer

I. INTRODUCTION

Bangladesh is an agricultural country. About 75% of people are directly or indirectly related to agriculture. On the other hand, it is a densely populated country worldwide. Most of the people of our country to fulfill their nutritional demands are largely dependent on vegetable. Cultivable land is decreasing day by day whereas the population of our country is increasing. Currently, 2.57 percent of Bangladesh's total land area is used for vegetable production, yielding 3.73 million tons of vegetables per year [1]. Farmers benefit far more from vegetables than from other crops. Vegetables have the potential to improve the nutritional status of Bangladeshi people who are severely malnourished.

The present consumption rate is 45 gm/day/person, whereas the recommended figure is 220 g/day/person [2]. As per recommendation, our requirement for vegetable production is 11.24 million MT. The

consumption poverty line is defined in terms of calories, leaving out minimum levels and requirements of vitamins and minerals. In Bangladesh, the consumption rates of vegetables are 17 kg/year, whereas in neighboring India the figure is 84 kg, and in China is 107 kg. However, the poorest people have a problem with having a diversified diet. The population is plagued with deficiency-related diseases associated with inadequate intake of minerals, essential amino acids, poor quality fat, and vitamins. Due to recent climate change, Bangladesh has been affected in various ways. Un-even rainfall, flooding, salinity increase, and water stagnate are causing different problems for crop and vegetable production. The sack gardening method was adopted by Solidarites in the slum areas of Sudan [3]. It was assumed that the technology might be applicable and effective for Bangladesh. It is also known as a vertical garden or portable garden. Sack gardening is suitable for the land or area which are not suitable for vegetable production such as saline soil, acid soil, submerged area, urban area and rooftop. The total amount of salinity affected land in Bangladesh was 83.3 million hectares in 1973, which had been increased up to 102 million hectares in 2000 and the amount has risen to 105.6 million hectares in 2009 and continuing to increase, according to the country's Soil Resource Development Institute [4]. In the last 35 years, salinity increased around 26 percent in the country, spreading into non-coastal areas as well.

Total haor area is 80000 sq. kilometres a huge amount of land is under water. These areas can be bringing under vegetable production by sack garden. Over the last 50 years, more than 40% the green space was lost due to the development of infrastructure, housing, etc. [5]. This method also offers big opportunity to use this recommended fertilizers in roof gardening. Moreover it may the best approach in disaster prune coastal ecosystem. Ecosystem-based approaches draw the attention of the DRR (Disaster Risk Reduction) scholars to response to the extreme disaster events worldwide [6]. Such an ecosystem based approach can be vertical gardening that grows upward (vertically) using a trellis or other support system rather than horizontally. Most of the lands become unavailable for cultivation during summer season and rainy season in Bangladesh due to natural disasters, flood, excessive rainfall etc. Most of the land become submerges where sack garden is suitable for this season. It helps to increase production and income of the marginal farmers. Different types of vegetables can be grown in sack garden. From the tops and sides of these sacks, referred to as multi-story gardens, Kibera farmers grow kale, spinach, onions, tomatoes, cucurbits, vegetables and arrowroot which sprout from the tops and sides. There are several varieties of bitter gourd available, having fruits 3-4 inches to even 12 inches in length. Two distinct fruits morph types are found in Bangladesh. One is small fruited type called "Uchta" and other is long fruited type called "Korolla" grown mostly in the summer season [7]. Vegetable consumers appreciate recently organic farming as it enhances quality of the produce [8]. The demand for organic vegetables is increasing notably among the health-conscious people in our country like elsewhere of the globe. Hence the study has been undertaken to find out the optimum does of cow urine based biochar for increasing the organic fertilizers uses in our agricultural practices.

II. METHODOLOGY

The details of the experiment and method used are described below-

Duration and location

The field experiment was conducted at the Germplasm Centre, department of Horticulture, Patuakhali Science and Technology University. The experimental duration was October 2019 to February 2020. Geographically, the research area was located in between $22^0 23'$ and $22^0 30'$ north latitudes and in between $90^0 17'$ and $90^0 27'$ east longitudes with an altitude of 3 meters above the mean sea level.

Climate and soil

The climate of the experimental site was tropical. During the maximum months of the year, there was significant rainfall in Dumki. There was only a short dry season. Precipitation was the lowest in December, with an average of 10 mm. Most precipitation falls in July, with an average of 2654 mm. At an average temperature of 30^0 C, May was the hottest month of the year. In January, the average temperature was 19.4^0 C. The average humidity was 80.9 %. The soil was sandy clay loam in texture with p^H <5.0.

Bag preparation and plot making

The experiment was conducted in sack garden. Sacks were collected from the local market each sacks capacity was 50 kg poultry feed which was made of plastic. Sacks

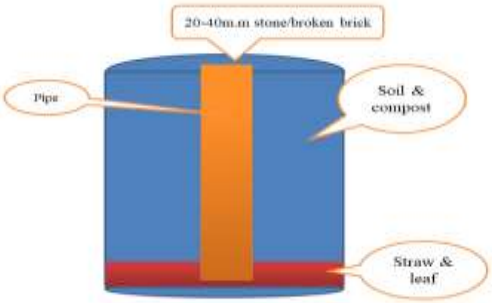

Figure: Design of a sack bag

were filled with soil, manure, and fertilizers. Weeds and stubbles were uprooted and removed from the field with the spade. Big clods were broken into fine soil particles. A hole was made with a bamboo stick in every sack and filled with broken bricks. This procedure helps to move water into the soil and prevents drying of lower soil. The experimental field was made plain and the sacks were laid out according to the plan. Twenty (20) sacks were prepared for this experiment.

Planting materials

A hybrid variety of bitter gourd i.e. Tiya Corola (Bitter Gourd) was collected from Lal Teer Seed company Limited, Bangladesh.

Treatments

The field experiment comprised of 5 treatments with 4 replications. Therefore, treatment combinations were 20 and the experiment consisted of a single factor. The experiment was conducted with the following treatments: T_1= Control (2 kg compost plant per plant), $T_{2=}$ 2 kg compost + 1 L cow urine +0.5 kg bc, T_3= 0.5 kg bc + NPK (40 g urea + 16 g TSP + 30 g MoP), T_4= NPK (40 g urea + 16 g TSP + 30 g MoP), and T_5= Compost 2 kg + 0.5 kg bc + NPK (40 g urea + 16 g TSP + 30 g MoP). In T_2 Cow urine and biochar are mixed before application and in T_3 and T_5 biochar and NPK fertilizers are mixed in liquid before application.

Design and layout of the experiment

The field experiment was conducted in Randomized Complete Block Design (RCBD) with 4 replications. The treatments were randomly assigned in each replication. There were 20 sacks in the experiment. Each sack was separated from the other by 1 m and 1 m, respectively. The laboratory experiment was done in Completely Randomized Design (CRD) with 3 replications.

Second year trial

This experiment was conducted as a consequence of the experiment 1 with a view to evaluate the residual effect of the previous season treatments. Three best treatments from such as T_2, T_3 and T_5 were chosen for conducting this experiment. The previous season used growing media of these treatments were rearranged with 50% manures and fertilizers of previous season treatments for evaluating the residual effects.

Data analysis

The data on crop growth and yield parameters were recorded using MS Excel computer programme. The recorded data were statistically analyzed using JMP-14 pro computer program and mean differences were compared by HSD tukey test.

III. RESULT

Effects of cow urine and biochar-based fertilizers

Germination

There was significant effect of organic and inorganic fertilizers on germination (Table 1). The maximum germination (78.33%) was obtained from the fertilization of Compost 2 kg + 1 L bc + NPK (40 g urea + 16 g TSP + 30 g MoP) followed by 2 kg compost + 1 L cow urine + 1 L biochar (65.00%) that was statistically similar with 1 L bc + NPK (40 g urea + 16 g TSP + 30 g MoP) (61.67%). The lowest germination was recorded in the control treatment (43.90%). Sankaranarayanan *et al*. (1994) also found that soaking the tamarind seeds in 10 % cow urine or in cowdung solution (500 g in 10 litres of water) for 24 hours increased the germination percentage from 37 (untreated controls) to 72.6 and 82.8, respectively.

Plant height (cm)

The plant heights at three different days after sowing (15, 30 and 45 DAS) were measured with six levels and found significant variation in (Table 1). It was observed that the longest plant (7.56, 61.24, and 178.4 cm) was from the application of 2 kg compost + 1 L Biochar +NPK (40 g urea + 16 g TSP + 30 g MoP) followed by the application of 2 kg compost + 1 L cow urine + 1 l Biochar (7.27, 58.94 and 177.0 cm respectively) at 15, 30 and 45 DAS. The lowest plant height was recorded from the control plot at 15 (5.63 cm), 30 (44.55 cm) and 45 DAS (170.5cm). Biochar holds the nutrients strongly in the root zone and reduced nutrient leaching from heavy rains. As a result, plant gets sufficient nutrients favours proper growth of plants. The stem growth was very significantly higher in tomatoes grown on SVG (Super vegetable Garden) beds treated with charcoal [9]

Table 1. Effects of cow urine and biochar-based fertilizers on germination and plant height of bitter gourd

Treatment	Germination (%)	Plant height (cm) at different DAS		
		15	30	45
T_1	45.00 c	5.40 d	47.63 cd	166.60 a
T_2	65.00 b	7.27 ab	58.94 a	177.00 a
T_3	61.67 b	6.60 bc	53.75 b	173.50 a
T_4	53.33 bc	5.99 cd	50.55 c	169.40 a
T_5	78.33 a	7.65 a	61.24 a	178.40 a
Level of significance	*	**	**	
CV (%)	17.01	8.80	4.01	NS

Means in a column followed by different letters differ significantly but with common letters do not differ significantly by DMRT. *and** = Significant at 5 and 1% levels of probability, respectively.

Number of leaves

Significant variation in the number of leaves plant^{-1} was observed due to different sources of organic and in organic fertilizers (Table 2).

Table 2. Effects of cow urine and biochar-based fertilizers on number of bitter gourd leaf

Treatment	Number of leaves at different DAS		
	15	30	45
T_1	6.18 d	23.18 d	39.51 d
T_2	8.60 b	30.93 b	51.27 b
T_3	7.75 c	28.08 c	46.75 c
T_4	6.83 d	25.50 cd	43.75 c
T_5	10.30 a	34.63 a	56.63 a
Level of significance	**	**	**
CV (%)	11.71	7.29	8.96

Means in a column followed by different letters differ significantly but with common letters do not differ significantly by DMRT. ** = Significant at 1% levels of probability.

The maximum number of leaves plant^{-1} was obtained from the application of 2 kg compost+ 2L biochar + NPK (40 g urea + 16 g TSP + 30 g MoP) at the 15 (10.30), 30 (34.63) and 45 DAS (56.63). The second highest number of leaves was produced by the plant fertilized with 2kg compost+ 1 L cow urine + 1L biochar at 15 DAS (8.60), 30 DAS (30.93) and 45 DAS (51.27) while the minimum number of leaf was observed in control treatment (6.18,23.18 and 39.51) at 15, 30 and 45 DAS. Biochar has the potential to improve fertilizer use efficiency through varied mechanisms, including chemical, biological and physical. As a result 2 kg compost+ 1L biochar + NPK (40 g urea+ 16 g TSP + 30 g MoP) ensured proper growth of bitter gourd that enhanced production of higher number of leaves per plant.

Number of fruit per plant

Significant variation was found in terms of fruit number per plant due to the application of organic and inorganic fertilizers (Fig 10). Application of 2 kg compost + 1 L biochar + NPK (40 g urea + 16 g TSP + 30 g MoP) produced the maximum number of fruit plant^{-1} (4.40,5.65 and 5.87 respectively) that was statistically similar to the fertilization of 2 kg compost + 1 L biochar + 1 L cow urine (4.07, 5.10 and 5.23) followed by 1 L

BC + NPK (40 g urea + 16 g TSP + 30 g MoP) (3.37, 3.94 and 4.20 respectively) at 70, 80 and 90 DAS. The lowest number of fruit plant^{-1} was obtained from the control plot at 70 (3.10), 85 (3.51) and 100 DAS (4.03). Supporting results were achieved by [10] who got the best results with the use of compost and urine together in spinach (Swiss chard). Increases in crop fruit yield with biochar application has been reported for crops such as cowpea [11].

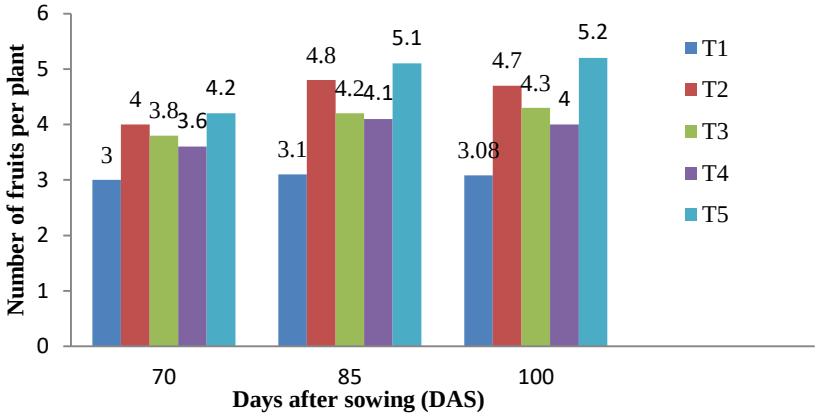

Figure 1: Effect of cow urine and biochar-based fertilizers on the number of fruits of bitter gourd.

Fruit size

Organic and inorganic fertilizers had significant role in increasing the size of fruits (Table 4). The heaviest fruits size with the length and width (14.31 cm x 10.90 cm) was recorded from T5 treatment. Statistically similar size fruits were obtained from the T5 treatment in 85 and 100 DAS harvest. Almost similar size fruits were obtained from T2 and T3 treatments in every harvest. On the contrary, the smallest fruit (11.21 cm, 16.02 cm and 21.14 cm length and 7.81 cm, 8.22 cm and 8.30 cm width, respectively) was obtained from the control plot at 70, 80 and 90 DAS.

Table 3: Effect of cow urine and biochar-based fertilizers on size (length and weight) of fruits of bitter gourd

Treatment	Length of fruit (cm) at different DAS			Width of fruit (cm) at different DAS		
	70	85	100	70	85	100
T_1	11.21 c	16.02 cd	21.14 c	7.81 d	8.22 d	8.30 d
T_2	13.00 ab	17.71 b	23.21 b	9.79 b	10.87 b	11.02 b
T_3	12.89 ab	17.61 b	23.53 b	9.05 bc	10.17 bc	10.32 bc
T_4	11.61 bc	16.46 c	22.04 bc	8.26 cd	9.47 cd	9.87 cd
T_5	14.31a	18.87 a	25.55 a	10.90 a	11.97 a	12.34 a
Level of significance	**	**	**	**	**	**
CV (%)	7.60	3.29	4.45	11.86	9.76	8.33

Means in a column followed by different letters differ significantly but with common letters do not differ significantly by DMRT. *and** = Significant at 5 and 1% levels of probability, respectively.

Weight of fruit

Significant variation in fruit weight was observed due to different sources of organic and inorganic fertilizers (Table 4). The heaviest fruit (83.925 g, 133.423 g and 211.23 g) harvested from T_5 treatment. On the contrary minimum weight of fruit was observed in control treatment (75.298 g, 113.965 g, 182.80 g) at 70 DAS, 85 DAS and 100 DAS respectively.

Table 4: Effect of cow urine and biochar-based fertilizers on fruits weight of bitter gourd

Treatment	Fruit weight (gm) at different DAS		
	70	85	100

T_1	75.29 c	113.96 d	182.80 c
T_2	83.02 a	137.27 a	205.55 ab
T_3	80.66 ab	126.23 bc	197.08 abc
T_4	77.09 bc	118.87 cd	192.08 bc
T_5	83.92 a	133.42 ab	211.23 a
Level of significance	**	**	**
CV (%)	3.71	4.85	5.76

Means in a column followed by different letters differ significantly but with common letters do not differ significantly by DMRT. and** = Significant at 1% levels of probability, respectively.

Germination

There was significant effect of organic and inorganic fertilizers on germination of bitter gourd (Table 5). Maximum germination (73.66%) was obtained from the fertilization of 1 kg compost + 0.5 L Biochar + NPK (20 g urea + 8 g TSP + 15 g MoP) followed by 1 kg compost + 0.5 L cow urine + 0.5 L Biochar + NPK (20 g urea + 8 g TSP + 15 g MoP) (64.20%) that was statistically similar with 0.5 L Biochar + NPK (20 g urea + 8 g TSP + 15 g MoP) (61.21%).All are almost similar with the result of first season treatment. Sankaranarayanan *et al*. (1994) also found that soaking the tamarind seeds in 10% cow urine or in cowdung solution (500 g in 10 litres of water) for 24 h increased the germination percentage from 37% (untreated controls) to 72.6 and 82.8%, respectively.

Table 5. Residual effects cow urine and biochar-based fertilizers on germination and plant height of bitter gourd

Treatment	Germination (%)	Plant height at (cm) at different DAS		
		15 DAS	30 DAS	45 DAS
RT_2	64.20 b	6.33 b	43.10 b	144.68 b
RT_3	61.21 c	5.85 c	40.42 c	137.78 c
RT_5	73.66 a	7.31 a	47.61 a	162.81 a
Level of significance	*	**	**	**
CV (%)	2.20	7.53	7.02	2.83

Means in a column followed by different letters differ significantly, but with common letter(s) do not differ significantly at 5% level of probability by DMRT. * and ** = Significant at 5 and 1% levels of probability, respectively.

Number of leaves

Significant variation in the number of leaves plant^{-1} was observed due to different sources of organic and in organic fertilizers (Table 6). The maximum number of leaves plant^{-1} was obtained from the RT_5 treatment and it was minimum in RT_3 treatment at 15, 30 and 45 DAS.

Table 6. Residual effects of cow urine and biochar-based fertilizers on number of bitter gourd leaf.

Treatment	Number of leaves at at different DAS		
	15 DAS	30 DAS	45 DAS
RT_2	8.55 b	29.78 b	48.44 b
RT_3	6.75 c	26.98 c	42.08 c
RT_5	10.10 a	32.53 a	53.56 a
Level of significance	**	**	**
CV (%)	8.34	6.06	2.92

Means in a column followed by different letters differ significantly but with common letters do not differ significantly by DMRT. ** = Significant at 1% level of probability.

Number of fruit per plant

Significant variation was found in terms of fruit number plant^{-1} due to the application of organic and inorganic fertilizers (Fig 2). Treatment RT_3 where 1 kg compost + 0.5 L biochar + NPK (20 g urea+ 8 g TSP + 15 g MOP) were applied that produced the maximum number of fruit plant^{-1} (4.30, 5.21 and 5.57, respectively). This was statistically similar to T_1 and T_2 treatment where the fertilization had applied 1 kg compost + 0.5 L cow urine + 0.5 L biochar (3.89, 4.99 and 5.11) followed by 0.5 L bc + NPK (20 g urea+ 8 g TSP + 15 g MOP) (2.98, 3.54 and 4.65, respectively). Supporting results were achieved by Hanke (2003) [10] who got the best

results with the use of compost and urine together in spinach (Swiss chard). Increases in crop yield with biochar application have been reported for crops such as cowpea [11], soybean [12], and maize [11 and 13].

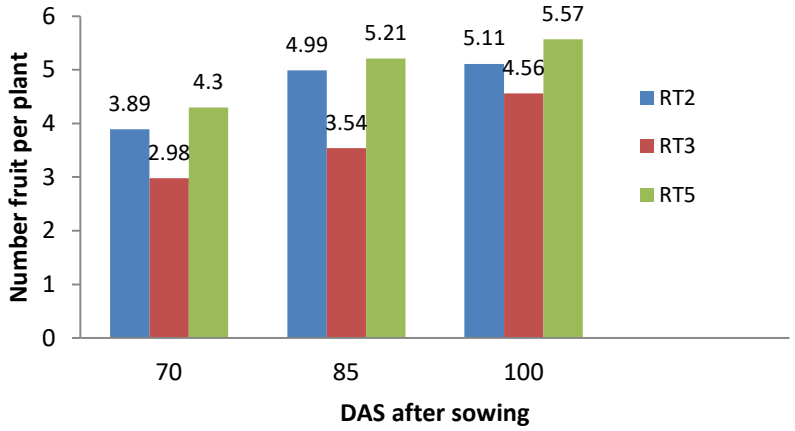

Figure 2: Residual effects of organic and inorganic fertilizers on the number of fruits of the bitter gourd Length of fruit

Organic and inorganic fertilizers had significant role in increasing size (length and width) of fruits (Table 8). At the 70 and 85 DAS, statistically similar longest fruit was obtained from all the treatments. On the contrary, the heaviest fruit (14.04, 18.10, 24.22 cm length and 11.50 cm, 15.71 and 16.55 cm, respectively) was obtained from RT_5 [application of 0.5 L Biochar + NPK (20 g urea + 8 g TSP + 15 g MoP)] at 70, 85 and 100 DAS.

Table 7. Residual effects of organic and inorganic fertilizers on the length and width of fruits of bitter gourd.

Treatment	Length of fruit at (cm) at different DAS			Width width at (g) at different DAS		
	70 DAS	85 DAS	100 DAS	70 DAS	85 DAS	100 DAS
RT_2	13.47 b	15.95 b	22.71 b	9.43 b	11.41 b	13.81 b
RT_3	12.64 b	15.90 b	22.01 b	9.81 b	11.58 b	13.30 b
RT_5	14.05 a	18.10 a	24.22 a	11.49 a	15.71 a	16.55 a
Level of significance	**	**	*	**	**	**
CV (%)	6.69	5.10	7.75	5.74	5.76	3.90

Means in a column followed by different letters differ significantly, but with common letter(s) do not differ significantly at 5% level of probability by DMRT. * and ** = Significant at 5 and 1% levels, respectively.

Weight of fruit

Significant variation in fruit weight was observed due to different sources of organic and inorganic fertilizers (Table 4). The heaviest fruit was obtained from the application of 1 kg compost + 0.5 L biochar + NPK (20 g urea + 8 g TSP + 15 g MoP) at 70 DAS (85.49 g), 85 DAS (135.71 g) and 100 DAS (209.55 g). The maximum weight of fruit in 1 kg compost + 0.5 L biochar + NPK (20 g urea + 8 g TSP + 15 g MoP) might be due to the supply of optimum nutrients that enhanced proper development of fruit. Supporting results were achieved by [14] who got the maximum fruit weight of mango (255.16 g) at 50% application of cow urine and lowest in the control treatment.

Table 7. Residual effects of organic and inorganic fertilizers on the fruits weight of bitter gourd.

Treatment	Fruit weight at (g) at different DAS		
	70 DAS	85DAS	100 DAS
RT_2	79.43 b	132.01 b	203.81 b
RT_3	78.81 c	124.81 c	198.30 c
RT_5	85.49 a	135.71 a	209.55 a
Level of significance	**	**	**
CV (%)	3.74	0.76	0.90

Means in a column followed by different letters differ significantly, but with common letter(s) do not differ significantly at 5% level of probability by DMRT. * and ** = Significant at 5 and 1% levels, respectively.

Based on the above results, it was noted that almost all of the growth and yield contributing characteristics of bitter gourd were best when the plant was cultivated with 2 kg compost+ 0.5 kg bc + NPK (40 g urea + 16 g TSP + 30 g MoP). It also noted that when plants were cultivated in the next season the requirement of fertilizers was 50% less than the first season in sack garden. Almost all of the growth and yield contributing characteristics of bitter gourd were best when the plant was cultivated with 1 kg compost+ 0.5 kg bc + NPK (20 g urea + 8 g TSP + 15 g MoP) for the next season in the same media. However to draw valid conclusion, further research with various varieties of bitter gourd are to be conducted for confirmation of the research.

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